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A Licence Renewal

Renouvellement d'un permis

Ontario Power Generation Inc.

Darlington Nuclear Generating Station

Ontario Power Generation Inc.

Centrale nucléaire de Darlington

Commission Public Hearing – Part 1

Audience publique de la Commission – Partie 1

Scheduled for:

26 March 2025

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Submitted by:

CNSC Staff

Soumis par :

Le personnel de la CCSN

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Summary

This CMD presents information about the following matters of regulatory interest with respect to Ontario Power Generation, herein known as OPG:

- Renewal of the power reactor operating licence (PROL) for the Darlington Nuclear Generating Station (NGS)
- Compliance with the safety and control areas for the safe operation of the facility
- Periodic safety review to identify and implement safety enhancements

CNSC staff recommend the Commission consider taking the following actions:

- Issue, pursuant to section 24 of the *Nuclear Safety and Control Act*, a Darlington NGS PROL authorizing OPG to carry out the activities listed in Part IV of the proposed licence from December 1, 2025 to November 30, 2055.

The following items are attached:

- The proposed PROL 13.00/2055
- The draft licence conditions handbook (LCH)
- The current PROL 13.05/2025

Résumé

Le présent CMD fournit de l’information sur les questions d’ordre réglementaire suivantes concernant Ontario Power Generation, ci-après OPG:

- renouvellement du permis d’exploitation d’un réacteur de puissance pour la centrale nucléaire de Darlington
- conformité avec les domaines de sûreté et de réglementation pour l’exploitation sûre de l’installation
- bilan périodique de la sûreté pour déterminer et mettre en œuvre des améliorations à la sûreté

La Commission pourrait considérer prendre les mesures suivantes :

- Délivrer, conformément à l’article 24 de la *Loi sur la sûreté et la réglementation nucléaires*, un permis d’exploitation pour la centrale de Darlington autorisant OPG à exercer les activités énumérées à la Partie IV du permis proposé, du 1er décembre 2025 au 30 novembre 2055.

Les pièces suivantes sont jointes :

- le permis proposé, PROL 13.00/2055
- l’ébauche du manuel des conditions de permis (MCP)
- le permis actuel, PROL 13.05/2025

Signed/Signé le

21 February 2025 / 21 février 2025

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Alexandre Viktorov, Ph.D.

Director General

Directorate of Power Reactor Regulation

Directeur général

Direction de la réglementation des centrales nucléaires

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Land Acknowledgement

The Darlington site is located on the north shore of Lake Ontario in Clarington, Ontario, 5 kilometers outside the town of Bowmanville and 10 kilometers southeast of Oshawa. The Darlington site resides on lands in which many Indigenous Nations and communities have a vested interest and rights, lying within the lands and waters of the Michi Saagiig Anishinaabeg, the Gunshot Treaty (1877-88), the Williams Treaties (1923), and the Williams Treaties Settlement Agreement (2018).

Plain Language Summary

Ontario Power Generation (OPG) has submitted an application to renew the current power reactor operating licence (PROL) for the Darlington Nuclear Generating Station (Darlington NGS) for a period of 30 years [1]. CNSC staff have assessed the application and present conclusions and recommendations, along with the supporting rationale, to the Commission in this Commission Member Document (CMD).

OPG is the owner and licensed operator of the Darlington NGS, which is located on the north shore of Lake Ontario in Clarington, Ontario, 5km outside the town of Bowmanville and 10km southeast of Oshawa. The Darlington NGS PROL governs four CANDU pressurized heavy water reactors that are rated at 881MWe (megawatts electrical) and a tritium removal facility (TRF). The current PROL is a consolidated licence for both facilities. The PROL was issued on January 1, 2016 and will expire on November 30, 2025.

This CMD outlines the results of staff's assessment of the licence application and supporting documentation, past performance in all safety and control areas (SCAs), future safety improvement commitments and long-term operation considerations, among other areas.

CNSC staff confirmed that OPG submitted an application in accordance with REGDOC-1.1.3, *Licence Application Guide: Licence to Operate a Nuclear Power Plant*. CNSC staff confirmed that the licence application described programs and processes in all SCAs that constitute an adequate licensing basis.

CNSC staff has been continuously verifying and assessing OPG's performance in each SCA throughout the current licensing period and reported the results of the assessments to the Commission during public Commission Meetings for the Regulatory Oversight Report for Nuclear Power Generating Sites every year.

CNSC staff note that there were no serious process system failures, the availability of special safety systems met regulatory requirements, and radiation doses to workers and the public were well below regulatory limits during the current licensing period. CNSC staff confirmed that OPG maintained adequate provisions to protect the public and workers.

OPG's performance throughout the current licensing period demonstrates stable safety performance and indicates that OPG will continue to comply with applicable regulatory requirements throughout the proposed licence period.

CNSC staff confirmed that OPG conducted a periodic safety review (PSR) in accordance with the requirements of REGDOC-2.3.3, *Periodic Safety Reviews*. CNSC staff note that the PSR did not identify any major gaps between the current state of the nuclear power plant and modern requirements.

CNSC staff confirmed that OPG prepared an appropriate integrated implementation plan (IIP) that identifies corrective actions and completion dates for closing the identified gaps.

CNSC staff reviewed OPG's request for a 30-year licence term and determined that the period requested was adequately substantiated.

CNSC staff reviewed OPG's preliminary decommissioning plan (PDP) and confirmed that it meets applicable regulatory requirements. CNSC staff also reviewed the associated financial guarantee and confirmed that adequate funds are available to cover decommissioning costs outlined in the PDP.

CNSC staff conclude that pursuant to section 24 of the *Nuclear Safety and Control Act* (NSCA), OPG is qualified to carry out the activities listed in the proposed licence, and will continue to make adequate provisions for the protection of the environment, the health and safety of persons and the maintenance of national security, and measures required to implement international obligations to which Canada has agreed.

CNSC staff recommend the Commission:

1. Renew the Darlington NGS PROL, authorizing OPG to carry out the licensed activities listed in Part IV of the proposed licence
2. Delegate authority to CNSC staff as set out in section 5.5 of this CMD

Referenced documents in this CMD are available to the public upon request, subject to confidentiality considerations.

CMD STRUCTURE

This Commission Member Document (CMD) is presented in 2 parts.

Part 1 of this CMD includes:

1. an overview of the matter being presented;
2. overall conclusions and overall recommendations;
3. general discussion pertaining to the safety and control areas (SCAs) that are relevant to this submission;
4. discussion about other matters of regulatory interest; and
5. appendices material that complements items 1 through 4.

Part 2 of this CMD provides all available information pertaining directly to the current and proposed licence.

1. Overview

1.1 Background

The Darlington NGS is owned and operated by Ontario Power Generation (OPG). The station is located on the north shore of Lake Ontario in Clarington, Ontario, 5km outside the town of Bowmanville and 10km southeast of Oshawa. The Darlington NGS PROL authorizes operation of four CANDU pressurized heavy water reactors that are rated at 881MWe (megawatts electrical) and a tritium removal facility (TRF). The current PROL is a consolidated licence for both facilities. The PROL was issued on January 1, 2016 and will expire on November 30, 2025.

The required land ownership and controlling information (titles, registration, etc.) have been submitted by OPG previously.

1.2 Highlights

In May 2024, OPG submitted an application [1] for the renewal of the Darlington NGS Power Reactor Operating Licence (PROL) for 30 years. The purpose of this Commission Member Document (CMD) is to provide Canadian Nuclear Safety Commission (CNSC) staff conclusions and recommendations to inform the Commission’s decision on the licence application.

This CMD includes information on CNSC staff review of all safety and control areas (SCAs) with focused highlights on:

1. programs and processes that constitute the licensing basis
2. periodic safety review findings and associated Integrated Implementation Plans (IIP) actions for the implementation of safety enhancements
3. performance assessments in all SCAs during the current licensing period
4. long-term operation considerations
5. engagement with the public and Indigenous Nations and communities

1.3 Overall Conclusions

CNSC staff reviewed OPG's licence application and supporting documents and confirmed that OPG's application meets the applicable regulatory requirements and establishes an adequate licensing basis for continued operation.

CNSC staff assessed OPG's performance during the current licence term to confirm compliance with applicable requirements. CNSC staff confirmed that OPG's performance was satisfactory and stable throughout the licensing period. CNSC staff note that OPG's historical performance suggests that they will be able to comply with applicable regulatory requirements.

CNSC staff note that OPG has committed through the IIP [2] to implement safety enhancements, to ensure the safety of the facility to a level approaching that of a modern nuclear power plant and to ensure continued safe operation.

Processes are established to inform the Commission of licensee's performance, changes in safety, security and safeguards provisions and of specific events.

Historically, the Commission credited the CNSC's sound regulatory framework, comprehensive regulatory oversight and reporting practices and safe industry performance before transitioning to licensing periods of five and subsequently, ten years. CNSC staff note that the current regulatory framework is robust to assure adequate regulatory oversight over the proposed licence period.

During the future licensing period, Indigenous Nations and communities, and the public may raise issues and concerns and participate through multiple channels that currently exist, such as long-term engagement and collaboration with CNSC and the proponent, the annual NPGS Regulatory Oversight Report process, and participation in environmental monitoring programs. Provision of funding facilitates Indigenous Nations and communities participation in CNSC processes. In fact, Indigenous Nations and communities and the public can bring their concerns to the Commission's, as well as the staff's attention at any time.

CNSC staff's review confirmed that OPG has established adequate safety and control measures to meet all applicable regulatory requirements.

OPG's PDP was last updated and presented to the Commission in 2022. CNSC staff verified that OPG's PDP complies with requirements. CNSC staff reviewed the associated financial guarantee and confirmed that adequate funds are available to cover decommissioning costs outlined in the PDP.

1.4 Overall Recommendations

CNSC staff provide the following recommendation regarding the duration of the licence period:

> Accept OPG's proposed licence length of 30 years. Introduce a new licence condition for OPG to conduct ongoing Indigenous engagement activities. The new licence condition would be a notable change to the licensing basis and ensure that OPG will continue engagement with Indigenous Nations and communities throughout the licence period.

CNSC staff recommend the following to the Commission:

1. **Conclude,** pursuant to paragraphs 24(4)(a) and (b) of the *Nuclear Safety and Control Act* **(NSCA) in that the licensee/applicant:**

   a) **Is qualified** to carry on the activity that the licence will authorize the licensee to carry on; and

   b) **Will, in carrying out that activity make adequate provision** for the protection of the environment, the health and safety of persons and the maintenance of national security and measures required to implement international obligations to which Canada has agreed.

2. **Renew** the Darlington NGS PROL authorizing OPG to carry out the licenced activities listed in part IV of the proposed licence
3. **Delegate** the authority to the CNSC staff as set out in section 5.6 of this CMD

2. Matters for Consideration

2.1 Regulatory and Technical Basis

The CNSC has established a mature regulatory framework that sets comprehensive, robust and modern requirements for the safe operation of nuclear power plants. The regulatory framework consists of the *Nuclear Safety and Control Act* (NSCA) and associated regulations, the licence and associated licence conditions handbook and regulatory documents and international standards referenced in the LCH.

For a nuclear power plant facility, the key requirements come directly from the following:

- *Nuclear Safety and Control Act* (NSCA)
- *General Nuclear Safety and Control Regulations* (GNSCR)
- *Radiation Protection Regulations* (RPR)
- *Class I Nuclear Facilities Regulations*
- *Class II Nuclear Facilities and Prescribed Equipment Regulations*
- *Nuclear Substances and Radiation Device Regulations*

- *Packaging and Transport of Nuclear Substances Regulations, 2015*
- *Nuclear Security Regulations* (NSR)
- *Canadian Nuclear Safety Commission Cost Recovery Fees Regulations*
- *Administrative Monetary Penalties Regulations*
- *Nuclear Non-Proliferation Import and Export Control Regulations*
- *Canadian Nuclear Safety Commission Rules of Procedure*

The proposed Darlington NGS PROL sets conditions that OPG must comply with. The associated LCH, included in Part Two of this CMD, describes the compliance verification criteria and guidance on how to meet the licence conditions, including international guidance documents, national and international standards and CNSC regulatory documents.

The regulatory and technical basis for the matters discussed in this CMD are provided in sections 2, 3, 4, 5 and Appendix B.1 in this document. The regulatory and technical bases, along with OPGs performance history, described in Section 3, and the rationale in Section 2.7 form the basis for CNSC staff's licensing period recommendation.

2.2 Relevant Safety and Control Areas

The licensing assessment and compliance oversight of any licensed facility or activity is structured according to a standard set of safety and control areas (SCAs).

The CNSC implements an SCA framework that has 14 SCAs, which are grouped into three primary functional areas: Management, Facility and Equipment, and Core Processes. Each SCA addresses an aspect of the overall safety profile of a proposed set of activities and is sub-divided into specific areas (SpAs) that define the key components of each SCA.

The SCA framework establishes comprehensive expectations for OPG to meet safety objectives, and for CNSC staff to continuously assess their performance against these objectives, to protect health, safety, security and the environment in accordance with regulatory requirements.

All 14 SCAs are relevant in this licence renewal application review. It should be noted that the SCA framework does not limit the CNSC in its conduct of regulatory oversight activities. Additional topics or safety areas may be added, as needed, at any time.

See Addendum C, "Safety and Control Area Framework", for further information about SCAs and Addendum C.2, "Specific Areas for this Facility Type", for further information on the SCAs and SpAs that are relevant to nuclear power plant facilities.

2.3 Major Project Status

Refurbishment

Refurbishment involves the replacement of key reactor parts, such as pressure tubes, and the modernizing and enhancement of major equipment and systems, which support long term, safe operation of the plant. Throughout OPG's refurbishment projects, CNSC staff conducted compliance verification activities as established in the Darlington Refurbishment Project Multi-Unit Compliance Plan and confirmed that OPG was in compliance with regulatory requirements.

Unit 2: Darlington NGS began the refurbishment outage of Unit 2 in October 2016. The final Regulatory Hold Point (RHP) was removed, and the Unit returned to commercial operation in June 2020.

Unit 3: Darlington NGS began the refurbishment outage of Unit 3 in September of 2020. The final RHP was removed, and the unit returned to commercial operation in July 2023.

Unit 1: Darlington NGS began the refurbishment outage of Unit 1 in February 2022. The final hold point was removed, and Unit 1 returned to commercial operation in November 2024.

Unit 4: Darlington NGS began the refurbishment outage of Unit 4 in July 2023 after Unit 3 was returned to service. The request for removal of RHP1 (approval to load fuel) is anticipated for September 2025.

Isotope Production

Molybdenum-99

In fall of 2021 the Commission amended OPG's PROL to include the production of Molybdenum-99 (Mo-99) through the use of a new Isotope Irradiation System (IIS) (also specifically known as the target delivery system (TDS); the Mo-99 IIS / TDS) [3.

Installation and commissioning activities commenced during 2022 with the successful completion and closure of two Regulatory Hold Points (RHPs) [4,5]. During 2023 and 2024, OPG progressed through activities related to fulfilling its final regulatory commitments established during the licence review process. Specifically, OPG provided confirmatory submissions to CNSC staff that included final commissioning documentation, and available for service (AFS) declarations. The TDS was declared available for service in September 2024.

Currently, OPG has continued operations to seed and harvest Mo-99 as part of normal operations, and CNSC staff have started performing compliance oversight of the system and its operations as part of CNSC's staff standard regulatory oversight baseline activities.

Cobalt-60

In the summer of 2024, the Commission amended OPG's PROL to authorize the production of Cobalt-60 (Co-60) [6]. OPG's first harvest of Co-60 is expected to occur in 2028 when Unit 1 enters a planned outage, having already installed the

Co-60 rods during the Unit 1 refurbishment outage [7]. CNSC oversight of activities related to Co-60 are being conducted under the standard baseline of compliance oversight activities. OPG continues to work towards the preparation of deliverables committed to during the licensing phase of the project. OPG's regulatory commitments for these operational related documents are being tracked by CNSC staff, and are required to be finalized and provided to CNSC staff before they are needed to support Co-60 harvesting and packaging activities.

2.4 Matters of Regulatory Interest

The following table identifies matters that are relevant to this application beyond the SCAs.

Table 2: Matters of regulatory interest addressed in this CMD

Matters of Regulatory Interest
Indigenous Consultation and Engagement
Public Information and Disclosure
Cost Recovery
Financial Guarantees
Nuclear Liability Insurance
Fisheries Act Authorization
Nuclear Substances and Prescribed Equipment
Delegation of Authority

These matters of regulatory interest are discussed in sections 4 and 5.

2.5 Environmental Reviews

CNSC staff reviewed the licence renewal application for the Darlington NGS to determine if an environmental review was required and if so, the type of environmental review that would be required. As part of this process, CNSC staff assessed whether a federal lands review under the *Impact Assessment Act* (IAA) is required. For this licence renewal application, a federal lands review is not required because the application does not include activities that meet the definition of a project on federal lands.

CNSC staff conduct Environmental Protection Reviews (EPR) for all licence applications with potential environmental interactions, in accordance with the CNSC mandate under the *NSCA* and associated regulations. The EPR informs the Commission's conclusion on whether the proposal provides adequate protection of the environment and the health of people.

An EPR (found in Part 2 of this CMD) was conducted for this licence renewal application. CNSC staff's assessment included a review of OPG's licence renewal application and supporting documents, including OPG's 2020 ERA [8] and addendum, annual compliance monitoring reports, environmental and groundwater monitoring programs, various health studies, the Preliminary Decommissioning Plan and past environmental performance for the facility. CNSC staff determined that the information provided by OPG regarding environmental protection is sufficient to meet the applicable regulatory requirements under the NSCA and associated regulations.

CNSC staff will continue to verify, through ongoing licensing and compliance verification activities and reviews, that the environment and the health of persons are protected and will continue to be protected over the proposed licence period.

2.6 Highlights of OPG's Licence Application

REGDOC-1.1.3, *Licence Application Guide: Licence to Operate a Nuclear Power Plant*, outlines the requirements and expectations for applying for a licence to operate a nuclear power plant (NPP). A licence renewal application must demonstrate due consideration to establishing an adequate and appropriate licensing basis that meets regulatory requirements, such as those outlined in the *Nuclear Safety and Control Act* (NSCA), *General Nuclear Safety and Control Regulations* (GNSCR), *Class I Nuclear Facilities Regulations* and relevant modern codes and standards.

OPG submitted an application, with supporting information, for a power reactor operating licence renewal in accordance with REGDOC-1.1.3. CNSC staff reviewed OPG's licence renewal application and following a sufficiency review where CNSC staff requested additional information [9] [10] [11], confirmed that it was complete and contained sufficient supporting information for CNSC staff to conduct a fulsome adequacy review of the application, as per the requirements in the NSCA, GNSCR and Class I Regulations as mentioned above. This review allowed CNSC staff to confirm that an adequate licensing basis has been established in each SCA to support continued operations.

CNSC staff note that in the licence application, OPG:

- States that nuclear safety is their priority; ensuring that personnel, the public and the environment are protected through maintaining the highest standards to operate Darlington NGS,
- Commits to ensuring a healthy safety culture, which is a foundation of their performance,
- Commits to invest in staff and ensure they are qualified and competent to operate the Darlington NGS,
- Commits to invest in and improve safety at Darlington NGS,
- Commits to and values open and transparent reviews of Darlington NGS processes,

- Outlines their programs in place to ensure that Systems, Structures and Components (SSCs) important to safety are fit for service, are effectively maintained and to ensure that these SSCs continue to provide safe performance over the life of the Darlington NGS,
- Demonstrates that processes such as Equipment Reliability, and System Health Monitoring are in place to assure that Darlington NGS systems and components are regularly reviewed, and that appropriate maintenance and testing is completed,
- Commits to invest in Darlington NGS to ensure it continues to meet or exceed industry standards to ensure continued long-term safe and reliable operations.

In the licence renewal application [1], OPG provided references to programmatic and process documents that demonstrate how they intend to operate the Darlington NGS.

CNSC staff have determined that OPG's licence renewal application for the continued operation of the Darlington NGS has sufficient information that meets regulatory requirements and demonstrates that OPG is qualified to continue undertaking the licensed activity and will make adequate provision to protect the health, safety and security of persons and the environment.

2.7 Periodic Safety Review

In early 2020, OPG notified CNSC staff [12] of their intent to conduct a PSR, in accordance with the PROL 13.04/2025 licence condition 3.4 and *REGDOC-2.3.3, Periodic Safety Reviews*, to support their next licence application.

The CNSC, in REGDOC 2.3.3 sets the objectives of a periodic safety review (PSR) to be to determine:

- The extent to which the facility conforms to modern codes, standards and practices,
- The extent to which the licensing basis remains valid for the next licensing period,
- The adequacy and effectiveness of the programs and the structures, systems and components (SSCs) in place to ensure plant safety,
- The improvements to be implemented to resolve any gaps identified in the review and timelines for their implementation.

During 2020-2023, OPG submitted the required PSR documentation, which CNSC staff accepted upon completion of a comprehensive review. The PSR-IIP was submitted in September 2023 [13] and contains a total of 17 actions for the period of 2025-2035. The majority of actions and improvements are program-related rather than pertaining to physical changes and/or upgrades to the facility itself.

CNSC staff have reviewed a number of the PSR submissions and accepted OPG's proposed Integrated Implementation Plan (PSR-IIP)[13]. The PSR-IIP is applicable for a period of post-refurbishment operations at Darlington NGS for 2025-2035, should the operating licence be renewed. CNSC staff find that OPG's latest PSR meets modern codes and standards and will allow for continued safe operation over the defined PSR period until the next comprehensive review. CNSC staff accepted the PSR-IIP in March 2024 [14]. Section 3 of this CMD lists which SCAs the 17 actions fall under.

Licence condition 3.4 in the proposed PROL pertains to conducting future PSRs. Compliance verification criteria for the PSR is detailed in Section 3.4 of the proposed LCH. The CNSC requires OPG to conduct a PSR every 10 years.

In summary, Ontario Power Generation conducted a PSR for the Darlington NGS in accordance with regulatory requirements.

2.8 Licensing Period

In their licence application, OPG has requested a 30-year operating licence. All NPPs in Canada are currently operating with a 10-year licence.

The Commission has flexibility regarding the establishment of licence periods and licence conditions as per section 26 of the NSCA. CNSC staff note that there is no set licence duration identified in the applicable Acts and Regulations. Recently, the Commission has granted PROLs for a duration of up to 10 years. Other types of nuclear facilities have been granted even longer licences. It is important to note that licensing period is a Commission decision. Regulatory oversight is conducted irrespective of licence period and is flexible to accommodate changes due emerging trends or specific concerns. The Commission in its recent decision to grant a 10-year licence to the Point Lepreau Nuclear Generating Station noted "that providing opportunities for intervenors to voice their views and for the Commission to hear them is necessary to sustain a dialogue with members of the public and Indigenous Nations and communities", and therefore recommended a 10-year licence with a public proceeding at the mid point to provide such opportunities. Staff in developing their recommendations considered this experience. This experience was also taken into account, in recent Commission decisions, where both the Key Lake and McArthur River uranium mines were granted 20-year licences.

CNSC staff's basis for the support of the requested licence period, considered the criteria outlined originally in CMD 02-M12 [15], New Staff Approach to Recommending Licence Periods. These criteria are elaborated in this section as follows:

- International Benchmarking
- Mature Canadian regulatory framework and regulatory oversight
- Transparency and Open Communication

- Input from Indigenous Nations and Communities

OPG’s basis for a 30-year licence period

International Benchmarking

CNSC staff considered international precedence and benchmarking regarding licence terms. CNSC staff noted that longer licence terms are implemented in conjunction with regulatory control measures for managing oversight of the long-term operation of facilities.

These control measures are mainly comprehensive reviews, including periodic evaluations of the overall plant design as per the PSR framework recommended by the International Atomic Energy Agency (IAEA) for nuclear power plants, and continuous monitoring of operational performance [16,17].

The Atomic Energy Act of the United States Nuclear Regulatory Commission (U.S. NRC) authorizes licences for commercial power reactors to operate for up to 40 years. Research by the U.S. NRC established a comprehensive program for NPP aging that concluded most aging issues do not pose a risk that would prevent them from operating additional years beyond their original 40-year licence period. These licences can be renewed for an additional 20 years at a time. The licence renewal and review process in the United States provides continued assurance that the current licensing basis of each NPP will maintain an acceptable level of safety for the period of extended operation [18].

CNSC staff observed that some regulators from Organization for Economic Co-operation and Development (OECD) countries, such as the Office for Nuclear Regulation (United Kingdom), issues licences for the lifetime of the facility. For countries that do not issue plant lifetime licences, the licence periods range from 10 to 40 years [19]. Licence periods in selected countries are outlined in Table 3 below.

Table 3: Licence periods and Periodic Safety Review requirements for nuclear power reactors

Country	Licence period	PSR frequency
Canada	10 years	every 10 years
France	plant lifetime	every 10 years
South Korea	30 years, 40 years and 60 years	every 10 years
United Kingdom	plant lifetime	every 10 years
United States	40 years, with 20-year renewal option	Regulatory oversight coupled with the back fitting rule as requested by the licensees

Regulators use comprehensive PSRs to gain insights into safety issues affecting the continued operation of a facility and to show that NPPs meet modern codes and standards and will continue to operate safely over the defined period of continued operation until the next comprehensive review.

The prevailing international experience and feedback suggests that the duration of a licence is largely a legal/administrative matter and has no bearing on safety performance [20].

The mature Canadian regulatory framework and regulatory oversight

The CNSC predecessor, the Atomic Energy and Control Board (AECB) issued licences which were valid for two years, or one year if performance was lacking. The licensing term was used as a tool for regulating in the absence of a fully developed and mature regulatory program and framework, by adding specific requirements to the licence. As regulatory experience has grown, this was found to be an ineffective way of regulating facilities and was not in line with international best practices.

With the implementation of the NSCA, which created the CNSC replacing the AECB in the year 2000, the licensing process became more streamlined and systematic. The CNSC moved towards regulating NPP facilities by assessing their established programs and processes, and more specifically, by conducting systematic reviews in all safety and control areas.

Two significant developments that strengthened the CNSC oversight capability were (1) the use of the licence conditions handbook (LCH) to outline compliance verification criteria and guidance on how to meet the licence conditions, and (2) establishment of a requirement to conduct a Periodic Safety Review (PSR), resulting in a comprehensive, in-depth assessment of safety against the modern standards.

The current CNSC regulatory framework, regulatory oversight and regulatory practices are characterized by the following:

1. The CNSC uses an SCA framework that provides a common approach that ensures comprehensive and consistent oversight of licensed activities and facilitates streamlined assessments, recommendations and reporting to the Commission.

   The use of a consistent framework promotes improved communications among CNSC staff, licensees, the Commission, members of Indigenous Nations and communities and members of the public.

   It should be noted that the SCA framework does not limit the CNSC in its conduct of regulator oversight activities. Additional topics or safety areas may be added, as needed, at any time.

2. The CNSC requires that NPP licensees conduct PSRs and implement the associated improvement plan, in accordance with REGDOC-2.3.3, *Periodic Safety Reviews,* every 10 years, to support continued long-term operation.

3. NPP licensees are required to conduct an ERA every 5 years, in accordance with REGDOC-2.9.1, *Environmental Protection:*

Environmental Principles, Assessments and Protection Measures. REGDOC-2.91 includes requirements to implement provisions to ensure the adequate protection of the environment and the health, safety and security of persons.

4. CNSC staff publish an Environmental Protection Report (EPR) every 5 years that includes engagement with Indigenous Nations and communities and interested members of the public.
5. NPP licensees are required to follow reporting requirements set out in REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants*. Reporting includes event reports for situations or events of higher safety significance and that may require short-term action by the CNSC.
6. NPP licensees are required to update the Probabilistic Safety Assessment every 5 years in accordance with REGDOC-2.4.2, *Probabilistic Safety Assessment (PSA) for Reactor Facilities*. This report outlines the models and analyses that have been appropriately reviewed and revised and that take into account the most up-to-date and relevant information, methods and revision summary with the differences between the existing probabilistic safety assessments referenced in the licensing basis and updated probabilistic safety assessments. The revision summary is publicly available.
7. NPP licensees are required to provide an update to the Preliminary Decommissioning Plan every 5 years in accordance with REGDOC-2.11.2, *Decommissioning*.
8. The CNSC has a whistleblower program, which ensures that anyone can report safety concerns to the regulator without fear of retaliation, providing CNSC staff with a valuable source of information.
9. The CNSC's flexible compliance verification activities which aims to verify compliance with requirements and a graduated enforcement strategy, which may include shutting down of a facility, if necessary.

Transparency and Open Communication

There are multiple opportunities for CNSC staff to bring matters of interest to the Commission's attention.

1. **Regulatory Oversight Report** - CNSC staff summarize the outcomes of regulatory oversight and highlights of the safety performance of Canadian nuclear power plants, and their associated waste management facilities in the annual Regulatory Oversight Report (ROR) for Nuclear Power Generating Sites.

   This forum also allows licensees to provide supplemental information as required. The ROR process encourages and facilitates interventions by members of Indigenous Nations and communities and the public.

2. **Status Report on Power Reactors updates** – CNSC staff deliver these at Commission meetings. They provide a vehicle for CNSC staff to present

routine updates throughout the year. These updates provide the Commission information on the current operating status of power reactors and any issues that nuclear generating stations may be encountering. Licensees are also present at these updates to answer any questions from the Commission.

3. **Event Initial Reports** - CNSC staff event initial reports (EIR) describe any potentially serious issues that the Commission should be made aware of. This reporting mechanism is considered as early notification of significant events to the Commission Members and informs them on the situation, impact and the status of controls in place to ensure safety and security of a nuclear facility.
4. **Licence amendments** - Should a licensee seek a change in the scope of their authorized activities or significantly modify safety, security and safeguards provisions, a licence amendment would be required. This would trigger a formal process involving staff providing recommendations to the Commission and, frequently, opportunities for public input.

There are also multiple avenues for CNSC staff to share information with Indigenous Nations and communities and the public, irrespective of the licence period, aside from Commission hearings and meetings.

1. **Open Government website** – this site allows CNSC staff to proactively share and provide details on all information which is publicly available, including projects such as Darlington relicensing and datasets, such as derived release limits.
2. **Independent Environmental Monitoring Program** – the CNSC maintains the IEMP to build Indigenous and public trust in the CNSC’s regulation of the nuclear industry, via an independent, technical and accessible environmental sampling program around nuclear facilities, with results available online.
3. **CNSC public website** – the CNSC public website contains up to date news on Commission decisions, events at nuclear facilities and articles of interest. It also provides access to the acts and regulations the CNSC uses to regulate nuclear activity.
4. **Radiological Monitoring Networks** – there are several networks around Canada that monitor radiation on a real-time basis, such as the Fixed Point Surveillance Network and the Canadian Radiological Monitoring Network that publish their datasets online.
5. **Educational Outreach** – such as hosting workshops, virtually and in the community, organizing tours of the nuclear facilities and participating in school programs to help demystify nuclear technology.

Additionally, the CNSC, and the Canadian nuclear industry as a whole, are subject to periodic international third-party reviews, outcomes of which are published publicly. These include audits such as the IAEA’s Integrated Regulatory Review Service (2009, 2011, 2019, 2024), the Emergency

Preparedness Review Service (2019, 2023) and the International Physical Protection Advisory Service (2015). Canada is also signatory to Conventions that evaluate the Canadian nuclear sector's performance, such as the Convention on Nuclear Safety and the Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management that take place every three years. The reports from all of these can be found on the CNSC website.

Input from Indigenous Nations and Communities

As per CNSC's commitment to meaningfully consider and address Indigenous Nations and communities concerns, staff's recommendation must, and does consider feedback raised by Indigenous Nations and communities with established or potential rights pertaining to lands and waters in relation to the facility and the expected and/or potential impacts of the proposed activities. The Darlington site resides on lands in which many Indigenous Nations and communities have a vested interest and rights, lying within the lands and waters of the Michi Saagiig Anishinaabeg, the Gunshot Treaty (1877-88), the Williams Treaties (1923), and the Williams Treaties Settlement Agreement (2018).

During engagement completed for this licence renewal application, Hiawatha First Nation and Curve Lake First Nation both raised concerns regarding the length of the licence OPG requested. Specific concerns raised were related to (a) the lack of ability to voice concerns to the Commission directly as part of a decision-making process and self-determination in relation to the project, (b) whether OPG would continue engagement and (c) how proper oversight and engagement would be maintained without regular re-licensing.

With the recommendation of a longer licencing term, CNSC staff acknowledge there is a risk of eroded trust and relationships with Indigenous Nations and communities and the public, the same concern as was seen with the re-licensing of the Point Lepreau Nuclear Power Plant in 2022 and Cameco's McArthur River/Key Lake uranium mine and mill in 2023 where staff supported 20-year terms.

In response to these concerns, CNSC staff highlighted there are multiple avenues through the existing relationship with the CNSC and the proponent to bring forth concerns. CNSC staff also emphasize that there is the ability to raise concerns at any time directly to CNSC staff and the Commission in written communication. It is crucial to keep in mind that the Commission are free to amend, suspend or revoke a licence at any time, in response to any concerns raised by the Indigenous Nations and Communities, the public or other interested parties.

Furthermore, CNSC staff reiterated that we are committed to working to address any issues and concerns as they might arise throughout the life cycle of the Darlington NGS, as there are opportunities for addressing concerns through the CNSC's oversight and ongoing engagement. One example of an opportunity is the inclusion of interested Indigenous Nations and communities in OPG's and CNSC environmental monitoring programs to reflect their knowledge and perspectives. In addition, Indigenous Nations and communities can intervene in both writing and orally as part of the annual NPGS Regulatory Oversight Report (ROR) Public

Commission meeting, which includes reporting on the performance of the Darlington NGS. Should such an intervention warrant an action, the Commission can make a licensing decision at any time. CNSC staff remain committed to collaborating with both CLFN and HFN, and any other interested Indigenous Nation and community, to address their concerns and will continue to provide updates on the Darlington NGS through regular meetings under the Terms of Reference for long-term engagement and regular meetings that CNSC staff have with both HFN and CLFN.

It is important to state that CNSC staff do not expect any new impacts to Indigenous and treaty rights as there are no proposed changes to the licensing basis that would lead to new potential impacts on rights. Should there be a request for a change in the licensed activities, thus would trigger a licence amendment process and create opportunities for consultation activities interventions as part of a public Commission hearing process.

On concerns related to addressing the Commission directly as part of a decision-making process, CNSC staff notes that Indigenous Nations and communities, and the public may raise issues and concerns and participate through channels that currently exist, such as long-term engagement and regular meetings with CNSC staff as well as collaboration with CNSC and OPG, the annual NPGS ROR Commission meeting, participation in environmental monitoring programs, and provision of funding to support Indigenous Nations and communities in participation in CNSC processes. These channels demonstrate that the CNSC is committed to listening actively and implementing feedback heard from Indigenous Nations which is an expectation as set out by the United Nations Declaration on the Rights of Indigenous Peoples.

To reflect the evolving and growing recognition of the important of engagement, CNSC staff recommend the inclusion of a licence condition requiring OPG to conduct ongoing Indigenous engagement activities. A similar licence condition has been included in the Staff's Supplemental 24-H3.B CMD for OPG's BWRX-300 Licence to Construct application.

The new licence condition would be a notable change to the licensing basis, and would be the first licence condition of its kind for an operating Canadian NPP. This licence condition would ensure opportunities for Indigenous concerns to be heard throughout the licence period.

Regardless of the licensing length, CNSC staff remain committed to building long-term relationships and ongoing engagement and collaboration with Indigenous Nations and communities who have interest in CNSC-regulated facilities within their traditional and/or treaty territories.

OPG's basis for a 30-year licence period

In their licence renewal application, OPG provided the following justifications in support of the request for a 30-year licensing term:

1. The renewed licence will differ very little from the current licence and contain the standard licence conditions. The key difference between the current licence and the proposed licence is the licensing term.
2. There would be no new authorized activities in the renewed licence. There would be no major activities (e.g. Refurbishment) being conducted throughout the 30-year proposed term. OPG would be required to seek Commission approval before proceeding with any changes to the licensed activities or licensing basis, regardless of licence term.
3. CNSC's staff regulatory oversight and control is maintained regardless of the licensing term.
4. A decrease in safety performance or a significant event would be reported to the Commission through established reporting mechanisms.
5. The Commission has the right to revoke or suspect the licence at any time, including at the request of OPG.
6. The schedule for OPG's PSR is every 10 years which provides 3 IIPs in that time.
7. OPG has committed to continuous engagement with the surrounding Indigenous Nations and communities.
8. OPG will have completed refurbishing all four units by 2026 and has established aging management and periodic inspection programs to monitor and trend the performance of pressure tubes and all pressure boundary components important to safe operation and are required to take corrective actions to maintain established safety margins over the proposed 30-year operating period.

Conclusion

Prevailing international experience and feedback indicate licence durations much longer than the historic Canadian practice.

OPG's performance throughout the current licensing period, as detailed in sections 3, 4 and 5 of this CMD demonstrates stable safety performance and provides evidence that OPG is qualified and will be able to comply with applicable regulatory requirements throughout the future operation. Processes are established to inform the Commission of licensee's performance, changes in safety, security and safeguards provisions and of specific events.

The Commission has credited the CNSC's sound regulatory framework, comprehensive regulatory oversight and reporting practices and safe industry performance before transitioning to licensing periods of five and subsequently, ten years. The mature regulatory framework is robust to assure adequate regulatory oversight over longer licence periods.

Indigenous Nations and communities feedback was taken into consideration when putting forward and selecting options for CNSC licence term recommendations. Longer license periods have also been considered in terms of the impact on CNSC staff resources and knowledge management and were not found to have significant negative impacts.

Therefore, CNSC staff provide the following recommendation regarding the duration of the licence period:

> Accept OPG's proposed licence length of 30 years. Introduce a new licence condition for OPG to conduct ongoing Indigenous engagement activities. The new licence condition would be a notable change to the licensing basis and ensure that OPG will continue engagement with Indigenous Nations and communities throughout the licence period.

3. General Assessment of SCAs

In developing recommendations regarding the application for a licence renewal, CNSC staff review and assess an applicant's proposed safety measures and controls, and as applicable, a licensee's past performance in each SCA. Of note, SCA ratings for 2024 were unavailable at the time of the writing of this CMD.

The specific areas that comprise the SCAs for this facility type are identified in Appendix C, section C.2. If specific areas are not listed for a given SCA in a relevant subsection of section 3, then a decision has been made to encompass them in an overall approach to that SCA. Included with each SCA in Section 3 is also a proposed improvements section, which describes activities detailed by OPG in their licence application to show commitment to safety improvement over the requested licence period.

3.1 Management System

The specific areas that comprise this SCA include:

- Management system
- Organization
- Performance assessment, improvement and management review
- Operating experience
- Change management
- Safety culture
- Configuration management
- Records management
- Management of contractors
- Business continuity

3.1.1 Assessment of Licence Application

In accordance with GNSCR General Application Requirements, subsection 3.(1.1), CNSC staff conducted a completeness check to verify that programs and topic areas applicable to the Management System SCA had sufficient supporting documentation referenced in OPGs application. This documentation also had to be sufficiently detailed to describe the nature of the safety and control measures relevant to applicable Management System topic areas. Some topics relevant to this SCA include:

- Nuclear Management System / Nuclear Safety Policy
- Managed Systems / Records and Document Control
- Business Planning / Nuclear Organization / Organizational Change Control / Contractor Management Program
- Nuclear Safety Oversight / Independent Assessment / Nuclear Safety Culture Assessment

Section 2.1, "Management System" of OPGs application [1] gives an overview of the specific programs linked to this SCA. Within each program there are associated references to the licensee process documents. The process documents detail the input and outputs to an adequate technical basis supporting the application and CNSC staff found that it met the requirements of the *Class I Nuclear Facilities Regulations* and the expectations outlined in *REGDOC-1.1.3, Licence Application Guide: Licence to Operate a Nuclear Power Plant* [Appendix B.2][21].

Following the sufficiency review, CNSC staff confirmed that the programs referenced in OPGs application demonstrated that an adequate technical basis has been established as relevant to the management system SCA; and confirmed that the programs within this SCA are adequate and effective to support the continued and safe operation of the plant.

3.1.2 Proposed Improvements

OPG details their plans to upgrade and modernize their cyber security program data protection as well as the security document access process during the next licensing period, as detailed in Section 2.1.7 of their application. This section also mentions that projects are underway to reduce the amount of paper records in vaults and to digitize them for ease of access. No IIP action items were raised related to this SCA.

3.1.3 Trends

The following table indicates the rating trends for the Management System SCA over the current licensing period:

TRENDS FOR MANAGEMENT SYSTEM				
Overall Compliance Ratings				
2016	**2017**	**2018**	**2019**	**2020**
SA	SA	SA	SA	SA
2021	**2022**	**2023**	**2024**	
SA	SA	SA	N/A	
Comments				

OPG continues to perform satisfactorily in this SCA. CNSC staff conclude that OPG's management system meets regulatory requirements.

3.1.4 Performance

Management system

OPG has a management system that is maintained and improved in accordance with CNSC regulatory requirements and the requirements of CSA N286-12, *Management system requirements for nuclear facilities*.

OPG's management system is documented in N-CHAR-AS-002, Nuclear Management System (the charter) that takes authority from N-POL-0001, Nuclear Safety & Security Policy, established by OPG's board of Directors. OPG's charter provides the framework for programs and processes that covers the licensed activities. OPG's Nuclear Safety & Security Policy defines the Chief Nuclear Officer (CNO) to be accountable for establishing a management system that fosters nuclear safety and security as the overriding priority.

CNSC staff conclude that the OPG Management System at the Darlington site has met the applicable regulatory requirements and confirm that its performance has been satisfactory over the licensing period. CNSC staff will continue to monitor the performance of OPG Management System through compliance verification activities to ensure it continues to meet the regulatory requirements.

Organization

CNSC staff review annual organizational update submissions and roles & responsibilities during compliance verification activities to ensure they meet regulatory requirements.

CNSC staff determined that OPG's organizational structure is adequately defined and roles and responsibilities are documented. CNSC staff have also established meetings with the licensee leadership to promote awareness of their responsibilities for safety. Based on inspections and compliance assessments conducted during the licence period, CNSC staff confirmed compliance of this specific area with applicable regulatory requirements.

Performance, assessment, improvement and management review

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

The OPG audit program includes the review of all of the programs in their management system including programs that are maintained and implemented by the corporate business unit. The OPG audit program frequency is based on program risk analysis. Some programs are audited annually, others on a three-year and five-year audit frequency. The selection of program elements to be assessed is also based on a risk assessment. The OPG self-assessment process is implemented by first line management to senior management. The structure of this process allows earlier detection of minor issues before they become major. Both the audit and self-assessment programs are in compliance with the requirements of CSA N286-12.

CNSC will continue to monitor OPG's Performance, Assessment, Improvement and Management Review during the compliance verification activities to ensure it meets the regulatory and CSA N286-12 requirements.

Operating Experience (OPEX)

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

Change Management

Change management encompasses changes to the OPG organizational design procedure, to the information management program and to the configuration management process including engineering change control and design management programs.

Changes made to the organization, processes, programs, designs, structures, systems, components, equipment, materials, software and documents are managed in accordance with approved change processes. Changes are tested, reviewed and approved before they are implemented.

During compliance verification activities, CNSC staff verified that changes are controlled and carried out as per OPG governance documentation and CNSC staff will continue to monitor the implementation of OPG changes.

Safety Culture

A healthy safety culture is a key factor in reducing the likelihood of safety-related events and mitigating their potential impact, and in continually improving safety performance. REGDOC-2.1.2, *Safety Culture* provides guidance to licensees on monitoring and assessing safety culture. Monitoring of safety culture provides insights as to how safety manifests itself in everyday operations. Assessing safety culture is a planned process to better understand how the organization performs its work, by collecting and analyzing data through various methods. OPG procedure N-PROC-AS-0077, Nuclear Safety and Security Culture Assessment, outlines the process by which safety culture self-assessment is to occur. The OPG procedure is based on industry best practice documented in NEI 09-07, Fostering a Healthy Nuclear Safety Culture, and INPO 12-012, Traits of a Healthy Nuclear Safety Culture. Self-assessment of safety culture is required by OPG procedure every 3 years. CNSC staff ensure that licensees document their commitment to fostering safety culture in governing documents and conduct comprehensive, systematic, and rigorous safety-culture self-assessments.

During the current Darlington licensing period, OPG submitted implementation plans for REGDOC-2.1.2. OPG's implementation plan laid out the timeline for

OPG to become fully compliant with REGDOC-2.1.2 by November 26, 2020. The CNSC accepted this implementation plan in early 2020. In 2018, an OPG-wide Safety Culture Self-Assessment was completed, and the high-level results were presented to the CNSC in July 2019.

CNSC staff have reviewed the Darlington 2021 safety culture self-assessment to verify compliance with REGDOC 2.1.2, and OPG's governance documents. OPG's assessments meets the guidance in Nuclear Energy Institution (NEI) 09-07 Fostering a Healthy Nuclear Safety Culture and N-PROC-AS-0077, Nuclear Safety and Security Culture Assessment.

In the safety culture self-assessment of 2021, OPG identified strengths, weaknesses, positive, negative, and general observations. OPG developed actions to address weaknesses and negative observations. All actions from the Darlington 2021 safety culture self-assessment are closed.

Recently, OPG conducted the Darlington 2024 safety culture self-assessment. The self-assessment report is expected to be completed in early 2025.

Configuration Management

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

During the current Darlington NGS licensing period CNSC staff conducted compliance verification activities to confirm that configuration management was controlled and the programs referenced in the LCH were found to be effective. The non-compliant findings identified during the licence period were not significant enough to change the overall performance rating of the SCA and CNSC staff were satisfied with how OPG dispositioned the non-compliances that were raised.

Record Management

OPG's record management system is governed by OPG-PROG-0001, Information Management. The record management system encompasses the control of documents and records. During the current licensing period, OPG made several enhancements to improve the record management system.

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

OPG is planning a new application to further automate OPG's client service processes and record projects to decrease the amount of legacy paper records for ease of access and secure fast retrieval. CNSC staff will continue to review such upgrades and changes to ensure they meet CNSC regulatory and CSA N286-12 requirements as part of ongoing compliance verification activities.

Throughout the licensing period, CNSC staff conducted inspections that included records management verifications and determined that the Darlington NGS continued to maintain and implement a record and document management system that complied with the requirements of CSA N286-12.

Management of Contractors

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

Business Continuity

CNSC staff confirmed that OPG has implemented business continuity processes, as documented in OPG-PROG-0033, Business Continuity Program, to address and minimize the impact of disruptions, caused by both internal and external factors, which affect the safe operation of the facility.

CNSC staff identified that OPG updated their business continuity processes to include COVID-19 mitigating strategies at the Darlington NGS. OPG continually updated station expectations for workers by aligning with the Office of the Chief Medical Officer of Health, Ontario.

CNSC staff determined that OPG's response to the COVID-19 pandemic met all applicable business continuity requirements.

3.1.5 Conclusion

Through the assessment of the licence renewal application and compliance verification activities during the current licence period, CNSC staff conclude that OPG has implemented and maintains a management system in accordance with CNSC regulatory requirements and the requirements of CSA N286-12. OPG regularly assesses its management system to ensure the adequacy and effectiveness of its programs, its change control processes and documentation. OPG continues to promote a healthy safety culture. CNSC staff's compliance verification activities confirm that OPG's management system is satisfactory.

3.2 Human Performance Management

The specific areas that comprise this SCA include:

- Human performance program
- Personnel training
- Personnel certification
- Work organization and job design
- Fitness for duty

3.2.1 Assessment of Licence Application

In accordance with GNSCR General Application Requirements, subsection 3.(1.1), CNSC staff conducted a completeness check to verify that programs and topic areas applicable to the Human Performance Management SCA had sufficient supporting documentation referenced in OPGs application. This documentation also had to be sufficiently detailed to describe the nature of the safety and control measures relevant to applicable Human Performance Management topic areas. Some of the topics relevant to this SCA are:

- Human Performance / Technical Procedures
- Continuous Behaviour Observation Program / Limits of Hours of Work / Minimum Shift Complement
- Leadership and Management Training / Training

Section 2.2, "Human Performance Management" of OPGs application [1] gives an overview of the specific programs linked to this SCA. Within each program there are associated references to the licensee process documents. The process documents detail the input and outputs to an adequate technical basis supporting the application and CNSC staff found that it met the requirements of the *Class I Nuclear Facilities Regulations* and the expectations outlined in REGDOC-1.1.3, *Licence Application Guide: Licence to Operate a Nuclear Power Plant* [Appendix B.2][21].

Following the sufficiency review, CNSC staff confirmed that the programs referenced in OPGs application demonstrated that an adequate technical basis has been established as relevant to the human performance SCA; and confirmed that the programs within this SCA are adequate and effective to support the continued and safe operation of the plant.

3.2.2 Proposed Improvements

In their application, OPG details several improvements related to innovative training techniques, including the use of simulators for fuel handling, virtual reality simulation of cranes and the tritium removal facility (see Section 2.2.2 of OPG's application). OPG has also established a team to model staffing numbers out to 2030. No IIP action items were raised related to this SCA.

3.2.3 Trends

The following table indicates the rating trends for the Human Performance Management SCA over the current licensing period:

TRENDS FOR HUMAN PERFORMANCE MANAGEMENT				
Overall Compliance Ratings				
2016	**2017**	**2018**	**2019**	**2020**
SA	SA	SA	SA	SA
2021	**2022**	**2023**	**2024**	
SA	SA	SA	N/A	
Comments				

OPG continues to perform satisfactorily in this SCA. CNSC staff conclude that OPG's human performance management programs meet regulatory requirements.

3.2.4 Performance

Human performance programs

OPG has implemented and maintained a comprehensive Human Performance Program (HPP) and has continued to improve its HPP over the current licensing period. CNSC staff verified compliance through field inspections and type II inspections, including a dedicated HPP type II inspection. CNSC staff identified numerous compliant findings related to the appropriate use of human performance tools, including procedure use and adherence, adequacy of communications, resource planning and worker support. These findings confirmed OPG's compliance with the applicable regulatory requirements for HPPs.

Personnel training

OPG has a well-established Systematic Approach to Training (SAT)-based training system described in OPG documents N-PROG-TR-0005 Training, N-PROC-TR-0008 Systematic Approach to Training and associated processes, procedures, instructions and job aids. OPG's training system is compliant with the requirements stipulated in REGDOC-2.2.2, *Personnel Training*.

Over the licensing period, CNSC staff conducted compliance verification activities of OPG training programs to verify that the SAT-based training system was adequately implemented at Darlington NGS.

CNSC staff conclude that Darlington NGS training programs are defined, designed, developed, evaluated and managed in accordance with OPG's SAT-based training system. OPG's maintenance of these programs ensures that Darlington NGS workers have the necessary knowledge and skills to safely carry out their duties.

OPG has established a robust methodology to assure that workers are trained and qualified to perform their duties safely. CNSC staff conclude that Darlington NGS has performed satisfactorily with respect to the personnel training specific area during the current licence period.

Personnel Certification

OPG implements and maintains programs and processes in support of CNSC certification in accordance with CNSC regulatory document REGDOC-2.2.3, *Personnel Certification, Volume III: Certification of Reactor Facility Workers*.

OPG continues to have sufficient numbers of certified personnel for all positions requiring certification at the Darlington NGS, the positions of which are Responsible (Senior) Health Physicists, Shift Managers, Control Room Shift Supervisors, Authorized Nuclear Operators and Unit 0 Control Room Operators

OPG maintains and administers Certification Examinations and Requalification Test program requirements in accordance with EG1, *Requirements and*

Guidelines for Written and Oral Certification Examinations for Shift Personnel at Nuclear Power Plants, EG2, *Requirements and Guidelines for Simulator-Based Certification Examinations for Shift Personnel at Nuclear Power Plants* and *Requirements for the Requalification Testing of Certified Shift Personnel at Nuclear Power Plants, Rev.2*. These documents specify requirements that NPP licensees must adhere to for the design, development, conduct and grading of initial certification examinations and requalification tests for personnel seeking or holding a certification issued by the CNSC.

During the current licensing period, , in addition to reviewing Darlington NGS' Quarterly Personnel Reports, REGDOC-3.1.1 Notification Reports, other licensee reports and applications for initial and renewal of certification, CNSC staff also completed a number of compliance verification activities. These activities were carried out to ensure that knowledge-based (i.e. written) certification examinations and performance-based (i.e. simulator) certification examinations and requalification tests were administered in accordance with CNSC's regulatory requirements. Some of the compliance verification activities also targeted certification support processes such as management interviews, co-piloting and retention of records supporting initial and renewal of certification.

Most findings from the compliance verification activities conducted during the licence period were of negligible or low safety significance. All related notices of non-compliance have either been closed or are being addressed by OPG to CNSC staff satisfaction.

CNSC staff continue to conclude that programs and processes in support of CNSC certification at Darlington met the applicable CNSC regulatory requirements during Darlington's licensing period.

Work Organization and Job Design

Minimum Shift Complement

The minimum shift complement (MSC) is the minimum number of qualified workers who must be always present to ensure the safe operation of the nuclear facility and to ensure adequate emergency response capability. Darlington's MSC personnel who are certified by the CNSC includes:

- Responsible Health Physicist,
- Shift Manager,
- Control Room Shift Supervisor,
- Authorized Nuclear Operator, and
- Unit 0 Control Room Operator.

Other MSC personnel include:

- nuclear operators,
- maintainers,

- fuel handlers,
- Security,
- Emergency Response Organization (ERO).

In June 2018, OPG provided prior written notification to the CNSC of a change to its Darlington Station Shift Complement regarding Mechanical Maintenance [19]. To complete the transition to a Days Based Maintenance organization, Mechanical Maintainers would be removed from the night shift minimum complement but would remain as part of the day shift minimum complement.

In 2021, CNSC staff accepted OPG's request to remove the Shift Advisor Technical (SAT) work group role from its minimum shift complement [20,21]. The SAT was a work group role, which takes on the role of the Emergency Shift Assistant (ESA) during an emergency. OPG filled the ESA role (formerly the SAT) with either the Chemistry Lab First Line Manager or the Tritium Removal Facility Field Shift Operating Supervisor as back up with the removal of the SAT.

OPG must report MSC violations to the CNSC in accordance with REGDOC-3.1.1. Over the licensing period, OPG reported between zero and three MSC violations annually at the Darlington NGS. All were of short duration, and in all cases Darlington NGS implemented the appropriate compensatory measures until replacement staff arrived, including entering quiet mode in which non-essential activities such as reactor fueling were postponed. At no time was the safety of Darlington NGS compromised. CNSC staff confirm that OPG has met regulatory requirements related to the MSC over the current licensing period.

Fitness for Duty

OPG has a Fitness for Duty program that includes a range of provisions to provide reasonable assurance that workers are psychologically and physically fit for duty. The most detailed CNSC requirements apply to staff who are certified by the CNSC and others who fill safety-sensitive or safety-critical positions, including operations personnel, emergency response team members, and nuclear security officers. Over the course of the licensing period, the CNSC published three regulatory documents related to fitness for duty, and OPG has implemented all of them. Further detail is provided in the three sub-sections below.

Fatigue Management and Hours of Work

As part of their fitness for duty provisions, OPG has procedures that limit hours worked by staff and has provisions for monitoring for signs of fatigue [N-PROC-OP-0047, Hours of work limits and managing worker fatigue]. As part of the CNSC regulatory oversight of fatigue management, CNSC staff completed a Type I Compliance Inspection in 2020 to assess compliance with REGDOC-2.2.4, *Fitness for Duty: Managing Worker Fatigue*, and applicable regulatory requirements. CNSC staff Concluded that OPG was in compliance with REGDOC-2.2.4, Fitness for Duty: Managing Worker Fatigue, and all non-compliances identified during the inspection were appropriately addressed to CNSC staff's satisfaction.

Managing Alcohol and Drug Use

Managing alcohol and drug use is another important aspect that affects fitness for duty. OPG has a Continuous Behavior Observation Program (CBOP), which provides guidance to workers to detect behavioral changes. To strengthen the regulatory oversight related to alcohol and drug use, and to ensure regulatory clarity and consistency in the area, the CNSC published REGDOC-2.2.4, *Fitness for Duty, Volume II: Managing Alcohol and Drug Use*, in 2017. This document sets out requirements and guidance for managing fitness for duty of workers occupying safety-sensitive and safety-critical positions in relation to alcohol and drug use at all high-security sites.

In May 2024, CNSC staff conducted a Type I Inspection to assess compliance with REGDOC-2.2.4, *Fitness for Duty, Volume II: Managing Alcohol and Drug Use, Version 3* and applicable regulatory requirements to manage the administration of alcohol and drug testing for safety-sensitive and safety-critical workers at Darlington NGS. At the time of writing of this CMD, OPG was in the process of developing corrective actions for the non-compliant findings with enforcement actions.

Nuclear Security Officer Medical, Physical and Psychological Fitness

CNSC staff conducted an inspection on public agent requirements at the DNGS. CNSC staff observed that OPG was non-compliant with the medical certificate requirements of REGDOC-2.2.4, *Fitness for Duty, Volume III: Nuclear Security Officer Medical, Physical and Psychological Fitness* section 4.1 and REGDOC-2.12.1, *High Security Facilities, Volume I: Nuclear Response Force, Version 2* section 4.2 for ensuring that Nuclear Security Officers have undergone the described medical assessment at least every 2 years.

Following a technical assessment of the corrective actions taken by OPG in relation to the public agent requirements, CNSC staff concluded that the actions taken were acceptable and closed the action items associated with the notices of non-compliance.

3.2.5 Conclusion

Through the assessment of the licence renewal application and compliance verification activities during the current licence period, CNSC staff conclude that OPG has implemented and maintains effective human performance programs at the Darlington NGS in accordance with regulatory requirements. CNSC staff confirmed that OPG has committed to implementing measures to meet applicable modern codes and standards.

3.3 Operating Performance

The specific areas that comprise this SCA include:

- Conduct of licensed activity
- Procedures

- Reporting and trending
- Outage management performance
- Safe operating envelope
- Severe accident management and recovery
- Accident management and recovery

3.3.1 Assessment of Licence Application

In accordance with GNSCR General Application Requirements, subsection 3.(1.1), CNSC staff conducted a completeness check to verify that programs and topic areas applicable to the Operating Performance SCA had sufficient supporting documentation referenced in OPGs application. This documentation also had to be sufficiently detailed to describe the nature of the safety and control measures relevant to applicable Operating Performance topic areas. Some of the topics relevant to this SCA are:

- Nuclear Operations / OP&Ps
- Safe Operating Envelope
- Plant Status Control / Chemistry
- Operating Experience Process / Corrective Action
- Reactor Safety Program / Reactivity Management / Heat Sink Management / Response to Transient
- Accident Management and Recovery
- Severe Accident Management and Recovery

Section 2.3, "Operating Performance" of OPGs application [1] gives an overview of the specific programs linked to this SCA. Within each program there are associated references to the licensee process documents. The process documents detail the input and outputs to an adequate technical basis supporting the application and CNSC staff found that it met the requirements of the *Class I Nuclear Facilities Regulations* and the expectations outlined in *REGDOC-1.1.3, Licence Application Guide: Licence to Operate a Nuclear Power Plant* [Appendix B.2][21].

Following the sufficiency review, CNSC staff confirmed that the programs referenced in OPGs application demonstrated that an adequate technical basis has been established as relevant to the operating performance SCA; and confirmed that the programs within this SCA are adequate and effective to support the continued and safe operation of the plant.

3.3.2 Proposed Improvements

In section 2.3.2 of their licence application, OPG details their work to implement an electronic based procedures project, which will digitize their procedural documentation. Section 2.3.4 of OPG's application provides information on a future initiative which includes schedule optimization of planned outages, improved resource strategies and the leveraging of innovative technologies. No IIP action items were raised related to this SCA.

3.3.3 Trends

The following table indicates the rating trends for the Operating Performance SCA over the current licensing period:

TRENDS FOR OPERATING PERFORMANCE				
Overall Compliance Ratings				
2016	**2017**	**2018**	**2019**	**2020**
FS	FS	FS	SA	SA
2021	**2022**	**2023**	**2024**	
SA	SA	SA	N/A	
Comments				
OPG continues to perform satisfactorily in this SCA. CNSC staff conclude that OPGs programs within the operating performance SCA meet regulatory requirements.				

3.3.4 Performance

Conduct of licensed activity

CNSC staff confirmed that OPG has implemented an Operating Policies and Principles (OP&Ps) document that establishes the operational activities at the Darlington NGS. The OP&Ps define the operating boundaries within which the station may be operated safely and specify how OPG will operate, maintain, and modify station systems while controlling risk to the public.

CNSC staff conducted inspections and assessments of OPG’s activities to verify compliance with the OP&Ps and have determined that OPG met regulatory requirements.

Unplanned transients

CNSC staff review events such as unplanned transients, including their causes and consequences because unplanned power reductions may indicate problems with plant equipment and can place strain on the plant process systems during the transient. Unplanned transients include setbacks, stepbacks and automatic reactor trips that result in a reactor shutdown. These unplanned transients are monitored by CNSC staff to ensure OPG adheres to their operating processes including the OP&Ps. Table 4 provides a list of the number of unplanned transients from January 1, 2016 to March 31, 2024.

Table 4: Number of unplanned transients from 2016 to 2024

	2016	2017	2018	2019	2020	2021	2022	2023	2024*
Unplanned Reactor Trips	1	1	0	0	0	0	1	2	N/A
Stepbacks	2	1	1	0	3	1	0	1	N/A
Setbacks	2	2	3	1	4	0	2	3	N/A
Total	5	4	4	1	7	1	3	6	N/A

*The data for the full year was unavailable at the time of writing

During the current licensing period, CNSC staff reviewed all reactor transients at Darlington NGS and conclude that OPG followed approved operating procedures, investigated, or evaluated the root causes of the events and took appropriate corrective actions. Although unplanned transients place a burden on the plant and its operating staff, none of the unplanned transients resulted in serious process failures and the reactor was controlled and the fuel cooled and contained for all events noted.

Procedures

Procedures are essential for safe execution of authorized activities. Procedures ensure that tasks are carried out in an approved, predictable, and safe manner to protect the workers, the station, and the environment.

CNSC staff continually assess OPG's procedures for all licensed activities. Oversight, in this specific area, focuses on ensuring that the licensee has an adequate process for the development, verification, validation, implementation, modification, and use of procedures. These oversight activities take into account human performance considerations that demonstrate mechanisms exist for ensuring and improving procedural adherence, where necessary.

During Darlington Refurbishment, and prior to restart of Units 2 and 3, CNSC staff reviewed procedures used during reactor start-up with fresh fuel to ensure compliance with regulatory requirements. Additionally, CNSC staff attended simulator-based verifications of new and revised procedures. OPG consistently adhered to regulatory requirements when creating new procedures and updating existing procedures and during validation activities. CNSC staff will continue to conduct compliance verification activities during start-up of Unit 4 to ensure all revised or newly developed procedures associated with start-up adhere to regulatory requirements.

CNSC staff determined that OPG meets regulatory requirements in this specific area.

Reporting and trending

During the current licensing period, OPG submitted reports for the Darlington NGS in accordance with CNSC regulatory document REGDOC-3.1.1.

Table 5 is the number of events reported by OPG during the current licensing period for the Darlington NGS.

Table 5: Darlington NGS reportable events

Year	2016	2017	2018	2019	2020	2021	2022	2023	2024*
Events Reported	52	52	56	59	43	58	37	30	N/A

*This information was unavailable at the time of writing

For all reportable events, CNSC staff confirm OPG followed up with corrective actions and root cause analyses, when appropriate.

For all scheduled reporting, OPG sent satisfactory reports to CNSC staff within the required frequency as per REGDOC-3.1.1.

OPG regularly updates the Commission on their licensed activities during the status updates on power reactors and respond to CNSC staff's updates annually with the Regulatory Oversight Report for Canadian Nuclear Generating Sites.

Outage management and performance

Outages are planned and undertaken by OPG to conduct maintenance, testing and inspections that cannot be performed when the reactor is at power.

Over the current licensing period, CNSC staff verified that adequate provision was established for reactor safety, heat sinks, radiation protection, and that all regulatory committed work had been performed safely and was completed.

During the current licensing period, OPG undertook 28 unplanned outages to fix or replace equipment. These were communicated to the Commission via status reports on power reactors and through the annual Regulatory Oversight Report for Canadian Nuclear Generating Sites. CNSC staff confirmed OPG conducted all appropriate follow-up actions for these outages.

Safe operating envelope

Darlington NGS has a well-established Safe Operating Envelope (SOE) program based on the requirements of CSA N290.15 *Requirements for the safe operating envelope of nuclear power plants.* The SOE program is comprised of a hierarchy of governance, standards, and processes supporting production, update, and maintenance of SOE documentation. Changes to the SOE documentations are communicated to the CNSC staff through version controlled Operational Safety Requirements (OSR) documentations. CNSC staff review and verify that changes are consistent with the CSA standard and the analysis of record.

CNSC staff verify OPGs compliance with the SOE applicable standard on a five-year cycle. This includes an annual field inspection for four years followed by a comprehensive desktop inspection on the fifth/last year of the cycle. Also, CNSC staff review SOE related unscheduled events reported under REGDOC 3.1.1. Corrective actions coming out of the reported events are verified for compliance with the REGDOC.

During the current licensing period, OPG launched an SOE improvement initiative at Darlington NGS, where the SOE documentation was reviewed for consistency and completeness, and the SOE staff training materials were revamped. CNSC staff continue to monitor the progress of this initiative through monthly update meetings until completion.

CNSC staff will continue to closely monitor and verify that Darlington NGS continues to operate within the requirements of CSA N290.15.

Severe accident management and recovery

A severe accident management (SAM) program provides an additional layer of defense against the consequences of beyond design basis accidents (BDBAs) including severe accidents. Severe accident management guidelines (SAMG) ensure that personnel involved in managing a BDBA have the information, procedures, and resources necessary to carry out effective on-site actions.

CNSC staff have reviewed OPG's submission [22] regarding the compliance assessment of their Severe Accident Management (SAM) program against the requirements of REGDOC-2.3.2, *Accident management, Version 2* and have observed that:

- OPG has completed a compliance assessment on the OPG SAM program to demonstrate that no implementation plan is necessary to transition to REGDOC 2.3.2, *Accident management, Version 2*,
- As of April 19, 2023, OPG has determined that Darlington NGS are able to fully comply with REGDOC 2.3.2, *Accident management, Version 2*.

The Containment Filtered Venting System (CFVS) has been installed at Darlington NGS and commissioning was completed in April 2017. The CFVS provides a means to vent containment during BDBA conditions to preserve containment integrity. Severe accident analyses have been performed using MAAP-CANDU software to demonstrate how the CFVS can effectively mitigate a wide range of accident scenarios and prevent containment failure due to slow over-pressurization. Requirements for the CFVS are established in the Darlington Beyond Design Basis Functional Safety Requirements guide.

After the commissioning of the CFVS, CNSC staff performed a Type II inspection [23]. The inspection identified 2 corrective action plans, and 3 in-progress activities related to the CFVS for OPG to provide information on once completed. OPG submitted their responses to the plans and provided the requested information; CNSC staff has reviewed and accepted the submissions [24].

Accident management and recovery

CNSC staff confirmed that OPG has implemented procedures that outline the necessary actions and response during abnormal incidents and design basis accidents. OPG has implemented a series of Emergency Operating Procedures (EOPs) and Abnormal Incident Manuals (AIMs) for Darlington NGS. The purpose of these procedures is to mitigate abnormal situations in order to return the plant to a safe and controlled state, and to prevent the escalation of abnormal incidents into more serious accidents.

CNSC staff routinely perform compliance verification activities to ensure that up to date EOPs and AIMs are available to the operators, should they be required and that operators are trained in their use.

The requirements of the Accident management specific area are aligned with the requirements in REGDOC-2.10.1, *Nuclear Emergency Preparedness and Response* including the requirements for drills and exercises that are covered under the Emergency Preparedness and Fire Protection SCA (Section 3.10 of this CMD).

3.3.5 Conclusion

Through the assessment of the licence renewal application and compliance verification activities during the current licence period, CNSC staff conclude that OPG has implemented and maintains effective operations programs at the Darlington NGS in accordance with regulatory requirements and has a clearly defined safe operating envelope. CNSC staff confirmed that OPG has committed to implementing measures to meet applicable modern codes and standards.

Based on CNSC staff assessments of the OPG licence application and past performance, CNSC staff conclude that OPG maintains an adequate licensing basis for continued safe operations.

3.4 Safety Analysis

The specific areas that comprise this SCA include:

- Deterministic safety analysis
- Hazard analysis
- Probabilistic safety assessment
- Criticality safety
- Severe accident analysis
- Management of safety issues

3.4.1 Assessment of Licence Application

In accordance with GNSCR General Application Requirements, subsection 3.(1.1), CNSC staff conducted a completeness check to verify that programs and topic areas applicable to the Safety Analysis SCA had sufficient supporting documentation referenced in OPGs application. This documentation also had to be sufficiently detailed to describe the nature of the safety and control measures relevant to applicable Safety Analysis topic areas. Some of the topics relevant to this SCA are:

- Reactor Safety Program / Risk and Reliability Program
- Safety Report / Analyses of Record

Section 2.4, “Safety Analysis” of OPGs application [1] gives an overview of the specific programs linked to this SCA. Within each program there are associated references to the licensee process documents. The process documents detail the input and outputs to an adequate technical basis supporting the application and CNSC staff found that it met the requirements of the *Class I Nuclear Facilities Regulations* and the expectations outlined in REGDOC-1.1.3, *Licence Application Guide: Licence to Operate a Nuclear Power Plant* [Appendix B.2][21].

Following the sufficiency review, CNSC staff confirmed that the programs referenced in OPGs application demonstrated that an adequate technical basis has been established as relevant to the safety analysis SCA; and confirmed that the programs within this SCA are adequate and effective to support the continued and safe operation of the plant.

3.4.2 Proposed Improvements

OPG is participating in industry-CNSC discussions related to REGDOC-2.4.1 compliance path forward. In addition, OPG will continue conducting deterministic safety analyses as per REGDOC-2.4.1 requirements.

The REGDOC-2.4.1 implementation plan is continuously updated and anticipated improvements for the safety analysis do not constitute any challenge to the safety of the facility. No IIP action items were raised related to this SCA.

3.4.3 Trends

The following table indicates the rating trends for the Safety Analysis SCA over the current licensing period:

TRENDS FOR SAFETY ANALYSIS				
Overall Compliance Ratings				
2016	**2017**	**2018**	**2019**	**2020**
FS	FS	FS	SA	SA
2021	**2022**	**2023**	**2024**	
SA	SA	SA	N/A	
Comments OPG continues to perform satisfactorily at the Darlington NGS. CNSC staff conclude OPGs Safety Analysis SCA meets regulatory requirements.				

3.4.4 Performance

Deterministic Safety Analysis

In October 2014, OPG submitted its implementation plan to update the Darlington safety analysis to meet the requirements of REGDOC-2.4.1 *Deterministic Safety Analysis* [25]. OPG's approach was to conduct all new analyses in accordance with REGDOC-2.4.1 and to update existing analyses which provided the most value in terms of demonstrable safety benefit.

In 2021, OPG submitted a revised REGDOC-2.4.1 implementation plan that included implementation activities for the 2022-2024 period [26], which was accepted by CNSC staff [27]. The latest status update on OPG's REGDOC-2.4.1 implementation activities was provided in December 2023 [24]. Thus far, OPG has submitted their progress to align with REGDOC-2.4.1 expectations for the following safety analyses [28]:

- Common Cause Events (CCE)[29]
- Loss of Moderator Heat Sink (LOMHS) events [30][31][32][34][35]
- Loss of Flow (LOF) events

- Loss of Reactor Power Regulation (LORPR) events, including the regulated bulk power increase event
- Large Break Loss of Coolant Accident (LBLOCA) events
- Small Break of Coolant Accident (SBLOCA) events, including In-core Loss of Coolant Accident (In-Core LOCA) events [33] [37].

CNSC staff review of the Loss of Moderator Heat Sink and Increase in Heat Transport System Tritium Concentration Limit analyses and Consequential Leak Assessment for the Loss of LPSW Event and Spurious Opening of Eight SRVs Event is on-going, while review of the other analyses is complete.

In 2022, OPG submitted a Large Break Loss of Coolant Accident (LBLOCA) Deterministic Safety Analysis (DSA) for the Darlington reactors [36]. The DSA used a hybrid analysis approach - breaks smaller than the Threshold Break Size (TBS) were analyzed using the traditional Limit of Operating Envelope (LOE) approach, while breaks larger than the TBS were analyzed using a realistic analysis approach. CNSC staff have identified some areas related to REGDOC-2.4.1 compliance that need further discussion with OPG to achieve a mutual understanding with respect to the implication of the analysis approach to operating limits and the level of confidence in the analysis results, and are currently engaged in discussions.

The current version of OPG's REGDOC-2.4.1 Implementation Plan addresses activities to the end of the year 2024. OPG committed to updating the implementation plan to address activities beyond 2024 [28].

CNSC staff continue to monitor and review the progress in the OPG REGDOC-2.4.1 implementation plan.

OPG submitted proposed changes to the Safety Analysis SCA of the Darlington Licence Conditions Handbook (LCH) to incorporate clarifications regarding compliance with REGDOC-2.4.1 [38]. The intent of the changes was to recognize the Darlington NGS was designed and built prior to REGDOC-2.4.1 and its requirements should be applied commensurate with risk, where compliance cannot be demonstrated, as permitted in Canadian Standards Association CSA N286-12. CNSC staff reviewed and accepted the proposed changes for the Darlington NGS LCH with some modifications [39]; the changes have been implemented in the attached revision of the Darlington LCH. CNSC staff notes that these changes have also been implemented in the LCHs of all other NPPs.

Impact of Aging on the Safety Analysis Margins

The aging of a reactor can affect characteristics of the heat transport system that result in a gradual reduction of safety margins. For this reason, the overall safety case of an NPP is periodically assessed, such that compensatory measures can be implemented to mitigate the impact of aging as needed. OPG extended their aging analysis for the Darlington NGS to demonstrate acceptable safety performance up to 9800 effective full power days (EFPD) of operation for the accidents susceptible to aging. Specifically, analyses of neutron overpower protection, loss of flow and small break loss of coolant accidents were submitted and reviewed by CNSC staff [40][41] and found to be of sufficient basis to justify continued operation until refurbishment. Presently, all Darlington units have already undergone or are in the process of refurbishment. The heat transport aged conditions assumed in the 9800 EFPD safety analysis is expected to bound the safety case for the operational period following refurbishment and if there are deviations, OPG has the capability to detect it through their systematic monitoring of aging parameters and then re-update the analysis as needed.

Safety Report Update

In accordance with REGDOC 3.1.1, OPG is required to provide an updated safety report every five years. In October 2022, OPG issued the Darlington Safety Report Part 3 to the CNSC [42]. CNSC staff reviewed and accepted Part 3 of the Safety Report with resolutions to be incorporated in the next revision [43].

Darlington Safety Report Parts 1 and 2 were submitted by OPG in November 2023 [44] and are currently being reviewed by CNSC staff.

Hazard Screening Analysis

In 2019, OPG submitted the Hazard Screening Analysis as a part of the 2020 Darlington Probabilistic Safety Assessment Update [45]. The update included consideration of non-reactor sources of hazards. The analysis systematically screened internal and external hazards (including potential combinations of external hazards) on reactor and non-reactor sources (irradiated fuel bay and used-fuel dry storage). CNSC staff completed their review of the updated hazard screening analysis and determined that OPG's submission complied with REGDOC-2.4.2 [46].

In the 2019 Hazard Screening Analysis, OPG also assessed the external flooding hazard at Darlington NGS from multiple sources of flooding, including surface runoff resulting from probable maximum precipitation (PMP) falling directly on the site, nearby streams and rivers, coastal flooding due to potential high lake levels combined with storm surge, wind waves, seiche, tsunami, and other causes. A probable maximum flood (PMF) event was used as the bounding flooding hazard and is based on a combination of PMP, a 1:100-year lake level (75.60 m) and storm surge (0.75 m). The estimated PMF event has a very low probability of occurrence or exceedance, with an estimated recurrence frequency of 10^{-6} per year [45] which is conservative and expected to bound apotential increase of flooding hazard due to climate change during the proposed operational life of Darlington NGS. CNSC staff conclude that no nuclear safety related impacts are expected due to external flooding hazards at Darlington NGS and OPG's assessment in [45] meets CNSC staff expectations stipulated in REGDOC-2.4.2.

In order to ensure Darlington NGS is resilient against potential changes in natural external hazards, such as extreme weather events due to climate change, during the proposed operating life, OPG have also conducted cyclical updates of hazard analysis as an integral part of probabilistic safety assessment (PSA) (e.g., [45]). As well as a periodic safety review (PSR) as per the regulatory requirements proposed operating life, OPG have also conducted cyclical updates of hazard analysis as an integral part of probabilistic safety assessment (PSA) (e.g., [45]). As well as a periodic safety review (PSR) as per the regulatory requirements (REGDOC -2.4.2 and REGDOC-2.3.3), so that the incremental effects of climate change are captured as an input to the PSA and PSR updates.

As requested by CNSC staff during the review of the licence application, OPG has committed to conduct a climate change risk assessment of the Darlington NGS design against the available climate projections for various climate change sensitive natural external hazards [47] and informed CNSC staff of their planned approach for this assessment in December 2024 [48]. The assessment is expected to be completed in 2027 and will determine the risk and impact on the safety of SSCs due to climate change during the proposed operational life and ensure that the plant continues to operate safely while protecting the environment and the public. CNSC staff will review this assessment to confirm it is aligned with industry best practices.

Probabilistic Safety Assessment

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

OPG has established the Risk and Reliability program for the development and use of PSA to manage radiological risk and contribute to safe operation of the station.

Darlington PSA 2020 (DARA 2020) Update submissions

This section discusses the results of CNSC staff's review of DARA 2020 update submitted as part of REGDOC-2.4.2 (May 2014) requirement related to the periodic update of the PSA models.

The transition plan to REGDOC-2.4.2, *Probabilistic Safety Assessment (PSA) for Reactor Facilities*, has been successfully implemented since 2020. In order to meet the requirement in Section 4.4 of REGDOC 2.4.2 (May 2014) related to the update period of the PSA models, OPG submitted the DARA 2020 update which includes an update of station operating experience (such as initiating event frequency, failure rate update, and Preventive Maintenance frequency), an update of any design modifications, as well as the consideration of CNSC staff review comments.

DARA 2020 was based on the requirements of REGDOC-2.4.2 and on OPG methodologies and computer codes which were previously accepted by CNSC staff [50][51][52][53][54].

CNSC staff reviewed DARA 2020 and concluded that it was compliant with REGDOC-2.4.2. OPG submitted PSA updates included the following elements:

- Hazard Screening (July 2019),

- Probabilistic Seismic Hazard Assessment (November 2019),
- Level 1 Internal Events at Power PSA (January 2020), and
- Level 2 Internal Events at Power PSA (October 2020).
- Internal Fire PSA,
- Internal Flood PSA,
- Seismic PSA,
- High Wind PSA, and
- Outage Level 1 Internal Events PSA.

CNSC staff confirmed that the updates were compliant with REGDOC-2.4.2.

In March 2021, OPG submitted a PSA summary report [55]. The results from the PSA submissions show that the Severe Core Damage Frequency (SCDF) and Large Release Frequency (LRF) for Darlington NGS are well below OPG's safety goals, of 1.00E-04 and 1.00E-05 respectively. Table 6 below provides the SCDF and LRF values for various elements of the PSA submitted by OPG [56]. It is important to note that safety goals are defined per hazard and per unit in the Risk and Reliability Program Report. There is no requirement for aggregated results.

Table 6: SCDF and LRF values for PSA elements

Model	Severe Core Damage Frequency (occurrences per reactor year)	Large Release Frequency (occurrences per reactor year)
Internal Events At-Power	1.7E-06	7.9E-07
Internal Events Outage	4.7E-07	4.6E-07
Internal Fire At-Power	2.8E-05	9.1E-06
Seismic At-Power	7.4E-06	7.4E-06
Internal Flooding At-Power	4.9E-08	1.3E-08
High Wind At-Power	1.9E-06	1.7E-06
Non-Reactor Sources	N/A	7.1E-08

Darlington PSA 2025 Update submissions

OPG continues to update their PSA for Darlington NGS on a 5-year cycle in accordance with requirements of REGDOC-2.4.2. In 2024, OPG submitted the revised PSA methodologies [56][57][58] for compliance with REGDOC-2.4.2, Version 2 (2022). The revision included alignment with current REGDOCs, and CSA Guides. CNSC staff concluded that the new and revised Darlington PSA methodologies met the applicable regulatory requirements and found them acceptable [59[][60][61].

OPG is currently updating the PSA for Darlington NGS in accordance with the requirements of REGDOC-2.4.2, which is expected to be completed by the end of December 2025.

Criticality Safety

OPG handles and stores fuel bundles containing irradiated natural or depleted uranium, and therefore have sufficiently low fissile content that they cannot become critical in air or in light water. As such, their respective facilities are not required to maintain nuclear criticality safety programs.

Severe Accident Analysis

Severe accidents represent the set of accidents that involve significant fuel degradation, either in core or in fuel storage.

The analysis provides insights into the challenges to the plant presented by severe accidents and ensures that prevention and mitigation measures are identified. These measures are used by Darlington NGS to identify equipment that can be included in the SAMGs. The details of OPG's SAM program, can be found in Section 3.3.3.

Severe accident analyses have been performed, with a number of cases identified for analysis using MAAP-CANDU software to demonstrate how the CFVS can effectively mitigate a wide range of accident scenarios and prevent containment failure due to slow over-pressurization [62]. Section 4 of the Darlington Safety Report Part 3 summarizes the severe accident analyses to support Beyond Design Basis Accidents for the Darlington NGS and it has been reviewed and accepted by CNSC staff [63].

Management of Safety Issues (including R&D programs)

CNSC staff continue to undertake systematic evaluations of OPG's research and development (R&D) activities. In accordance with REGDOC-3.1.1, OPG submitted the latest annual report regarding Strategic R&D programs within CANDU Owners Group (COG) in June 2024 [64]. With respect to the Safety Analysis SCA, industry is undertaking work to support REGDOC-2.4.1 implementation and compliant analysis [65].

CANDU safety issues, are generic safety issues related to CANDU NPPs, which are addressed in three categories, according to the adequacy and effectiveness of the control measures implemented by licensees to maintain safety margins. Category 3 issues are of concern in Canada, however, measures are in place to maintain safety margins but the adequacy of these measures needs to be confirmed. Category 2 issues are considered a safety concern in Canada, but appropriate measures are in place to maintain safety margin. All 4 Category 3 CANDU Safety

Issues (CSI) that were open during the current licensing period for OPG have been re-categorized to Category 2 for Darlington NGS:

- AA3 - Computer Code and Plant Model Validation
- AA9 - analysis for void reactivity coefficient
- PF9 - fuel behaviour in high temperature transients
- PF10 - fuel behaviour in power pulse transients

In 2014, the CSI AA3 was re-categorized from Category 3 to Category 2 with follow up activities related to CNSC staff comments on code validation and accuracy estimation being tracked under formal action items [66][67]. In 2020, the closure criteria were met, and the action items were closed [68]. CNSC staff provided feedback that more validation work is needed to evaluate the modeling uncertainties and the code accuracies for the key Figure of Merit (FOM) parameters [69]. OPG is working towards this as part of ongoing AA3-related work with their industry partners.

Based on the review of OPG’s proposed Threshold Break Size analysis, CNSC staff re-categorized the remaining 3 LBLOCA-related CSIs, AA9, PF9 and PF10, from Category 3 to a lower risk category(Category 2) in 2023 [70].

CNSC staff will continue to monitor industry progress on these Category 2 issues.

The systematic application of the risk informed decision-making process for the identification of a path forward and resolution of the remaining CSIs, along with on-going regulatory research and taking operation experience into account are key aspects of the overarching safety principle of continuous safety improvement.

3.4.5 Conclusion

Through the assessment of the licence renewal application and compliance verification activities during the current licence period, CNSC staff conclude that OPG has implemented and maintains an effective safety analysis program at Darlington NGS in accordance with regulatory requirements.

3.5 Physical Design

The specific areas that comprise this SCA include:

- Design governance
- Site characterization
- Facility design
- Structure design
- System design
- Component design

3.5.1 Assessment of Licence Application

In accordance with GNSCR General Application Requirements, subsection 3.(1.1), CNSC staff conducted a completeness check to verify that programs and topic areas applicable to the Physical Design SCA had sufficient supporting documentation referenced in OPGs application. This documentation also had to be sufficiently detailed to describe the nature of the safety and control measures relevant to applicable Physical Design topic areas. Some of the topics relevant to this SCA are:

- Fire Protection
- Pressure Boundary Program
- Environmental Qualification

Section 2.5, "Physical Design" of OPGs application [1] gives an overview of the specific programs linked to this SCA. Within each program there are associated references to the licensee process documents. The process documents detail the input and outputs to an adequate technical basis supporting the application and CNSC staff found that it met the requirements of the *Class I Nuclear Facilities Regulations* and the expectations outlined in REGDOC-1.1.3, *Licence Application Guide: Licence to Operate a Nuclear Power Plant* [Appendix B.2][21].

Following the sufficiency review, CNSC staff confirmed that the programs referenced in OPGs application demonstrated that an adequate technical basis has been established as relevant to the physical design SCA; and confirmed that the programs within this SCA are adequate and effective to support the continued and safe operation of the plant.

3.5.2 Proposed Improvements

Environmental Qualification (EQ) of Equipment

In their licence application, OPG presented a list of EQ related planned and in-progress projects for continuous improvement in the reliability and performance of the Structures, Systems and Components (SSCs), with continued prioritization of safe station operation.

Electrical Power Systems

OPG has listed several improvements for each electrical power system.

Process Systems

In their licence application, OPG presented a list of planned and in-progress projects for various process systems to support improvement of safety, reliability and availability of their systems.

CNSC staff will follow up on each of the above activities to verify their successful implementation. No IIP action items were raised related to this SCA.

3.5.3 Trends

The following table indicates the rating trends for the Physical Design SCA over the current licensing period:

TRENDS FOR PHYSICAL DESIGN
Overall Compliance Ratings

2016	2017	2018	2019	2020
SA	SA	SA	SA	SA
2021	**2022**	**2023**	**2024**	
SA	SA	SA	N/A	
Comments				
OPG continues to perform satisfactorily at the Darlington NGS. CNSC staff conclude OPGs Physical Design SCA meets regulatory requirements.				

3.5.4 Performance

Design Governance

Design program

OPG has a design management program that covers changes to systems, structures, components, software, and engineered tools. This program describes the interrelationship between interfacing engineering program and documentation. CNSC staff monitor the design management program through regular compliance verification activities.

Pressure boundary program

OPG's pressure boundary program is comprised of many sub-programs, processes, and procedures to ensure compliance with CSA N285.0, *General requirements for pressure-retaining systems and components in CANDU nuclear power plants*. As required by its PROL, OPG has a formal service agreement with the Technical Standards and Safety Authority as the authorized inspection agency.

Based on inspections and document reviews conducted during the licence period, CNSC staff conclude that OPG's pressure boundary program continues to be in compliance with CNSC regulatory requirements.

Human factors in design

In November 2022, CNSC staff conducted a technical evaluation of Darlington's Human Factors Engineering Documentation Governing Engineering Changes as part of Unit 3 Refurbishment. The review focused on the governance and process support controlled documents that flowed from the top-level document for Human Factors in Design [71].

CNSC staff raised recommendations to address the review comments and OPG's responses can be found in reference [72]. CNSC staff were satisfied with OPG's responses.

Process Systems

CNSC staff performed reviews of design governance documents including revised procedures and operational safety reports within the scope of the process system subject matter and concluded that the revisions made did not negatively affect the licensing basis.

Environmental Qualification (EQ) of Equipment

The Darlington NGS EQ program establishes an integrated set of requirements that provides assurance that essential equipment can perform as required if exposed to harsh DBA conditions and that this capability is preserved over the life of the plant. The effectiveness of Darlington NGS EQ program is evaluated using the EQ Program Health Report, and the current status of the program meets requirements and is sustainable.

An action item related to a Type II inspection conducted in 2022 [73] is still open pending successful software integration with Plant Information (PI) to meet regulatory expectations for EQ temperature monitoring. CNSC staff is following up on a closure of this action item through compliance verification activities.

OPG's licence application included a list of EQ related planned and in-progress projects for continuous improvement in the reliability and performance of the Structures, Systems and Components (SSCs), with continued prioritization of safe station operation. CNSC staff will follow up on each item to verify successful implementation and completion of these projects.

Site characterization

Site characterization is the process for describing the distinguishing characteristics, qualities, physical features, and environment of the land upon which the Darlington NGS is located. Site characterization information for the Darlington NGS is contained within the Darlington NGS Safety Report, Part 1 and 2 (SR) [44].

Structure Design

For the civil structures at site, OPG has established programs for engineering change control (ECC), design management, procurement, classification, and replacement.

CNSC staff perform reviews and inspections regularly and have not identified concerns based on past performance. OPG's licence renewal application does not request any changes to the design of civil structures and, as such, CNSC staff have no concerns with this aspect of OPG's licensed activities.

Seismic Qualification

OPG has an established program for seismic qualification at the Darlington NGS facility. Modifications and replacements are governed by the ECC program and seismic qualification (SQ) checks are built into that program.

CNSC staff have been regularly involved in desktop reviews and inspection activities that ensure the preservation of SQ at the facility. The OPG licence renewal application does not request any changes to its seismic qualification program and CNSC staff are satisfied that OPG meets regulatory expectations.

System Design

Process Systems

There have been no significant safety concerns in the specific area of Process Systems over the current licensing period at Darlington NGS.

Instrumentation and control

Based on the compliance verification activities conducted, there are no safety significant concerns in instrumentation and control at Darlington NGS. The performance of Darlington NGS's instrumentation and control met the regulatory requirements in the current licensing period.

Electrical Power Systems

There are no significant safety concerns in the specific area of Electrical Power Systems (EPS) at Darlington NGS.

In their licence application, OPG presented a list of planned and in-progress projects for every EPS to improve the reliability and availability of their systems.

Fire Protection Design

During the current licensing period, OPG has revised its Fire Protection Assessments (FPA) —including the Fire Hazard Assessment (FHA) and Fire Safe Shutdown Analysis (FSSA)—to demonstrate that its fire protection design is in compliance with the requirements of CSA N293 *Fire Protection for Nuclear Power Plants* and best industry practices. CNSC staff concluded that the FP design meets the requirements of CSA N293. Similarly, OPG has carried out a code compliance review (CCR) [74] of its facilities to ensure alignment with CSA N293 as well as key referenced standards such as the *National Building Code of Canada*, *National Fire Code of Canada*, and associated NFPA standards. OPG has indicated compliance with the programmatic and operational requirements of CSA N293. CNSC staff concluded that the review findings are not considered risk-significant and that the proposed modifications will enhance the facility's safety margin concerning fire protection.

CNSC staff also performed desktop reviews of the third-party reviews of design changes and concluded that they meet the requirements of OPG's operating licence.

Component Design

Cables

Darlington NGS has a mature aging management program in place for cables. CNSC staff perform oversight activities over this program during electrical power systems inspections.

3.5.5 Conclusion

Through the assessment of the licence renewal application and compliance verification activities during the current licence period, CNSC staff conclude that OPG has implemented and maintains an effective design program at the Darlington NGS in accordance with regulatory requirements.

3.6 Fitness for Service

The specific areas that comprise this SCA include:

- Equipment fitness for service / equipment performance
- Maintenance
- Structural integrity
- Aging management
- Chemistry control
- Periodic inspection and testing

3.6.1 Assessment of Licence Application

In accordance with GNSCR General Application Requirements, subsection 3.(1.1), CNSC staff conducted a completeness check to verify that programs and topic areas applicable to the Fitness for Service SCA had sufficient supporting documentation referenced in OPGs application. This documentation also had to be sufficiently detailed to describe the nature of the safety and control measures relevant to applicable Fitness for Service topic areas. Some of the topics relevant to this SCA are:

- Conduct of Maintenance / Integrated Aging Management
- Equipment Reliability / Component and Equipment Surveillance / Reliability and Monitoring of Systems Important to Safety
- Major Component / Life Cycle Management Plans
- Non-Destructive Examination

Section 2.6, “Fitness for Service” of OPGs application [1] gives an overview of the specific programs linked to this SCA. Within each program there are associated references to the licensee process documents. The process documents detail the input and outputs to an adequate technical basis supporting the application and CNSC staff found that it met the requirements of the *Class I Nuclear Facilities Regulations* and the expectations outlined in REGDOC-1.1.3, *Licence Application Guide: Licence to Operate a Nuclear Power Plant* [Appendix B.2][21].

Following the sufficiency review, CNSC staff confirmed that the programs referenced in OPGs application demonstrated that an adequate technical basis has been established as relevant to the fitness for service SCA; and confirmed that the programs within this SCA are adequate and effective to support the continued and safe operation of the plant.

3.6.2 Proposed Improvements

In section 2.6 of their licence application, OPG presented a list of planned and in-progress projects to support improvement of safety, reliability and availability of their systems. CNSC staff will continue to monitor each item to ensure successful implementation and completion of these projects as it relates to the licensing basis.

There were 16 IIP action items raised related to the fitness for service SCA. The majority of these were related to implementation of updated CSA standards and incorporation of requirements into OPG governance. The rest were related to updated periodic inspection plans and the conduct of those inspections.

3.6.3 Trends

The following table indicates the rating trends for the Fitness for Service SCA over the current licensing period:

TRENDS FOR FITNESS FOR SERVICE				
Overall Compliance Ratings				
2016	**2017**	**2018**	**2019**	**2020**
SA	SA	SA	SA	SA
2021	**2022**	**2023**	**2024**	
SA	SA	SA	N/A	
Comments				
OPG continues to perform satisfactorily in this SCA at the Darlington NGS. CNSC staff conclude OPGs Fitness for Service SCA meets regulatory requirements.				

3.6.4 Performance

Equipment Fitness for Service / Equipment Performance

CNSC staff have verified that OPG has procedures in place to monitor the fitness for service of systems, structures and components to support the continued safe operation of Darlington NGS for the proposed licensing period. There have been no significant safety concerns in the specific area of Equipment Performance over the most recent licensing period at Darlington NGS.

CNSC staff confirmed that OPG has established and implemented a Reliability Program according to *REGDOC-2.6.1, Reliability Programs for Nuclear Power Plants*. A Reliability Program includes measures that confirm that systems important to safety are operated as per their design and at an acceptable level of reliability.

In accordance to REGDOC-3.1.1, OPG continues to report the results of the Darlington NGS Reliability Program to CNSC staff annually. In 2023, Darlington NGS updated all unavailability models for the 2023 Annual Reliability Report (ARR) based on DARA2020, following CNSC staff's request [75].

In general, for the operating performance during the current licensing period, all the Special Safety Systems (SSS) met their unavailability targets for Predicted Future Unavailability (PFU).

CNSC staff determined that Darlington NGS meets regulatory requirements in this specific area and will continue monitoring the performance of SIS based on the compliance verification activities.

Maintenance

OPG has satisfactory policies, processes and procedures in place that provide direction and support for its maintenance program. At Darlington NGS, the maintenance program meets the requirements and expectations set out in REGDOC-2.6.2, *Maintenance Programs for Nuclear Power Plants*.

The performance of Darlington's maintenance program met the regulatory requirements in the current licensing period. The critical corrective maintenance backlog, deficient maintenance backlog and the number of critical preventive maintenance deferrals were reduced and maintained at a very low level in the past 5 years. The average preventive maintenance completion ratio in 2023 was 96%, which demonstrated the overall effectiveness of the preventive maintenance program and was determined to be acceptable. There were no safety significant findings related to maintenance based on the review of the events reported by the licensee and the maintenance related inspections conducted in the current licensing period. The corrective critical maintenance backlog, deficient critical maintenance backlog, and the number of critical preventive maintenance deferrals are given in Table 7.

Table 7: Trend of maintenance backlogs and deferrals for critical components for Darlington NGS, 2019 to 2023

Parameter	Average quarterly work orders per unit					Five year trending	Industry average for 2023
	2019	2020	2021	2022	2023		
Corrective maintenance backlog	1	0	0	0	0	steady	1
Deficient maintenance backlog	5	1	1	1	1	steady	3
Deferrals of preventive maintenance	2	1	1	1	1	steady	2

In summary, CNSC staff determined that Darlington NGS maintenance program met the applicable regulatory requirements and performance expectations during the current licensing period. CNSC staff will continue monitoring and oversight based on the existing oversight strategy.

Aging Management

CNSC staff confirmed that OPG continues to implement its aging and obsolescence management programs and processes within a systematic and integrated framework in accordance with CNSC REGDOC-2.6.3, *Aging Management*. OPG N-PROG-MP-0008, Integrated Aging Management is OPG's governing aging management program and N-PROC-MP-0060, Aging

Management Process is its implementing process. Interfacing programs for Darlington NGS include N-PROG-MA-0025, Major Components, N-PROG-MA-0017, Component and Equipment Surveillance, N-PROG-MA-0026, Equipment Reliability, N-STD-MA-0024, Obsolescence Management, N-PROG-OP-0004, Chemistry. Lifecycle management plans for major components and reactor components continued to meet the applicable regulatory requirements.

Fuel Channels

Fuel channels were replaced during the refurbishment of Darlington Units 1, 2 and 3 while Unit 4 is currently undergoing refurbishment. OPG has developed a lifecycle management plan to implement aging management requirements for fuel channels.

Fuel Channel Feeders

Fuel channel feeders were replaced during the refurbishment of Darlington Units 2 and 3 whereas Units 1 and 4 are currently undergoing refurbishment.

Steam Generators

Steam generators were not replaced during refurbishment of Darlington Units 1, 2 and 3 and they remain in a long-term operation managed under Steam Generators Life Cycle Management Plans, which are reviewed and inspection by CNSC staff. Similarly, steam generators at Darlington Unit 4 are not being replaced during ongoing refurbishment but planned to continue operation.

Reactor Components and Structures

The Reactor Components and Structures LCMP, N-PLAN-01060-10003, establishes the strategy or identifies necessary actions to ensure that aging effects on reactor components and structures are appropriately managed for the operating life of OPG's fleet of nuclear units.

Civil Structures, including Containment

CNSC staff had been carrying out regulatory oversight and compliance and verification activities to confirm that OPG continues to meet regulatory expectations for the aging management, testing and inspection of civil structures, including containment, provided for by the Darlington NGS LCH. OPG dedicated significant effort to the pressure testing of the reactor vault portion of containment for the units that either went into refurbishment (to verify the proper isolation from the rest of the containment which remains operational) or return to operation after completing the refurbishment (to confirm that the reactor vault containment is fit for service and meets the pre-established leak rate criteria). OPG has remained compliant with the terms and conditions of their LCH.

Chemistry Control

OPG has a well-developed chemistry program at the Darlington NGS that meets CNSC requirements and expectations. A CNSC staff inspection of OPG's chemistry control program in 2021 [76], as well as a compliance assessment performed in March 2024 [77] confirmed that the chemistry control program meets regulatory requirements.

Periodic Inspection and Testing

OPG has submitted periodic inspection program documents which outline the licensee inspection activities required to comply with the CSA group standards. Ongoing monitoring of program implementation is verified by CNSC staff through desktop reviews of OPG's inspection reports and compliance monitoring inspections.

CNSC staff verified through review of OPG submissions that OPG complies with CSA N285.4-14 for the inspection of fuel channels, feeders, steam generators, and reactor components. CNSC staff continue to verify the programs associated with CSA N285.4-14.

OPG complies with CSA N285.5-18 for the inspection of containment components. Each inspection location is inspected once within each unit's 10-year inspection interval; except for components whose inspection requires a Vacuum Building Outage (VBO), where inspections are performed at least once every 12-years. CNSC staff continue to verify the programs associated with CSA N285.5-18.

OPG performs periodic inspection and testing of civil structures as per CSA N291 and CSA N287.7. CNSC staff have not identified any areas of concern or deficiencies in the activities performed by OPG for civil structures.

3.6.5 Conclusion

Through the assessment of the licence renewal application and compliance verification activities during the current licence period, CNSC staff conclude that OPG has implemented and maintains effective programs that meet regulatory requirements under the fitness for service SCA.

3.7 Radiation Protection

The specific areas that comprise this SCA include:

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

3.7.1 Assessment of Licence Application

In accordance with GNSCR General Application Requirements, subsection 3. (1.1), CNSC staff conducted a completeness check to verify that programs and topic areas applicable to the Radiation Protection SCA had sufficient supporting documentation referenced in OPGs application. This documentation also had to be sufficiently detailed to describe the nature of the safety and control measures relevant to applicable Radiation Protection topic areas. Some of the topics relevant to this SCA are:

- Radiation Protection / Controlling Exposure ALARA
- Occupational Action Levels

Section 2.7, "Radiation Protection" of OPGs application [1] gives an overview of the specific programs linked to this SCA. Within each program there are associated references to the licensee process documents. The process documents detail the input and outputs to an adequate technical basis supporting the application and CNSC staff found that it met the requirements of the *Class I Nuclear Facilities Regulations* and the expectations outlined in REGDOC-1.1.3, *Licence Application Guide: Licence to Operate a Nuclear Power Plant* [Appendix B.2][21].

Following the sufficiency review, CNSC staff confirmed that the programs referenced in OPGs application demonstrated that an adequate technical basis has been established as relevant to the radiation protection SCA; and confirmed that the programs within this SCA are adequate and effective to support the continued and safe operation of the plant.

3.7.2 Proposed Improvements

In its licence renewal application, OPG has not proposed any improvements to their RP program related to the operation of the Darlington NGS. No IIP action items were raised related to this SCA.

The discovery of unanticipated neutron hazards within the Darlington reactor refurbishment waste is an area undergoing current research by OPG, and the Canadian nuclear industry. CNSC staff will continue to monitor OPG's findings in this area and assess whether enhancements to OPG's RP program are required.

3.7.3 Trends

The following table indicates the rating trends for the Radiation Protection SCA over the current licensing period:

TRENDS FOR RADIATION PROTECTION				
Overall Compliance Ratings				
2016	**2017**	**2018**	**2019**	**2020**
FS	SA	SA	SA	SA
2021	**2022**	**2023**	**2024**	
SA	SA	SA	N/A	
Comments				

OPG has implemented and maintained an effective radiation protection program at the Darlington NGS, as required by the *Radiation Protection Regulations*. Over the current licensing period, no worker received a radiation dose in excess of regulatory dose limits as a result of the licensed activities conducted at the Darlington NGS.

OPG continues to perform satisfactorily in this SCA. CNSC staff conclude that OPG's performance in the Radiation Protection SCA met regulatory requirements.

3.7.4 Performance

Application of ALARA

OPG's application of the ALARA principle is documented in its RP governance, N-PROG-RA-0013, Radiation Protection, which includes requirements for management commitment and oversight, personnel qualification and training, exposure control and contamination control. The program integrates ALARA into engineering design, work management, and control of radiological activities. N-STD-RA-0018, Controlling Exposure As Low As Reasonably Achievable, establishes the necessary prerequisites to keep occupational exposures ALARA.

As required by N-STD-RA-0018, OPG has a site-specific ALARA Committee at the Darlington NGS that is chaired by and comprised of senior managers, each of whose role has some level of control over radiological work performed at the Darlington NGS and thus the exposures received by workers. The ALARA Committee is required to meet at minimum quarterly and is responsible for: approving and supporting a 5-Year ALARA Plan for the Darlington NGS; establishing an annual collective dose target for the Darlington NGS; approving work with collective dose projections that equal or exceed 30 person-mSv; establishing ALARA priorities within the Darlington NGS work program; and, reviewing ALARA performance and enacting corrective actions, if required.

N-STD-RA-0018 also requires OPG to perform a self-assessment of the ALARA process at Darlington NGS at least every 3 years. CNSC staff verified that OPG met this requirement, and that through their self-assessments, OPG identified several opportunities for improvement at Darlington NGS, with actions assigned to achieve them.

N-STD-RA-0018 also requires managers at Darlington NGS to prepare annual dose targets for their individual Work Groups (e.g.: Fuel Handling, Mechanical Maintenance, etc.). These dose targets are based on the planned outage work and routine operation and maintenance work scheduled for the year. Managers must also develop Work Group specific dose reduction activities that will improve upon worker doses compared to prior years. Similarly, N-STD-RA-0018 requires that planned outages for the Darlington NGS have collective dose targets that are based upon the work scheduled to be completed during the outage, and the targets are required to be rationalized against previous experience and to incorporate dose reductions due to application of an ALARA dose reduction plan.

At Darlington NGS, radiological work planning is a key element to ensuring radiological exposures are kept ALARA. OPG procedure N-PROC-RA-0027, Radioactive Work Planning, Execution and Close Out requires collective dose projections to be prepared for all radioactive work, and formal ALARA Plans to be written for ALARA Committee approval if the dose projection meets the 30 person-mSv threshold. N-PROC-RA-0027 also requires tracking of collective dose performance during the conduct of work, and if the collective dose trending projects that the target value will not be met, then recovery plans are required to be developed and implemented to achieve (as best possible) the original ALARA target. On work completion, lessons learned are required to be recorded for use in the event the work is ever repeated in the future.

Annual collective dose data are used by OPG as a tool for optimization of RP in the control of occupational exposures and takes account of all individuals at the nuclear facility (staff, contractors, and visitors). Table 8 illustrates the distribution of annual collective dose per operational state (routine versus outage) and the distribution of dose by internal and external contribution over the period 2015 to 2023, as reported by OPG. (Note that the number of monitored workers in each year along with a dose breakdown is presented in Figure 1). The annual collective dose is the sum of all doses to all individuals at the Darlington NGS over the period of one year. The variations in annual collective effective dose from year to year are due primarily to the number of and scope of maintenance outages.

Table 9 illustrates the contribution of refurbishment work to the collective dose listed in Table 8. The magnitude of the contribution for each year depends upon the work performed. For example, core dismantlement is significantly more dose intensive than core reconstruction or reactor return-to-service work. Tritium is typically the largest single contributor to internal dose at the Darlington NGS. During refurbishment, the moderator and primary heat transport system waters are removed from the reactor thereby removing a significant radiological hazard and reducing the magnitude of the internal dose that workers involved in refurbishment work receive.

Table 8: Breakdown of collective dose for Darlington NGS, 2015 to 2023 (person-mSv)

Year	Routine Operations	Outages	Internal Dose	External Dose	Total Dose
2015	329	2 311	485	2 155	2 640
2016(1)	495	2 600	519	2 576	3 095
2017	429	12 068	542	11 955	12 497
2018	449	9 506	457	9 498	9 955
2019	394	7 263	469	7 188	7 657
2020(2)	311	2 375	296	2 390	2 686
2021	273	13 135	448	12 960	13 408
2022(3)	259	10 694	325	10 628	10 953
2023(4)	312	9 766	335	9 743	10 078

(1) Unit 2 refurbishment occurred from October 2016 to June 2020.
(2) Unit 3 refurbishment occurred from September 2020 to July 2023.
(3) Unit 1 refurbishment occurred from February 2022 to November 2024.
(4) Unit 4 refurbishment started in July 2023 and is ongoing.

Table 9: Contribution of Refurbishment Work to Darlington NGS Collective Dose

Year	Unit	Internal Dose (person-mSv)	External Dose (person-mSv)	Total Dose (person-mSv)
2017	Unit 2	196	9 838	10 034
2018	Unit 2	81	7 808	7 889
2019	Unit 2	92	5 087	5 179
2020	Unit 2	46	566	612
	Unit 3	97	1 142	1 239
2021	Unit 3	72	10 300	10 372
2022	Unit 3	38	3 255	3 293
	Unit 1	110	6 908	7 018
2023	Unit 3	59	529	588
	Unit 1	116	4915	5 031
	Unit 4	50	4073	4 123

In addition to Darlington refurbishment, OPG also completed numerous maintenance outages over the period 2015 to 2024, including planned outages on Unit 1 in 2017 and 2021, Unit 2 in 2022, Unit 3 in 2015, 2018 and 2020, Unit 4 in 2016, 2019 and 2021, the Darlington NGS Vacuum Building in 2015 and the Tritium Removal Facility in 2015, 2018 and 2021.

Inspection items specific to assessing OPG's implementation of its ALARA program were included in several inspections performed by CNSC staff on each of the Darlington NGS reactors as they underwent refurbishment. All the ALARA-related findings were determined to be compliant. Through these regulatory oversight activities, CNSC staff concluded that during the current licence period, OPG was compliant with regulatory requirements for implementing measures to keep exposures to sources of radiation to levels that are ALARA.

Worker Dose Control

OPG's RP program is designed to ensure that the exposures of workers to radiation are controlled so that doses received by them do not exceed regulatory limits. Exposure control at the Darlington NGS is achieved through a number of engineered and administrative barriers.

Engineered barriers established by OPG within the Darlington NGS, which aim to prevent workers from entering into radiation fields and receiving unintended doses due to unplanned exposure to radiation include, among others: the establishment of radiological zones, the construction of contamination control areas, the use of physical barriers (dedicated rooms, enclosures/tents, gates, barrier chains/skirts), the locking of doors, and the installation of temporary shielding.

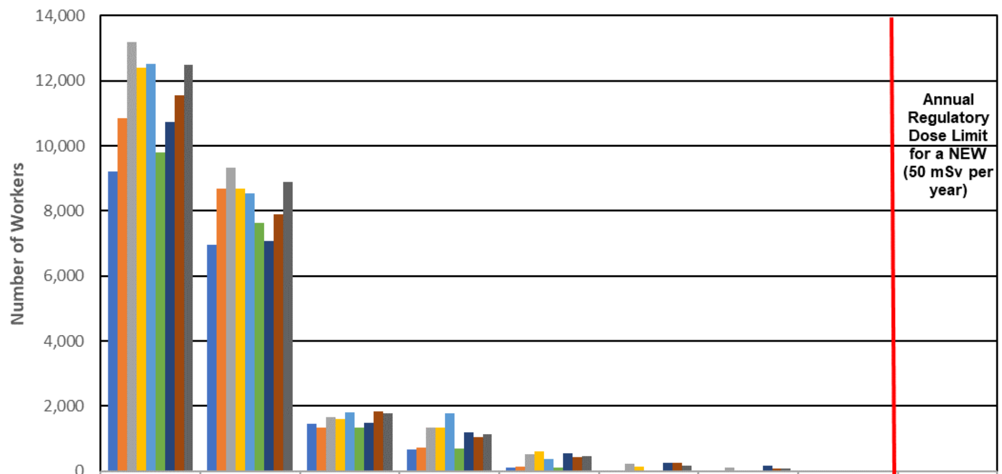
Multiple administrative barriers are implemented by OPG within the Darlington NGS to control the doses received by workers. Such barriers include only allowing workers that have been classified as Nuclear Energy Workers (NEWs) to perform radiological work; providing all NEWs with formal radiation protection training that is commensurate with their roles; ensuring that all radiological work is planned according to an approved procedure, N-PROC-RA-0027, Radioactive Work Planning, Execution and Close-out; beginning all radiological work with a pre-job briefing. These briefings explain to workers: the radiological hazards, the doses the workers are expected to receive, the conditions that would trigger a stop work and safe backout, the radiation personal protective equipment to be worn, and the dose monitoring techniques that will be employed; and, documenting these parameters on an approved Radiation Exposure Permit (REP) that must accompany and that governs the radioactive work.

OPG's RP program requires the establishment of a series of exposure control levels (ECLs) and administrative dose limits (ADLs) for every individual worker, both of which are set well below the regulatory limits. Monitoring worker doses against these parameters is done daily, and requests to exceed them must be justified by line management and approved by higher levels of management.

OPG has a CNSC-licensed dosimetry service and they utilize this service as part of the dosimetry program implemented at the Darlington NGS to monitor, ascertain and assign doses to workers who have been exposed to sources of ionizing radiation.

During the current licensing period, there were no radiation exposures reported at the Darlington NGS that exceeded the annual regulatory limit for effective dose for a NEW (50 mSv). Figure 1 presents the distribution of annual effective doses to all monitored workers at the Darlington NGS for the years 2015-2023. The monitored workers include NEWs and non-NEWs, and both OPG employees and contractors.

Figure 1: Distribution of annual effective doses to all monitored workers at Darlington NGS, 2015 – 2023



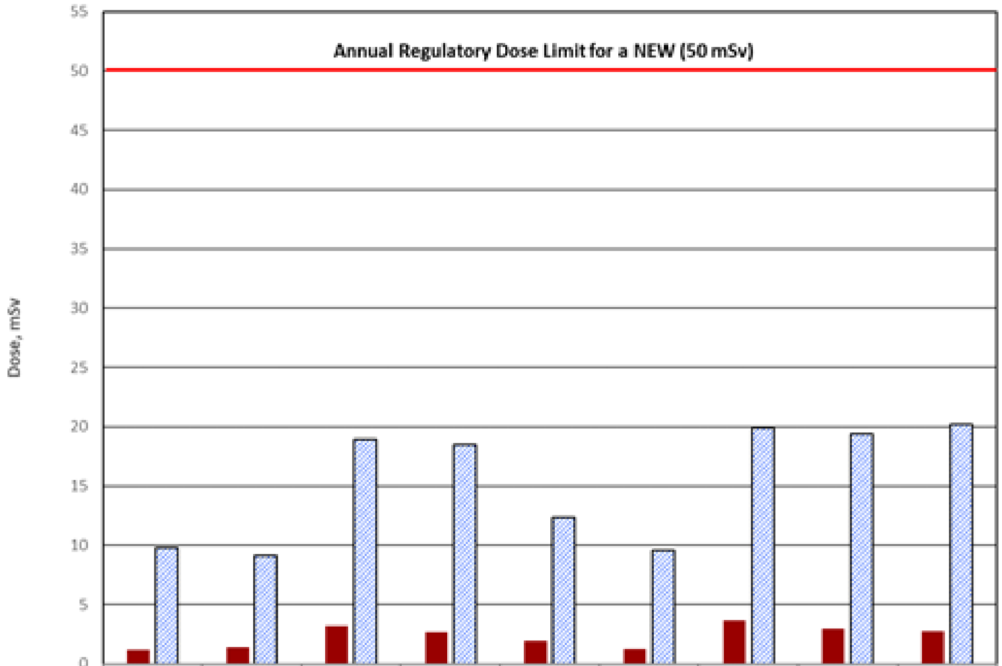
	Number of Workers Monitored	< 0.01 mSv (Reportable Level)	0.01 - 1 mSv	1.01 - 5 mSv	5.01 - 10 mSv	10.01 - 15 mSv	15.01 - 20 mSv	20.01 - 50 mSv	> 50 mSv
2015	9,203	6,956	1,460	679	108	0	0	0	0
2016	10,864	8,679	1,326	713	146	0	0	0	0
2017	13,194	9,338	1,659	1,330	514	238	115	0	0
2018	12,389	8,689	1,612	1,349	594	128	17	0	0
2019	12,504	8,543	1,805	1,789	359	8	0	0	0
2020	9,792	7,637	1,351	702	102	0	0	0	0
2021	10,735	7,077	1,489	1,196	553	261	159	0	0
2022	11,564	7,886	1,850	1,057	439	244	88	0	0
2023	12,484	8,881	1,766	1,131	452	181	72	1	0

Dose Range, mSv

Figure 2, which illustrates the non-zero, average and non-zero, maximum individual effective doses received by a NEW from 2015 to 2023, at the Darlington NGS, shows that the average doses ranged from 1.18 mSv to 3.67 mSv and the maximum doses received by a NEW ranged from 9.13 mSv to 20.20 mSv.

The trend of effective doses shown by figures 1 and 2 are reflective of the work performed at the Darlington NGS and the radiological conditions within which that work was performed. The previous subsection on Application of ALARA provides additional discussion on the work performed.

Figure 2: Average and maximum individual effective doses to NEWs at Darlington NGS, 2015 – 2023



	2015	2016	2017	2018	2019	2020	2021	2022	2023
Average	1.18	1.42	3.24	2.67	1.93	1.25	3.67	2.98	2.80
Maximum	9.78	9.13	18.94	18.47	12.37	9.59	19.95	19.43	20.20

Radiation Protection Program Performance

CNSC staff assessed OPG's RP program performance at Darlington NGS through CNSC compliance inspections and desktop reviews of OPG quarterly performance reports.

OPG's quarterly performance reports include information on the safety performance indicators (SPIs) of Collective Radiation Exposure, Personnel Contamination Events, Unplanned Dose/Unplanned Exposure, and Loose Contamination Events. CNSC staff's review of these reports determined that the submissions satisfied the regulatory requirements specified in CNSC staff's review of the SPIs indicated no adverse trends.

As described in Section 6 of the *Radiation Protection Regulations*, OPG has devised a set of dose-based and contamination-based Action Levels that if reached require OPG to investigate and take action to restore the effectiveness of the RP program. OPG last reviewed and updated their RP action levels in 2022. In 2024, a desktop compliance assessment conducted by CNSC staff of OPG's action levels determined that the parameters were appropriate and that over the course of the current licence, OPG applied them in a suitable way at the Darlington NGS.

Over the course of the current licence period, OPG has had occasion to revise its RP program to enhance its robustness and to improve its effectiveness. As noted above, in the "Worker Dose Control" subsection, doses to workers at the Darlington NGS were well within regulatory limits during the current licence period and CNSC staff are satisfied with OPG's RP program performance at Darlington NGS.

Radiological Hazard Control

OPG's RP program is designed to ensure that adequate measures are in place to monitor and control radiological hazards at the Darlington NGS. This is accomplished by radiation monitoring of areas, materials, and personnel; controlling contamination at its source; and containing and controlling radioactive and radiologically contaminated materials.

Radiation monitoring includes performing routine contamination surveys of the facility and performing non-routine surveys during the conduct of radiological work. It also includes monitoring personnel and material as they move throughout the facility, in particular at the juncture of zone boundaries and at the exit point from radiological work areas. Monitoring includes both surfaces and in-plant air.

Control of radiation hazards is achieved through the establishment of radiological zones, and contamination control areas within the zones. Access to radiologically controlled areas is restricted to authorized personnel. OPG's objective is to reduce the number of radiological hazards, and for those that cannot be eliminated, to keep their sizes small and to contain the spread of any contamination away from the original source.

As stated above, under the Worker Dose Control subsection, according to the *Radiation Protection Regulations*, action levels are a specific dose of radiation or other parameter that, if reached, may indicate a loss of control of part of a licensee's RP program and trigger a requirement for specific action to be taken. OPG has developed contamination-based RP action levels that are applied to the Darlington NGS. During the current licence period, there was no exceedance of a contamination-based action level at Darlington NGS.

3.7.5 Conclusion

Through the assessment of the licence renewal application and compliance verification activities during the current licence period, CNSC staff conclude that OPG has implemented and maintains effective programs that meet regulatory requirements under the radiation protection SCA.

3.8 Conventional Health and Safety

The specific areas that comprise this SCA include:

- Performance
- Practices
- Awareness

3.8.1 Assessment of Licence Application

In accordance with GNSCR General Application Requirements, subsection 3.(1.1), CNSC staff conducted a completeness check to verify that programs and topic areas applicable to the Conventional Health and Safety SCA had sufficient supporting documentation referenced in OPGs application. This documentation also had to be sufficiently detailed to describe the nature of the safety and control measures relevant to applicable Conventional Health and Safety topic areas. Some of the topics relevant to this SCA are:

- Health and Safety Policy
- Conventional Safety / Work Protection

Section 2.8, "Conventional Health and Safety" of OPGs application [1] gives an overview of the specific programs linked to this SCA. Within each program there are associated references to the licensee process documents. The process documents detail the input and outputs to an adequate technical basis supporting the application and CNSC staff found that it met the requirements of the *Class I Nuclear Facilities Regulations* and the expectations outlined in REGDOC-1.1.3, *Licence Application Guide: Licence to Operate a Nuclear Power Plant* [Appendix B.2][21].

Following the sufficiency review, CNSC staff confirmed that the programs referenced in OPGs application demonstrated that an adequate technical basis has been established as relevant to the conventional health and safety SCA; and confirmed that the programs within this SCA are adequate and effective to support the continued and safe operation of the plant.

3.8.2 Proposed Improvements

Section 2.8.3 of OPG's licence application details health and safety improvement initiatives that are currently ongoing and will continue into the proposed licence period. No IIP action items were raised related to this SCA.

3.8.3 Trends

The following table indicates the rating trends for the Conventional Health and Safety SCA over the current licensing period:

TRENDS FOR CONVENTIONAL HEALTH AND SAFETY				
Overall Compliance Ratings				
2016	**2017**	**2018**	**2019**	**2020**
FS	FS	FS	SA	SA
2021	**2022**	**2023**	**2024**	
SA	SA	SA	N/A	
Comments				

OPG continues to perform satisfactorily in this SCA at the Darlington NGS. CNSC staff conclude OPGs Conventional Health and Safety SCA meets regulatory requirements.

3.8.4 Performance

Performance

The accident severity rate (ASR), accident frequency (AF) and industrial safety accident rate (ISAR) are parameters reported by NPP licensees that measure the effectiveness of the conventional health and safety program with respect to worker safety. The ASR measures the total number of days lost due to injury for every 200,000 person-hours (approximately 100 person-years) worked at an NPP. The AF is a measure of the number of fatalities and injuries (lost-time and medically treated) due to accidents for every 200,000 person-hours worked at an NPP. The ISAR is a measure of the number of lost-time injuries for every 200,000 hours worked by NPP personnel. The Serious Injury Incidence Rate (SIIR) is a metric introduced in 2020 and is a measure of the number of work-related accidents for all OPG employees that result in serious injuries or fatalities, per 200,000 person-hours worked.

Table 10 below shows the AF, ASR, ISAR and SIIR for the Darlington NGS from 2015 to 2023 (Quarter 3).

Table 10. Accident Frequency, Accident Severity Rates and Industrial Safety Accident Rate – Darlington NGS

Year	Accident Severity Rate (ASR)	Accident Frequency Rate (AF)	Industrial Safety Accident Rate (ISAR)	Serious Injury Incidence Rate (SIIR)
2015	1.4	0.28	0.09	N/A
2016	1.3	0.18	0.04	N/A
2017	2.25	0.32	0.04	N/A
2018	0.2	0.32	0.08	N/A
2019	0	0.21	0	N/A
2020	0	0.17	0	0
2021	0	0.07	0	0
2022	0	0.08	0	0
2023 (Q3)	0	0.16	0	0

There have been no lost-time injuries since 2018 at Darlington NGS (to 2023 Q3).

Performance indicators for the conventional health and safety SCA are reported annually to the Commission as part of the CNSC Staff Regulatory Oversight Report for Canadian Nuclear Power Plants. CNSC staff are satisfied with OPG's performance in this area.

Practices and Awareness

OPG's conventional health and safety program is regulated by the Ontario Occupational Health and Safety Act. OPG's emphasis on safety is reflected in its Employee Health and Safety Policy (OPG-POL-0001) which describes the approach and commitments to Conventional Health and Safety for the organization, and the requirements and accountabilities of all employees. OPG's program OPG-PROG-0005, Environment Health and Safety Managed Systems is designed to implement the Health and Safety Policy.

The conventional health and safety work practices and conditions at the Darlington NGS continued to achieve a high degree of personnel safety. There continues to be a safe and efficient working environment where situational awareness and safe work practices are encouraged.

During the current licensing period, OPG's performance in the practice and awareness specific areas met CNSC requirements for Darlington NGS.

3.8.5 Conclusion

Through the assessment of the licence renewal application and compliance verification activities during the current licence period, CNSC staff conclude that OPG's conventional health and safety program for the Darlington NGS continues to meet regulatory requirements.

3.9 Environmental Protection

The specific areas that comprise this SCA include:

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

3.9.1 Assessment of Licence Application

In accordance with GNSCR General Application Requirements, subsection 3.(1.1), CNSC staff conducted a completeness check to verify that programs and topic areas applicable to the Environmental Protection SCA had sufficient supporting documentation referenced in OPGs application. This documentation also had to be sufficiently detailed to describe the nature of the safety and control measures relevant to applicable Environmental Protection topic areas. Some of the topics relevant to this SCA are:

- Environmental Policy / Environmental Management / Derived Release Limits and Environmental Action Levels

Section 2.9, “Environmental Protection” of OPGs application [1] gives an overview of the specific programs linked to this SCA. Within each program there are associated references to the licensee process documents. The process documents detail the input and outputs to an adequate technical basis supporting the application and CNSC staff found that it met the requirements of the *Class I Nuclear Facilities Regulations* and the expectations outlined in REGDOC-1.1.3, *Licence Application Guide: Licence to Operate a Nuclear Power Plant* [Appendix B.2][21].

Following the sufficiency review, CNSC staff confirmed that the programs referenced in OPGs application demonstrated that an adequate technical basis has been established as relevant to the environmental protection SCA; and confirmed that the programs within this SCA are adequate and effective to support the continued and safe operation of the plant.

3.9.2 Proposed Improvements

Over the next licence period, CNSC staff expect OPG to implement the following standards and regulatory requirements applicable to the Environmental Protection SCA to improve the OPG Environmental Protection Program:

- REGDOC-2.9.2, Controlling Releases to the Environment
- CSA N288.1-20, *Guidelines for Calculating Derived Release Limits for Radioactive Material in Airborne and Liquid Effluents for Normal Operation of Nuclear Facilities*
- CSA N288.6-22, *Environmental Risk Assessment at Nuclear Facilities and Uranium Mines and Mills*
- CSA N288.7-23, *Groundwater Protection Programs at Nuclear Facilities and Uranium Mines and Mills*

OPG has notified CNSC staff of planned submission dates for implementation plans and dates, and gap analyses for the above standards except for REGDOC-2.9.2. CNSC staff will be formally requesting implementation plans and gap analyses for REGDOC-2.9.2 during the next proposed licence term. No IIP action items were raised related to this SCA.

3.9.3 Trends

The following table indicates the rating trends for the Environmental Protection SCA over the current licensing period:

TRENDS FOR ENVIRONMENTAL PROTECTION				
Overall Compliance Ratings				
2016	**2017**	**2018**	**2019**	**2020**
SA	SA	SA	SA	SA
2021	**2022**	**2023**	**2024**	

SA	SA	SA	N/A	
Comments OPG continues to perform satisfactorily at the Darlington NGS. CNSC staff conclude OPGs Environmental Protection SCA meets regulatory requirements.				

3.9.4 Performance

Environmental Risk Assessment

Environmental risk assessment (ERA) is a systematic process used by licensees to identify, quantify and characterize the risk posed by contaminants and physical stressors in the environment on human and other biological receptors, including the magnitude and extent of the potential effects associated with a facility. The ERA serves as the basis for the development of site-specific EP measures and the results from the ERA updates determine whether the facility's effluent monitoring and Environmental Monitoring Program (EMP) are effective. The results of these programs, in turn, inform and refine future revisions of the ERA.

In March 2021, OPG submitted their 2020 Environmental Risk Assessment for the Darlington Nuclear site (2020 ERA) [74] in accordance with the requirements set out in CSA N288.6-12, and REGDOC-2.9.1 which stipulates that licensees must review and revise their ERA every 5 years. OPG's ERA submission is site-wide and encompassed the entirety of the DN site, including the Darlington Waste Management Facility (DWMF). The DN site-wide 2020 ERA included an ecological risk assessment (EcoRA) and a human health risk assessment (HHRA) for nuclear and hazardous contaminants and physical stressors. The 2020 ERA included risks associated with the DN site based on effluent/emission and environmental monitoring data for the period between 2016 to 2019. CNSC staff reviewed OPG's revised ERA and determined it to be compliant with CSA N288.6-12 and REGDOC-2.9.1. Based on the ERA conclusions, no unreasonable risks to human health and the environment attributable to Darlington NGS and DWMF operations were identified.

In September 2024, OPG submitted an addendum to the 2020 site-wide ERA [78] with a focus on years 2020 to 2022 (or 2023 where data were available when the addendum was being prepared). This addendum report was prepared in accordance with the guidance set out in CSA N288.6-22, which is the revised version of CSA N288.6-12 standard. CNSC staff are currently reviewing this report to determine whether the addendum is compliant with CSA standard N288.6-22. The ERA is required to be reviewed and revised every five years, or earlier, should there be significant changes in either the facility or activity, or in the science on which the ERA is based. OPG's next review and revision of the DN site ERA will be submitted to the CNSC by November 30, 2026.

Effluent and emissions control and monitoring (releases)

CNSC staff confirmed that OPG continues to adequately control releases of nuclear and hazardous substances to the environment. OPG has implemented and maintains an effluent and emissions monitoring program at the Darlington NGS, as required by the *Class I Nuclear Facilities Regulations* and compliant with CSA N288.5-22, *Effluent Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills*. OPG's effluent and emissions monitoring program defines the methods and procedures for monitoring releases of radioactive nuclear and hazardous substances, identifies and monitors discharge pathways for releases to the environment, and maintains releases below regulatory limits and action levels.

OPG has controls in place to minimize airborne emissions and waterborne effluents for radiological and non-radiological contaminants of potential concern (COPCs), and to ensure that releases are within regulatory limits and ALARA.

Based on CNSC staff assessment of the results presented in OPG's quarterly and annual reports, as well as compliance verification activities conducted during the licensing period, CNSC staff determined that radiological and non-radiological releases from the Darlington NGS remained below their respective regulatory limits and OPG has met expectations in the area of effluent and emissions control (releases).

CNSC staff conclude that the effluent monitoring program currently in place for the Darlington NGS continues to provide adequate protection to the environment and meets regulatory requirements.

Radiological releases

The limits for radiological releases are known as the Derived Release Limits (DRLs). In 2022, OPG updated its DRLs at the Darlington NGS in accordance with Update No. 3 of CSA N288.1-14, *Guidelines for Calculating Derived Release Limits for Radioactive Material in Airborne and Liquid Effluents for Normal Operation of Nuclear Facilities* issued June 2018. CNSC staff reviewed and accepted the new DRLs which continue to provide adequate protection to the environment and to people from impacts of radionuclides. The new DRLs were implemented in 2022.

Annual radionuclide releases to atmosphere and surface water of tritium, carbon-14, noble gases, iodine-131 and particulates from 2016 to 2023 are presented in Table 11 and Table 12, respectively:

Table 11: Annual airborne releases from the Darlington Nuclear Site compared with applicable derived release limits (2016 – 2023)

Parameter (Bq/yr)	2016	2017	2018	2019	2020	2021	2022	2023	DRLs
Tritium oxide	$1.8.x10^{14}$	$2.4x10^{14}$	$2.1x10^{14}$	$2.0x10^{14}$	$1.9x10^{14}$	$2.6x10^{14}$	$2.2x10^{14}$	**$5.3x10^{14}$**	**$3.91x10^{16}$**
Elemental tritium*	$1.7x10^{13}$	$1.4x10^{14}$	$4.7x10^{13}$	$2.5x10^{13}$	$1.5x10^{13}$	$1.7x10^{13}$	$9.2x10^{13}$	**$1.3x10^{15}$**	**$6.26x10^{17}$**
Noble gas**	$1.6x10^{13}$	$1.5x10^{13}$	$4.7x10^{13}$	$5.0x10^{13}$	$2.4x10^{13}$	$2.7x10^{13}$	$2.2x10^{13}$	**$4.4x10^{13}$**	**$3.46x10^{16}$**
Iodine-131	$1.4x10^{8}$	$1.5x10^{8}$	$1.4x10^{8}$	$1.4x10^{8}$	$1.5x10^{8}$	$1.5x10^{8}$	$1.4x10^{8}$	**$1.2x10^{8}$**	**$1.74x10^{12}$**

Particulate gross beta-gamma	$3.2x10^{7}$	$2.6x10^{7}$	$2.5x10^{7}$	$2.6x10^{7}$	$3.1x10^{7}$	$2.0x10^{7}$	$2.9x10^{7}$	**$2.8x10^{7}$**	**$5.51x10^{11}$**
Carbon-14	$1.6x10^{12}$	$1.4x10^{12}$	$8.4x10^{11}$	$9.7x10^{11}$	$8.3x10^{11}$	$1.2x10^{12}$	$1.2x10^{12}$	**$1.1x10^{12}$**	**$7.68x10^{14}$**

* Emissions from Darlington Tritium Removal Facility
** Airborne noble gas emission units are in becquerel- Mega electron-volt (Bq-MeV)

Table 12: Annual waterborne releases from the Darlington Nuclear Site compared with applicable release limits (2016 – 2023)

Parameter (Bq/yr)	2016	2017	2018	2019	2020	2021	2022	2023	DRL
Tritium oxide	$3.5x10^{14}$	$5.6x10^{14}$	$2.2x10^{14}$	$1.0x10^{14}$	$1.2x10^{14}$	$1.9x10^{14}$	$2.0x10^{14}$	$2.7x10^{14}$	$6.36x10^{18}$
Gross beta-gamma	$4.9x10^{10}$	$2.6x10^{10}$	$2.6x10^{10}$	$2.3x10^{10}$	$2.5x10^{10}$	$1.6x10^{10}$	$9.3x10^{9}$	$1.7x10^{10}$	$3.47x10^{13}$
Carbon-14	$2.2x10^{9}$	$1.7x10^{9}$	$1.2x10^{9}$	$3.8x10^{8}$	$3.8x10^{8}$	$1.9x10^{9}$	$9.7x10^{8}$	$2.2x10^{8}$	$6.97x10^{14}$

Data in Table 14 and Table 15 demonstrate that radiological releases continued to be well below their corresponding DRLs.

Non-radiological releases

Non-radiological air emissions and waterborne effluent from the DN site are controlled in accordance with provincial Environmental Compliance Approval (ECA) requirements. OPG did not report any ECA non-compliances for air emissions or water effluent to the provincial regulator or the CNSC during the 2016-2023 period. Ozone depleting substances are used in refrigeration systems, releases between 10kg and 100kg are reported to Environment Canada in semi-annual reports. During the current licence term, there were 6 ozone depleting substance releases that have been minimized through routine maintenance of equipment.

Assessment and Monitoring

Since the implementation of CSA N288.4-10, *Environmental Monitoring at Class I Nuclear Facilities and Uranium Mines and Mills* in 2013, OPG expanded its program scope to encompass protection of both the public and the environment from nuclear substances, hazardous substances, and physical stressors.

The objectives of OPG’s environmental monitoring program are to:

- Assess the impact on human health and the environment of contaminants and physical stressors of concern resulting from operation of OPG nuclear facilities.
- Demonstrate compliance with limits on the concentration and/or intensity of contaminants and physical stressors in the environment or assess their effect on the environment.

- Demonstrate the effectiveness of containment and effluent and emissions control and provide public assurance of the effectiveness of containment and effluent control, independent of effluent monitoring.
- Verify the predictions made by the Environmental Risk Assessments (ERAs), refine the models used, and reduce the uncertainty in the predictions made by these assessments and models.

In 2020, OPG implemented a groundwater protection program (GWPP) in accordance with CSA 288.7- 15 *Groundwater protection and monitoring programs for nuclear facilities and uranium mines and mills*, which includes a groundwater monitoring program (GWMP). The purpose of the GWPP is to minimize or prevent releases and impacts to groundwater, as well as to confirm that adequate measures are in place to control and/or monitor these releases.

Results from OPG's GWMP demonstrate that radiological and non-radiological releases of COPCs to groundwater have remained below levels of concern and there are no adverse effects on groundwater quantity or quality from operations at the DN site.

Sampling and analysis within the environmental monitoring program supports the calculation of the annual public dose resulting from the Darlington NGS.

Review of OPG's results of the environmental monitoring programs reports for the period of 2016-2023 shows that the concentration of radionuclides in the environment resulted in very low doses to the public, well below the regulatory dose limit of 1 mSv per year.

Based on the results from OPG's EMP and GWMP, CNSC staff conclude that OPG's reported radiological and non-radiological releases from the Darlington NGS are low and there are no adverse effects on the environment and the public. Additional information is provided in the EPR Report in Section 2 of this CMD.

Protection of People

This specific area within the environmental protection SCA aims to ensure that there is no unreasonable risk to members of the public or to Indigenous Nations and communities, resulting from exposures to releases of nuclear and hazardous substances to the environment, including from spills, and ensuring that the radiation dose received by members of the public does not exceed the regulatory annual public dose limit of 1 mSv/year.

At the Darlington Nuclear site, systems that discharge conventional (non-radiological) contaminants to the environment are approved under the Ontario Ministry of Environment in the Environmental Certificates of Approvals. These approvals are issued in accordance with provincial legislation (e.g., *Environmental Protection Act, Water Resources Act*).

CNSC staff receive reports of releases to the environment (e.g. spills) through reporting requirements outlined in CNSC REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants*. CNSC staffs review of these reports confirms that the environment and the public are protected from non-radioactive discharges to the environment from the Darlington NGS.

Performance information from technical reviews of quarterly and annual reports, as well as the results of inspections from 2016 to 2023 met regulatory requirements in this specific area.

OPG's effluent and emissions monitoring program at Darlington NGS considers two main exposure pathways (airborne and waterborne releases) to estimate radiation dose to a member of the public. The estimated dose to the public from Darlington NGS for 2016 to 2023 is provided in Table 13. These values are consistently well below the regulatory dose limit of 1 mSv/yr (1000 µSv/yr), which is the public dose limit in the *Radiation Protection Regulations*. This shows the risk to the public from Darlington NGS's operations remains low.

Table 13. Darlington Site annual dose to public 2016-2023

2016	2017	2018	2019	2020	2021	2022	2023	Regulatory Limit
0.6 µSv	0.7 µSv	0.8 µSv	0.4 µSv	0.4 µSv	0.6 µSv	0.6 µSv	0.7 µSv	1000 µSv

CNSC staff concluded that the people living in the vicinity of Darlington NGS were protected from the impacts of releases of radiological and non-radiological substances from the facility between 2016 and 2023.

Environmental Management System

OPG has established and implemented an Environmental Management System (EMS) in accordance with CNSC REGDOC-2.9.1, *Environmental Protection Policies, Programs and Procedures*, and is registered with the International Organization for Standardization (ISO) 14002 Environmental Management System Standard. While registration / certification to this standard is not required by the CNSC, it is one measure of verification with CNSC requirements and expectations in that the certification indicates recognition of OPG's EMS by a third party.

OPG's EMS and its supporting governing documents establish the provision of the protection of the environment at the Darlington NGS and continual improvement of environmental performance as required by CNSC REGDOC-2.9.1.

CNSC staff confirm that OPG has maintained a comprehensive EMS at Darlington NGS over the current licensing period that meets CNSC requirements.

3.9.5 Conclusion

Based on CNSC staff's assessments of OPG's Environmental Protection Program at Darlington NGS, OPG's licensing application, supporting documentation and past performance in the Environmental Protection SCA, CNSC staff conclude that there are no concerns related to the protection of the public or the environment. The ERA is required to be updated every 5 years or earlier if there are significant operational changes. CNSC staff noted that no new risks have emerged since the previous ERA revision and no unreasonable risks to human health and the environment attributable to Darlington NGS and DWMF operations were identified. CNSC staff conclude that OPG continues to maintain and implement an effective Environmental Protection Program at Darling NGS.

3.10 Emergency Management and Fire Protection

The specific areas that comprise this SCA include:

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

3.10.1 Assessment of Licence Application

In accordance with GNSCR General Application Requirements, subsection 3.(1.1), CNSC staff conducted a completeness check to verify that programs and topic areas applicable to the Emergency Management and Fire Protection SCA had sufficient supporting documentation referenced in OPGs application. This documentation also had to be sufficiently detailed to describe the nature of the safety and control measures relevant to applicable Emergency Management and Fire Protection topic areas. Some of the topics relevant to this SCA are:

- Emergency Management Policy / Nuclear Pandemic Plan / Consolidated Nuclear Emergency Plan
- Fire Protection

Section 2.10, "Emergency Management and Fire Protection" of OPGs application [1] gives an overview of the specific programs linked to this SCA. Within each program there are associated references to the licensee process documents. The process documents detail the input and outputs to an adequate technical basis supporting the application and CNSC staff found that it met the requirements of the *Class I Nuclear Facilities Regulations* and the expectations outlined in REGDOC-1.1.3, *Licence Application Guide: Licence to Operate a Nuclear Power Plant* [Appendix B.2][21].

Following the sufficiency review, CNSC staff confirmed that the programs referenced in OPGs application demonstrated that an adequate technical basis has been established as relevant to the emergency management and fire protection SCA; and confirmed that the programs within this SCA are adequate and effective to support the continued and safe operation of the plant.

3.10.2 Proposed Improvements

OPG has committed to replace the public address system, with an in-service estimate of December 2026 projected. CNSC staff will continue to monitor the progress towards the completion of this upgrade activity. There was one IIP action item raised associated with this SCA, related to revising existing governance for alignment with the National Building Code of Canada Part 3.

3.10.3 Trends

The following table indicates the rating trends for the Emergency Management and Fire Protection SCA over the current licensing period:

TRENDS FOR EMERGENCY MANAGEMENT AND FIRE PROTECTION				
Overall Compliance Ratings				
2016	**2017**	**2018**	**2019**	**2020**
SA	SA	SA	SA	SA
2021	**2022**	**2023**	**2024**	
SA	SA	SA	N/A	
Comments				
OPG continues to perform satisfactorily in this SCA. CNSC staff concludes that OPG's emergency management and fire protection program meet regulatory requirements.				

3.10.4 Performance

Conventional Emergency Preparedness and Response

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

Nuclear Emergency Preparedness and Response

Nuclear emergency preparedness at Darlington NGS is governed by the (CNEP) and its supporting program documentation.

The CNEP designates the Emergency Management Ontario (EMO) as being responsible for the protection of the public. This is documented in the PNERP Implementation Plan for the Darlington NGS.

As part of their emergency preparedness programs, the licensees conduct emergency preparedness training, drills and exercises to ensure that their sites have adequate and robust emergency notification and response capability from their own on-site staff and/or nearby emergency services with which they have memoranda of understanding or agreements for the provision of assistance in the event of an emergency.

CNSC staff concluded that OPG has sufficient provisions for preparedness and response capability to mitigate the effects of accidental releases of nuclear and hazardous substances on the environment and maintain the health and safety of persons and the national security.

During the current licensing period, OPG conducted two full-scale emergency exercises. Exercise Unified Control in December 2017 and Exercise Unified Command in February 2022. CNSC staff conducted inspections of both exercises and were satisfied with OPGs corrective actions for the non-compliances identified.

Fire Emergency Preparedness and Response

The Darlington NGS Emergency Response Team (ERT) is part of the minimum shift complement for Darlington NGS and responds to events within the protected area.

OPG's fire response program meets the regulatory requirements set out in CSA N293-12 (R2017): *Fire Protection for Nuclear Power Plants* and continues to evolve through a comprehensive training and drill program. Fire training occurs at OPG's live fire training facility in Wesleyville, Ontario and on-site. The Darlington ERT continues to train and drill with its mutual aid partners, Clarington Emergency and Fire Services (CEFS). OPG trains with CEFS during live fire training and on-site for mutual aid fire drills.

CNSC staff concluded that OPG has sufficient provisions for preparedness and response capability to fires at Darlington NGS.

Fire Protection

OPG continues to maintain a comprehensive fire protection program designed to minimize both the probability of fire occurrence and the consequences of fire at their facilities. The fire protection program elements implemented by OPG meet CNSC's regulatory requirements and cover all required elements as outlined in CSA N293.

The implementation of the fire protection program ensures the inspection, testing, and maintenance of fire protection design features and equipment. Additionally, the program establishes the standards and procedures for fire protection design, documentation, and modifications of the plant, while managing changes that affect fire protection.

OPG audits its fire protection program every three years. These audits include the inspection, testing, and maintenance programs, ensuring continued compliance with applicable codes and standards. The audits also identify program weaknesses and areas with precursors to unsafe fire conditions at the plant.

3.10.5 Conclusion

Through the assessment of the licence renewal application and compliance verification activities during the current licence period, CNSC staff conclude that OPG Darlington has sufficient provisions to ensure preparedness and a response capability that would mitigate the effects of accidental releases of nuclear and hazardous substances on the environment and the health and safety of persons. CNSC staff are satisfied that OPG Darlington has made adequate preparations to respond to an emergency. OPG's emergency management and fire protection programs meet regulatory requirements.

3.11 Waste Management

The specific areas that comprise this SCA include:

- Waste characterization
- Waste minimization
- Waste management practices
- Decommissioning plans

3.11.1 Assessment of Licence Application

In accordance with GNSCR General Application Requirements, subsection 3.(1.1), CNSC staff conducted a completeness check to verify that programs and topic areas applicable to the Waste Management SCA had sufficient supporting documentation referenced in OPGs application. This documentation also had to be sufficiently detailed to describe the nature of the safety and control measures relevant to applicable Waste Management topic areas. Some of the topics relevant to this SCA are:

- Nuclear Waste Management Program
- Waste Management
- Decommissioning Planning / Preliminary Decommissioning Plan

Section 2.11, "Waste Management" of OPGs application [1] gives an overview of the specific programs linked to this SCA. Within each program there are associated references to the licensee process documents. The process documents detail the input and outputs to an adequate technical basis supporting the application and CNSC staff found that it met the requirements of the *Class I Nuclear Facilities Regulations* and the expectations outlined in REGDOC-1.1.3, *Licence Application Guide: Licence to Operate a Nuclear Power Plant* [Appendix B.2][21].

Following the sufficiency review, CNSC staff confirmed that the programs referenced in OPGs application demonstrated that an adequate technical basis has been established as relevant to the waste management SCA; and confirmed that the programs within this SCA are adequate and effective to support the continued and safe operation of the plant. Over the period of the proposed licence, routine activities related to waste management will continue in a safe manner, including regular shipments of waste to the Darlington Waste Management Facility, and the Western Waste Management Facility for processing and interim storage.

3.11.2 Proposed Improvements

OPG will provide CNSC staff with an implementation plan by the end of 2024 for CSA N292.3-2014 (R2019), *Management of low- and intermediate-level radioactive waste,* CSA N292.0-2019*, General principles for the management of* *radioactive waste and irradiated fuel,* and CNSC [REGDOC-2.11.1 (2021), *Waste Management, Volume I: Management of Radioactive Waste*].

OPG will update its PDP for the Darlington NGS by December 31, 2026, as part of the planned 5-year PDP update cycle.

No IIP action items were raised related to this SCA.

3.11.3 Trends

The following table indicates the rating trends for the Waste Management SCA over the current licensing period:

TRENDS FOR WASTE MANAGEMENT				
Overall Compliance Ratings				
2016	**2017**	**2018**	**2019**	**2020**
FS	FS	SA	SA	SA
2021	**2022**	**2023**	**2024**	
SA	SA	SA	N/A	
Comments				
OPG continues to perform satisfactorily in this SCA at the Darlington NGS. staff conclude OPGs Waste Management SCA meets regulatory requirements				

3.11.4 Performance

Waste Characterization

Waste produced at the Darlington NGS is initially characterized as either radioactive or non-radioactive. All radioactive waste is then further characterized as Low-level waste (LLW), Intermediate-level waste (ILW) or High-level waste (HLW). Non-radioactive waste is characterized as conventional solid waste, or hazardous chemical waste. Dose rates for LLW waste must be less than 10mSv/h at 30cm, while ILW is greater than or equal to 10mSv/h at 30cm. HLW is used irradiated fuel that has been removed from the reactor. OPG utilizes procedure W-PROC-WM-0096, Nuclear Waste Characterization, to document the characterization requirements for LLW and ILW, as well as the steps needed to prepare a waste characterization plan.

Waste Minimization

OPG implements strategies to minimize waste at the Darlington NGS, both by minimizing the volume of waste generated and reducing the quantity of radioactive waste which is generated. These goals are accomplished by utilizing waste segregation, volume reduction, and decontamination steps in the overall waste management process.

CNSC staff verify the performance of waste minimization through the review of safety performance indicators (SPI) for Low- and Intermediate- Level Radioactive

Solid Waste Generated for Darlington NGS. These results are reported to the CNSC quarterly as per [REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants.*]

Waste Management Practices

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

The waste management program is governed by the following documents to ensure that adequate provisions are in place to limit the generation of radioactive and conventional waste, and to direct how waste is, controlled, managed, handled, stored, and disposed in a safe manner:

- OPG-PROG-0005, Environment Health and Safety Managed Systems
- OPG-STD-0156, Management of Waste and Other Environmentally Regulated Materials
- W-PROG-WM-0001, Nuclear Waste Management Program

Decommissioning

In accordance with paragraph 3(k) of the *Class I Nuclear Facilities Regulations*, OPG is required to maintain a decommissioning plan throughout the life of the station.

OPG's Preliminary Decommissioning Plan (PDP) for the Darlington NGS sets out the strategy and the preliminary plan by which the facility will be decommissioned after the permanent shutdown. Decommissioning involves administrative and technical actions taken to allow the removal of some or all the regulatory controls from a facility, location, or site where nuclear substances are managed, used, processed, or stored. Decommissioning activities are conducted in a manner that ensures that the health, safety, and security of workers, people, and the environment are protected. After decommissioning, OPG will retain ownership of the property and the site will then be available for other industrial, non-nuclear OPG uses, also known as a "brownfield".

OPG's PDP was last updated and presented to the Commission in 2022. CNSC staff verified that OPG's PDP complies with requirements, including CSA N294-19, *Decommissioning of facilities containing nuclear substances*, which OPG implemented in 2021. OPG is required to update its PDP every 5 years. OPG's next PDP will reflect the implementation of REGDOC-2.11.2, *Decommissioning*.

3.11.5 Conclusion

Based on CNSC staff assessments of OPG's licence application and past performance, CNSC staff conclude the implementation of the waste management program at the Darlington NGS establishes an adequate technical basis and continues to meet regulatory requirements.

Based on the assessment of the 2022 version of the PDP, CNSC staff conclude that the PDP meets the regulatory requirements in CSA N294-19, and CNSC Regulatory Guide G-219.

3.12 Security

The specific areas that comprise this SCA include:

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

3.12.1 Assessment of Licence Application

In accordance with GNSCR General Application Requirements, subsection 3.(1.1), CNSC staff conducted a completeness check to verify that programs and topic areas applicable to the Security SCA had sufficient supporting documentation referenced in OPGs application. This documentation also had to be sufficiently detailed to describe the nature of the safety and control measures relevant to applicable Security topic areas. Some of the topics relevant to this SCA are:

- Nuclear Security
- Darlington NGS Security Report

Section 2.12, "Security" of OPGs application [1] gives an overview of the specific programs linked to this SCA. Within each program there are associated references to the licensee process documents. The process documents detail the input and outputs to an adequate technical basis supporting the application and CNSC staff found that it met the requirements of the *Class I Nuclear Facilities Regulations* and the expectations outlined in REGDOC-1.1.3, *Licence Application Guide: Licence to Operate a Nuclear Power Plant* [Appendix B.2][21].

Following the sufficiency review, CNSC staff confirmed that the programs referenced in OPGs application demonstrated that an adequate technical basis has been established as relevant to the security SCA; and confirmed that the programs within this SCA are adequate and effective to support the continued and safe operation of the plant.

3.12.2 Proposed Improvements

OPG has indicated plans for improvements related to the enhancement of security systems at Darlington NGS, including hardware updates, upgrades to the Central Alarm System and integration of the Entry Control System. As the details of these improvements are confidential in nature, they cannot be discussed in this CMD.

In February 2023, CNSC staff issued an action item to OPG for updating OPG's cyber security program to comply with a new revision of N290.7 published in 2021: CSA N290.7:21, *Cyber Security for Nuclear Facilities*.

In September 2023, OPG submitted their gap analysis and implementation plan [79] to CNSC staff. Based on the OPG implementation plan, OPG plans to complete their implementation by March 31, 2027. CNSC staff accepted OPG's gap analysis and implementation plan to fully comply with CSA N290.7:21.

CNSC staff will continue to monitor OPG's CSA N290.7:21 implementation progress through the conduct of regular compliance verification activities during the Darington NGS relicensing period.

No IIP action items were raised related to this SCA.

3.12.3 Trends

The following table indicates the rating trends for the Security SCA over the current licensing period:

TRENDS FOR SECURITY				
Overall Compliance Ratings				
2016	**2017**	**2018**	**2019**	**2020**
SA	SA	SA	SA	SA
2021	**2022**	**2023**	**2024**	
BE	BE	SA	N/A	
Comments				
OPG's performance in this SCA was rated below expectations (BE) in 2021 and 2022. CNSC staff have increased regulatory scrutiny in this SCA and are satisfied that OPG is adequately addressing the identified issues. OPG received a rating of Satisfactory (SA) in 2023 reflecting progress with identified improvement. CNSC staff continue to assess OPG's performance into 2024, which included at Type 1 Reactive Inspection on the Fleetwide Security program. CNSC staff conclude that while OPG continues to work through their corrective action program, OPG's programs within the security SCA are suitable for continued operation.				

3.12.4 Performance

Facilities and Equipment

OPG's Security Program ensures the possession, deployment and operation of required facilities and equipment at Darlington NGS in accordance with the *Nuclear Security Regulations*, and REGDOC-2.12.1, *High-Security Facilities, Volume II: Criteria for Nuclear Security Systems and Devices*.

Response Arrangements

In accordance with the Nuclear Security Regulations and REGDOC-2.12.1, *High Security Facilities, Volume I: Nuclear Response Force, Version 2*, OPG maintains an on-site response force. In addition, OPG has written arrangements with Durham Regional Police Service (DRPS) to provide off-site armed response force support to Darlington NGS. Throughout the current licensing period, OPG submitted their annual threat and risk assessment in accordance with regulatory requirements.

Security Practices

OPG has procedures in place at Darlington NGS to guide plant and security personnel in security practices. OPG's security clearance process ensures that personnel requiring access to OPG locations or access to OPG Security Protected information do not pose a risk to the facilities. OPG-PROC-0119, Clearance Process, and OPG-GUID-61400-0001, Guide to Security Clearance, are maintained in accordance with REGDOC-2.12.2, *Site Access Security Clearance*.

Drills and Exercises

OPG has processes in place to conduct drills and exercises at Darlington NGS. In accordance with subsection 36(2) of the *Nuclear Security Regulations (NSRs)*, Darlington NGS conducts a security exercise every 2 years to test the effectiveness of the contingency plan and of the physical protection system. During the COVID-19 pandemic, the Commission temporarily exempted OPG and other high-security sites from the requirements of subsection 36(2) of the NSRs for a period of 12 to 24 months. Darlington NGS conducted their most recent force-on-force exercises in March 2023. CNSC staff are monitoring OPG corrective actions as a result of this exercise. Darlington NGS will conduct its next security exercise in March 2025.

OPG has undertaken an initiative to realign the security training organization to report into the Nuclear Training Organization, which enables the incorporation of lessons learned and best practices from across OPG's departments. OPG maintains a training program for security personnel to demonstrate compliance with REGDOC -2.12.1, *High-Security Facilities, Volume I: Nuclear Response Force, Version 2* and ensure security officers are able to perform duties as required by the *NSR*s.

Cyber Security

OPG has continued to maintain its cyber security program at Darlington NGS. With the issuance of the CSA N290.7-14, *Cyber Security for Nuclear Power Plants and Small Reactor Facilities*, in October 2015, CNSC staff requested OPG perform a gap analysis between the current cyber security program at Darington

NGS and the requirements of the CSA N290.7-14 and submit an implementation plan to address any identified gaps.

In 2016, OPG submitted an implementation plan to address the identified gaps between the Darington cyber security program and the requirements of the CSA N290.7-14. CNSC staff accepted the gap analysis and implementation plan. Since 2016, OPG has updated its cyber security program to comply with CSA N290.7-14 and completed their implementation in 2019.

CNSC staff concluded that OPG's cyber security program meets applicable regulatory requirements in this specific area over the current licensing period.

3.12.5 Conclusion

During the majority of the licence period, CNSC staff were satisfied with Darlington NGS's performance in the Security SCA, however for the years of 2021 and 2022, several challenges led the Security SCA to be rated as below expectations in the regulatory oversight report. OPG has developed corrective actions to correct deficiencies as a result of non-compliant findings. CNSC staff are satisfied that OPG continues to implement adequate corrective action to address identified deficiencies and that the issues do not pose an immediate risk to safety or security. CNSC staff continue to maintain increased regulatory scrutiny over the Security Program at OPG. Based on CNSC staff's assessment of OPG's application, supporting documentation, and performance during the licence period, CNSC staff conclude that OPG's security program implemented at Darlington NGS is suitable to carry on the licensed activities to operate a Class I nuclear facility.

3.13 Safeguards and Non-Proliferation

The specific areas that comprise this SCA include:

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

3.13.1 Assessment of Licence Application

In accordance with GNSCR General Application Requirements, subsection 3. (1.1), CNSC staff conducted a completeness check to verify that programs and topic areas applicable to the Safeguards and Non-Proliferation SCA had sufficient supporting documentation referenced in OPGs application. This documentation also had to be sufficiently detailed to describe the nature of the safety and control measures relevant to applicable Safeguards and Non-Proliferation topic areas. The topic relevant to this SCA is:

- Nuclear Safeguards

Section 2.13, “Safeguards and Non-Proliferation” of OPGs application [1] gives an overview of the specific programs linked to this SCA. Within each program there are associated references to the licensee process documents. The process documents detail the input and outputs to an adequate technical basis supporting the application and CNSC staff found that it met the requirements of the *Class I Nuclear Facilities Regulations* and the expectations outlined in REGDOC-1.1.3, *Licence Application Guide: Licence to Operate a Nuclear Power Plant* [Appendix B.2][21].

Following the sufficiency review, CNSC staff confirmed that the programs referenced in OPGs application demonstrated that an adequate technical basis has been established as relevant to the safeguards and non-proliferation SCA; and confirmed that the programs within this SCA are adequate and effective to support the continued and safe operation of the plant.

3.13.2 Proposed Improvements

The IAEA approved a revised State-level approach for Canada in 2016. The customized approach establishes the technical objectives that the IAEA must achieve in order to reach its annual conclusion on the peaceful uses of nuclear material in Canada. The IAEA has proposed a Canadian equipment-based approach (CEBA) to verify the loading and transfer of spent fuel from wet to dry storage at the CANDU stations. The CNSC continues to engage with OPG and the IAEA on the implementation of this revised approach, including a series of technical meetings to address issues and to discuss the strategies for implementing the IAEA’s proposals for Darlington NGS.

No IIP action items were raised related to this SCA.

3.13.3 Trends

The following table indicates the rating trends for the Safeguards and Non-Proliferation SCA over the current licensing period:

TRENDS FOR SAFEGUARDS AND NON-PROLIFERATION				
Overall Compliance Ratings				
2016	**2017**	**2018**	**2019**	**2020**
SA	SA	SA	SA	SA
2021	**2022**	**2023**	**2024**	
SA	SA	SA	N/A	
Comments				
OPG continues to perform satisfactorily in this SCA at the Darlington NGS. CNSC staff conclude OPGs Safeguards and Non-Proliferation SCA meets regulatory requirements.				

3.13.4 Performance

Nuclear material accountancy and control

OPG has complied with the CNSC's regulatory requirements in accordance with REGDOC-2.13.1, *Safeguards and Nuclear Material Accountancy*. OPG has submitted the required monthly general ledgers, among other required forms, over the licence period without significant delays.

Access and assistance to the IAEA

In general, OPG has granted adequate access and assistance to the IAEA for safeguards activities during the licensing period.

During the licensing period, the IAEA performed numerous inspections and verifications activities including 9 physical inventory verifications (PIVs), 11 design information verifications (DIVs), 10 short notice random inspections (SNRIs), and 31 unannounced inspections (UIs) at Darlington NGS. In addition, the IAEA performed 2 complementary access (CA) visits at Darlington NGS during the licensing period. In most cases, OPG provided the IAEA with the necessary access and assistance to perform their activities and complied with all regulatory requirements.

Operational and design information

During the licensing period, OPG submitted its annual operational programs and Additional Protocol declarations, as well as quarterly updates to the operational program in a timely manner. The CNSC reviewed these documents and determined that they met requirements.

OPG has provided revisions to their Design Information Questionnaire (DIQ) throughout the licensing period to reflect the safeguards-relevant changes to the facility and its safeguards program.

Safeguards equipment, containment and surveillance

During the licensing period, OPG provided the assistance required for the IAEA's safeguards equipment, containment, and surveillance activities.

Over the Fall of 2024, OPG is coordinating the replacement of the IAEA's four Core Discharge Monitor (CDM) detector boxes and associated wiring in Unit 4 at Darlington NGS. The associated Data Acquisition and Collection Module (DCAM) boxes will be upgraded conjunction with the CDM replacement project. Similar projects were already executed in Unit 1, 2 and 3 at Darlington NGS during the licensing period.

Import and Export

The scope of the non-proliferation program is limited to the tracking and reporting of foreign obligations and origins of nuclear material. This tracking and reporting assist the CNSC in the implementation of Canada's bilateral Nuclear Cooperation

Agreements with other countries. CNSC staff determined that OPG has complied with the CNSC's regulatory requirements.

The import and export of controlled nuclear substances, equipment and information identified in the *Nuclear Non-proliferation Import and Export Control Regulations* require separate authorization from the CNSC, consistent with section 3.(2) of the *General Nuclear Safety and Control Regulations*.

3.13.5 Conclusion

Based on CNSC staff's assessments of OPG's licence renewal application, supporting documents and OPG's past performance in this SCA, CNSC staff conclude that OPG has implemented and maintains effective programs that meet regulatory requirements under the safeguards and non-proliferation SCA.

3.14 Packaging and Transport

The specific areas that comprise this SCA include:

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

3.14.1 Assessment of Licence Application

In accordance with GNSCR General Application Requirements, subsection 3.(1.1), CNSC staff conducted a completeness check to verify that programs and topic areas applicable to the Packaging and Transport SCA had sufficient supporting documentation referenced in OPGs application. This documentation also had to be sufficiently detailed to describe the nature of the safety and control measures relevant to applicable Packaging and Transport topic areas. The topic relevant to this SCA is:

- Radioactive material Transportation

Section 2.14, "Packaging and Transport" of OPGs application [1] gives an overview of the specific programs linked to this SCA. Within each program there are associated references to the licensee process documents. The process documents detail the input and outputs to an adequate technical basis supporting the application and CNSC staff found that it met the requirements of the *Class I Nuclear Facilities Regulations* and the expectations outlined in REGDOC-1.1.3, *Licence Application Guide: Licence to Operate a Nuclear Power Plant* [Appendix B.2][21].

Following the sufficiency review, CNSC staff confirmed that the programs s referenced in OPGs application demonstrated that an adequate technical basis has been established as relevant to the packaging and transport SCA; and confirmed that the programs within this SCA are adequate and effective to support the continued and safe operation of the plant.

3.14.2 Proposed Improvements

There are no proposed improvements in the Packaging and Transport SCA for the requested licence period. No IIP action items were raised related to this SCA.

3.14.3 Trends

The following table indicates the rating trends for the Packaging and Transport SCA over the current licensing period:

TRENDS FOR PACKAGING AND TRANSPORT				
Overall Compliance Ratings				
2016	**2017**	**2018**	**2019**	**2020**
SA	SA	SA	SA	SA
2021	**2022**	**2023**	**2024**	
SA	SA	SA	N/A	
Comments				
OPG continues to perform satisfactorily in this SCA at the Darlington NGS. CNSC staff conclude OPGs Packaging and Transport SCA meets regulatory requirements.				

3.14.4 Performance

Packaging and Transport

CNSC staff conducted 2 packaging and transport inspections at the Darlington site over the current licensing period. As a result of the inspections, there were no issues reported. CNSC staff concluded packaging and transport of nuclear substances at the Darlington site meets regulatory requirements and expectations.

3.14.5 Conclusion

Based on CNSC staff assessments of OPG's Darlington licence application, supporting documents and past performance, OPG's implementation of the packaging and transport SCA has met and continues to meet all applicable regulatory requirements.

4. Indigenous and Public Consultation and Engagement

4.1 Indigenous Consultation and Engagement

The common-law duty to consult with Indigenous Nations and communities applies when the Crown contemplates actions that may adversely affect potential or established Indigenous and/or treaty rights. The CNSC ensures that all of its licence decisions under the *NSCA* uphold the honour of the Crown and upholds Indigenous peoples' potential or established Indigenous and/or treaty rights pursuant to section 35 of the Constitution Act, 1982.

CNSC staff are committed to building long-term relationships with Indigenous Nations and communities who have interest in CNSC-regulated facilities within their traditional and/or treaty territories. The CNSC's Indigenous engagement practices include sharing information, discussing topics of interest, seeking feedback and input on CNSC processes, and providing opportunities to participate in environmental monitoring. The CNSC also provides funding support (through the CNSC's Participant Funding Program and Indigenous and Stakeholder Capacity Fund) for Indigenous peoples to meaningfully participate in Commission proceedings and ongoing regulatory activities.

4.1.1 Discussion

Based on the information received in the proponent's application, the licence renewal is unlikely to cause new adverse impacts to the exercise of established or potential Indigenous and/or treaty rights as continued operations will not change the Darlington NGS site characterization or result in the installation of new facilities at the site. The renewal does not include expanding the site footprint or any new activities.

The Darlington site is located on the north shore of Lake Ontario in Clarington, Ontario, 5 kilometers outside the town of Bowmanville and 10 kilometers southeast of Oshawa. The Darlington site resides on lands in which many Indigenous Nations and communities have a vested interest and rights, lying within the lands and waters of the Michi Saagiig Anishinaabeg, the Gunshot Treaty (1877-88), the Williams Treaties (1923), and the Williams Treaties Settlement Agreement (2018). The CNSC has ensured it has carried out a thorough engagement process so that CNSC staff can understand, and work to address, any concerns that Indigenous Nations and communities may have with respect to OPG's licence renewal application. The CNSC is committed to keeping the identified Indigenous Nations and communities informed of ongoing activities in their territories.

CNSC Staff Engagement Activities

The Indigenous Nations and communities listed below have been identified based on analysis conducted by CNSC staff using Crown Indigenous Relations and Northern Affairs Canada's (CIRNAC) Aboriginal and Treaty Rights Information System (ATRIS) and other mapping tools, as well as through a review of existing CNSC and open resources including records of Indigenous Nations and communities who may have expressed interest in OPG's Darlington NGS in the past. Should other Indigenous Nations and communities not included in the list identify interest in the licence application moving forward, they will be added as appropriate.

CNSC staff identified the following Indigenous Nations and Communities who have Indigenous and/or Treaty rights in the area where Darlington NGS is located:

- Alderville First Nation (AFN)
- Curve Lake First Nation (CLFN)

- Hiawatha First Nation (HFN)
- Mississaugas of Scugog Island First Nation (MSIFN)
- Chippewas of Beausoleil First Nation
- Georgina Island First Nation
- Chippewas of Rama First Nation

In addition, CNSC staff have identified the following Indigenous Nations and communities that have expressed interest in the Darlington NGS site:

- Mohawks of the Bay of Quinte
- Métis Nation of Ontario (MNO)
- Six Nations of the Grand River
- Mississaugas of the Credit First Nation (MCFN)
- Saugeen Ojibway Nation (SON)

A Notice of Public Hearing was sent to the identified Indigenous Nations and communities on March 25, 2024. The notice also included information on participant funding; the CNSC made available up to $100,000 through its Participant Funding Program (PFP) to support Indigenous Nations and communities and members of the public in providing value added information to the Commission through informed and topic-specific interventions.

Full details on the participant funding made available and all parties that were awarded funding are available in Section 4.2 of this CMD. MSIFN, SON, CLFN and HFN applied for and received funding to participate in this Commission hearing.

Following up on the initial notification sent on March 25, 2024, project notification letters were sent out on July 3, 2024, to each Indigenous Nation and community. These letters reiterated information regarding the proposed licence renewal application and opportunities to participate in the Commission's hearing process. CNSC staff offered to meet with all identified Indigenous Nations and communities to discuss the application and raised OPG's licence renewal application in regular meetings under Terms of Reference for long-term engagement arrangements with CLFN, HFN and MSIFN. The CNSC currently has a Terms of Reference for long-term engagement with CLFN, HFN, MSIFN, SON and MNO. The CNSC is open to developing Terms of Reference for long-term engagement with other interested Indigenous Nations and communities as appropriate.

All the identified Indigenous Nations and communities have been encouraged to participate in the regulatory review process and in the Commission hearing through written and/or oral interventions to advise the Commission directly of any concerns they may have in relation to this licence renewal application.

To date, MSIFN, SON, CLFN, HFN and MCFN have expressed interest in the licence renewal application. Of all identified Indigenous Nations and communities, HFN, CLFN, MSIFN and MCFN took the CNSC's offer for specific Darlington NGS licence renewal meetings. On May 16, 2024, CNSC staff gave a presentation [80] and discussed the CNSC's licensing process and OPG's Darlington NGS licence renewal application with HFN. Specific topics of interest that were discussed with CNSC staff are summarized here:

- **Concerns on the 30-year licence, specifically on how OPG plans to engage with Indigenous Nations within a 30-year licence term**. CNSC staff committed to bringing the identified concerns to the Commission and OPG through this CMD. Staff noted that the application is still being reviewed and no decisions on the length of the licence have been determined. Staff elaborated that the Commission will base their decision on OPG's application, CNSC staff's recommendations and information received from Indigenous Nations and communities and the public as part of their interventions. CNSC staff noted that, regardless of how long the licensing period is, there are multiple ways CNSC staff assess and report on licensee performance and activities during their licensing period. For example, the use of periodic safety reviews, environmental monitoring, regulatory oversight reports, event initial reports, scheduled reporting and compliance verification activities and regular updates to the Commission. Indigenous Nations can bring to the Commission's attention any issue of concern during any of the Commission proceedings and, in fact, at any time of their choosing.
- **Outstanding concerns on Darlington NGS waste storage, transportation and management.** CNSC staff note that OPG has a mature waste management program at the Darlington NGS that governs activities to minimize, control and properly dispose of radioactive, hazardous, and conventional waste. OPG continues to meet regulatory requirements relevant to the Waste Management at the Darlington NGS. The CNSC staff regularly perform inspections and other compliance verification activities to verify that waste is controlled, managed, handled, transported, and stored in a safe manner and in accordance with regulatory requirements. The CNSC is committed to working with HFN to respond to and address concerns and questions in relation to waste management and transportation in relation to the Darlington NGS and are committed to ongoing meaningful engagement with HFN throughout the full life cycle of the Darlington NGS.
- **Concerns on the short deadline for submitting a PFP application.** CNSC staff confirmed that May 24th was the deadline but was happy to extend the deadline should the Nation require more time. To address these Concerns CNSC staff granted an extension to HFN, who submitted a PFP application on August 2, 2024.

- **Lack of ability to voice concerns and exercise self-determination in relation to the project, especially with a 30-year licence.** CNSC staff highlighted there are avenues to bring forth concerns through the existing relationships between the CNSC and the proponent and through the Commission proceedings, such as regulatory oversight reports (RORs). CNSC staff also highlighted the ability to raise concerns at any time directly to Commission in written communication. CNSC staff remain committed to collaborating with HFN to address their concerns and will continue to provide updates on the Darlington NGS through regular meetings under the Terms of Reference for long-term engagement. Furthermore, the CNSC is committed to working to address any issues and concerns as they arise throughout the life cycle of the Darlington NGS, as there are opportunities for addressing concerns through the CNSC's ongoing oversight. One example of an opportunity is the inclusion of HFN in Darlington NGS and CNSC environmental monitoring programs to reflect their knowledge and perspectives. In addition, HFN and other Indigenous Nations and communities are able to intervene in both writing and orally as part of the annual NPGS Regulatory Oversight Report Public Commission meeting, which includes the Darlington NGS. Finally, CNSC staff are recommending an additional Darlington NGS licence condition that requires OPG to continue ongoing engagement with identified Indigenous Nations and communities regarding their own operations and report annually to the CNSC. The CNSC is committed to collaborating with HFN and other Indigenous Nations on the ongoing oversight and reporting on OPG's engagement related to the Darlington NGS.

On May 16, 2024, CNSC staff gave a presentation [81] and discussed the CNSC's licensing process and OPG's Darlington NGS licence renewal application with CLFN. Specific topics of interest that were discussed with CNSC staff are summarized here:

- **Concerns on the length of the licence; 30 years is very long and CLFN is not supportive of this length.** CNSC staff highlighted that this is what OPG is requesting, and the Commission will have to decide whether to grant the request. CNSC staff noted that a decision on the length of the licence cannot be determined other than by the Commission and that the Commission will base their decision on OPG's application, CNSC staff's recommendations and information received from Indigenous Nations and communities and the public. As mentioned above, CNSC staff noted that, regardless of how long the period is, there are multiple ways CNSC staff assess and frequently report on licensee performance and activities during their licensing period. For example, the use of periodic safety reviews, environmental monitoring, regulatory oversight reports, event initial reports, scheduled reporting and compliance verification activities, RORs, and regular updates to the Commission as well as CNSC staff's proposed licence condition for OPG's ongoing engagement with Indigenous nations and communities.

- **Inquiries on whether a licence re-evaluation can be triggered by the Nations if they are unsatisfied with OPG after 5 or 10 years even if they are granted the 30-year licence.** CNSC staff highlighted that the Commission has the power to revoke or update a licence at any point if the licensee were not meeting their legal obligations and it was determined the licence would need re-evaluation. CNSC staff noted that performance is monitored, analyzed, reported on with opportunities to be involved through processes such as the annual regulatory oversight report and mid-term updates and that the Nation can write at any time directly to the Commission to raise their concerns as well. In addition, the CNSC is committed to collaborating with CLFN and other Indigenous Nations on the ongoing oversight and reporting on OPG's engagement related to the Darlington NGS as per the proposed licence condition for OPG's ongoing engagement for the Darlington NGS.
- **Reliance on CNSC staff and Western processes to understand and bring forward issues to ensure Indigenous rights are properly respected.** CNSC staff acknowledged these concerns and highlighted that there are mechanisms in place to ensure Indigenous rights are protected and concerns of the Nations are heard and responded to. CNSC staff noted that the current avenues include the existing relationship with the CNSC, the yearly regulatory oversight reports and the intervention process. The CNSC is committed to working to address any issues and concerns as they arise throughout the life cycle of the Darlington NGS, as there are opportunities for addressing concerns through ongoing oversight of the Darlington NGS such as inclusion of CLFN in Darlington NGS and CNSC environmental monitoring programs to reflect their knowledge and perspectives. In addition, CLFN and other Indigenous Nations and communities are able to intervene in both writing and orally as part of the annual NPGS Regulatory Oversight Report Public Commission meeting, which includes the Darlington NGS. In addition, the CNSC is committed to collaborating with CLFN and other Indigenous Nations on the ongoing oversight and reporting on OPG's engagement related to the Darlington NGS as per the proposed licence condition 2.7 for OPG's ongoing engagement for the Darlington NGS.

On October 31, 2024, CNSC staff gave a presentation [82] and discussed the CNSC's licensing process and OPG's Darlington NGS licence renewal application with MCFN. Specific topics of interest that were discussed with CNSC staff are summarized here:

- **Interest in projects occurring at the Darlington site and other nuclear generating stations along Lake Ontario as they relate to MCFN's Unextinguished Aboriginal Title Claim to the waters in its territory, including Lake Ontario.** MCFN didn't raise specific concerns regarding the Darlington NGS renewal, however, CNSC staff responded that they are open to receiving more information from MCFN on their concerns as it relates to nuclear facilities near Lake Ontario and will work to address any related concerns in collaboration with MCFN and relevant CNSC licensees. CNSC staff confirmed they will continue to keep MCFN informed of projects of interest and encouraged MCFN to express their views directly to the Commission to help inform their decision making for the OPG's Darlington NGS licence renewal application.

- **Difficulty receiving information regarding the Department of Fisheries and Oceans' (DFO's) Fisheries Act Authorization (FAA) as it relates to the Darlington NGS.** CNSC staff note that DFO is the lead on the reviews and assessments for anything related to FAAs; CNSC staff typically review and submit comments back to DFO for their consideration when they respond to OPG. CNSC staff offered to support MCFN with following up with DFO and OPG to get a status update should that be of interest. Since the October 31st meeting with MCFN, CNSC staff have followed up with DFO to inquire on the status of the FAA and have arranged between DFO and interested Indigenous Nations and communities and facilitated sharing of information to provide clarity on the status of the FAA for the Darlington NGS.
- **Lack of capacity for MCFN to participate in projects such as the Darlington NGS licence renewal application.** CNSC staff reiterated the different funding options available that the CNSC offers for the purpose of building capacity and supporting Indigenous Nations like MCFN in their participation in the CNSC's regulatory processes, specifically the PFP and Indigenous and Stakeholder Capacity Fund. MCFN was included on all communications regarding funding made available for participation in the Darlington NGS licence renewal application Commission proceedings, however, MCFN did not submit a funding application. CNSC staff noted that they would be happy to work with MCFN to support them in submitting future funding applications when there are relevant funding opportunities, should that be of interest to MCFN.

On November 15, 2024, CNSC staff gave a presentation [127] and discussed the CNSC's licensing process and OPG's Darlington NGS licence renewal application with MSIFN. Specific topics of interest that were discussed with CNSC staff are summarized here:

- **Lack of opportunity for MSIFN and other Indigenous Nations to participate in or to speak at the Part I Commission Hearing as government entities and organizations are invited to do so.** CNSC staff noted that the Part 1 and Part 2 Commission hearings for the Darlington NGS licence renewal hearing are both parts of the same hearing, and that all issues are open to be discussed and addressed at Part 2 when interventions from Indigenous Nations are included. CNSC staff are aware that the Commission Registry is considering adjustments to the hearing process, to make it more inclusive for Indigenous participants. CNSC staff have been supportive of MSIFN working with the Registry to discuss feedback on the CNSC's Commission proceeding process in order to better incorporate ceremony and cultural protocols into the Commission hearing process and ensure that the Nations are treated as rights holders as part of the decision making and regulatory process. Based on feedback received from Indigenous Nations and communities through previous hearing processes for other projects, CNSC staff have worked with MSIFN and the Commission Registry to set up meetings to discuss this topic further.

CNSC staff inquired whether MSIFN had specific questions or concerns in relation to OPG's licence renewal application, including the requested 30-year timeframe. MSIFN noted that they had no further comments in relation to the Darlington NGS renewal application at the time of the meeting on November 15th. They indicated that MSIFN's position on the licence renewal application and any further concerns would be communicated in the intervention they intend to submit to the Commission.

CNSC staff continue to follow up with HFN, CLFN and MSIFN in monthly meetings on their interests and questions regarding OPG's application and the Darlington NGS facility. MNO has not raised concerns in monthly meetings with CNSC staff in relation to OPG's licence renewal application to date. CNSC staff have also continued to provide information and offered to meet to discuss CNSC's role and OPG's application with other Indigenous Nations and communities with potential rights and interests in relation to the Darlington NGS. Follow up e-mails were sent to each Indigenous Nation and community on October 2nd and 3rd, 2024 followed by phone calls to Indigenous Nations and communities who did not respond on October 11th, 2024.

CNSC staff have worked to address the concerns raised to date to the greatest extent possible by having discussions, reflecting Indigenous Nations and community's views in CNSC's documentation, communicating concerns to OPG, discussing the Darlington NGS at regularly scheduled meetings, offering to meet to better understand concerns and identify a path forward to addressing the concerns. CNSC staff have responded to all questions and concerns raised to date and have recommended a Darlington NGS specific licence condition requiring OPG to continue ongoing engagement with Indigenous Nations and communities and report annually to the CNSC to help address the concerns the CNSC has heard to date regarding the requested licence term length.

Based on CNSC staff's engagement activities to date, CNSC staff have not identified any concerns with respect to potential new impacts to Indigenous or treaty rights in relation to the licence renewal application and remain committed to ongoing engagement with all identified Nations and communities moving forward.

The identified Indigenous Nations and communities have been encouraged to participate in the regulatory review process and in the public Commission Hearing to advise the Commission directly of any concerns they may have in relation to OPG's application. CNSC staff have also encouraged OPG to continue engagement with Indigenous Nations and communities about their long-term plans for the Darlington NGS site.

Engagement on CNSC Staff's Environmental Protection Review Report (EPRR)

As per the CNSC's Indigenous Knowledge Policy Framework, the CNSC recognizes the importance of considering and including Indigenous Knowledge in all aspects of its regulatory processes, including Environmental Protection Review Report (EPRRs). On September 4, 2024, CNSC staff shared the Darlington Nuclear Site EPR (part 2 of this CMD) with the Nations most engaged and interested in reviewing the report – HFN, CLFN and MSIFN – to review and add comments to ensure it appropriately reflects any information in relation to Indigenous Knowledge as well as Indigenous and/or Treaty rights that is shared with the CNSC. MSIFN and CLFN provided comments on the report. CNSC staff updated the report based on the feedback received and worked with MSIFN and CLFN to include views expressed sections within the EPRR. The sections highlight overarching comments to be addressed as longer-term goals and were shared with MSIFN and CLFN for review and comment.

Collaboration on Environmental Monitoring Activities

In advance of the 2023 CNSC IEMP sampling campaign around the Darlington NGS, CNSC staff notified Indigenous Nations and communities of the planned sampling campaign, sought their input on the sampling plan and invited them to join CNSC staff in the field for sampling activities.

The MSIFN reviewed the sampling plan in early 2023 and provided comments on species and locations of importance. Three representatives from MSIFN joined the sampling team in the field in September 2023 to collect water, vegetation, and soil samples. CNSC staff and the MSIFN representatives discussed the IEMP and walked through techniques for sampling air, water and soil, as well as packaging and chain of custody procedures.

Representatives from CLFN and HFN also expressed an interest in participating in the campaign and joined the CNSC field team to collect samples. The CLFN and HFN representatives assisted in the collection of water, vegetation, sand, and soil samples and requested that CNSC staff test manoomin (wild rice) harvested from Chemong Lake (located in the CLFN community). Manoomin was sampled that day and again when CNSC staff returned to the area on September 10, 2024.

Having MSIFN, CLFN and HFN representatives participate in IEMP sampling provided an opportunity for mutual learning and understanding while supporting transparency and building trust. CNSC staff are committed to continuing to provide Indigenous Nations and communities with opportunities to participate in IEMP planning and sampling around Darlington NGS and other sites of interest.

Licensee Engagement Activities

Based on the information in OPG's application, the licence renewal is unlikely to cause new adverse impacts to the exercise of potential or established Indigenous and/or Treaty rights as the licence renewal will not change the Darlington NGS site characterization, authorize new activities or result in the construction of new facilities at the site. As it is unlikely that the licence renewal could have an adverse impact on Indigenous and/or Treaty rights, the requirements in REGDOC-3.2.2: *Indigenous Engagement* do not apply.

However, OPG's licence renewal application does include details on OPG's Indigenous engagement policy and activities completed to date. The application states that OPG's intent is to develop a framework for both the licence renewal application process as well as ongoing engagement after a licensing decision is made and will work in collaboration with Indigenous Nations and communities to build community specific engagement plans. The application also describes its Indigenous Relations Policy which includes the following initiatives:

- Establishment of several Framework Agreements with Indigenous Nations and communities to support regular engagement.
- Invitations provided to several Indigenous Nations and communities to engage on this licence renewal application.
- Ongoing meetings with Indigenous Nations and communities to discuss station operations and performance and other priority topics from the communities.
- Invitations to participate in the Canadian Centre for Nuclear Sustainability and its Indigenous Advisory Council.
- Creation and participation in the Indigenous Opportunities Network, an OPG community-centered program aimed to increase the representation of Indigenous workers at OPG and within the broader energy sector.

OPG also states their commitment to support continued, meaningful dialogue with Indigenous Nations and communities and members of the public, during the requested licence term to ensure concerns are addressed. OPG has established Framework Agreements with the CLFN, HFN, the MSIFN, the Six Nations of the Grand River, and AFN, which allow for dedicated time and capacity funding to support ongoing, regular engagement on OPG's operations. For those Nations and communities with whom there are no established agreements, OPG has provided Darlington NGS PROL renewal information and has offered to meet.

OPG's engagement specific to the Darlington NGS licence renewal has consisted of:

- In December 2023, provision of initial information and offers to meet to discuss further.
- In August 2023, introductory Darlington NGS licence renewal presentations to CLFN and HFN.
- In September 2023, relationship building with CLFN.
- In February 2024, update meetings with CLFN, HFN and MSIFN.

In the Darlington NGS PROL Licence Renewal Application, OPG has committed to:

- Work in collaboration with Indigenous Nations to build a Draft Darlington NGS PROL Relicensing Indigenous Engagement Plan and circulate it to identified Indigenous Nations and communities.
- Work in collaboration with Indigenous Nations and communities to identify approaches to engagement that is considerate of the engagement context and the interests of each Indigenous Nation and community.
- Support the development of an Indigenous Knowledge Study (IKS), led by MSIFN, CLFN, HFN and AFN. The initial focus will be on the Darlington New Nuclear Project area and will extend to Darlington and Pickering NGS, and in time, to WTFN shared and treaty territory. This IKS will help to inform OPG regarding cumulative effects of nuclear development in the territory and an enhanced monitoring program featuring participation of the Nations.
- Providing upcoming opportunities for site visits, workshops and information sessions will be extended, or as interest is expressed by Indigenous Nations and communities.
- Responding to questions, concerns or comments from Indigenous Nations and communities, and continual improvement upon its engagement activities.

CNSC staff are satisfied with OPG's engagement activities to date and encourages OPG to continue working with Indigenous Nations and communities through ongoing engagement, including discussing issues and concerns raised and working collaboratively to address them. CNSC staff are also proposing a licence condition to require OPG to continue to engage with Indigenous Nations throughout the licensing term of the Darlington NGS to ensure ongoing oversight and reporting on OPG's activities and commitments with Indigenous Nations.

4.1.2 Conclusion

CNSC staff have determined that the requested licensing decision is unlikely to have new impacts on Indigenous and/or treaty rights.

For this licence renewal application, both OPG and the CNSC conducted engagement activities with interested Indigenous Nations and communities to ensure that each Nation has the ability to express any issues or concerns with regards OPG's licence application and participate in the regulatory review process including the Commission Hearing. The CNSC and OPG have worked to identify potential solutions and commitments to address the concerns raised by Indigenous Nations and communities to date.

The CNSC is committed to meaningful, ongoing engagement and collaboration with Indigenous Nations and communities that have an interest in CNSC regulated facilities and activities and encourages OPG to continue to engage with interested Indigenous Nations and communities on this licence application and other ongoing activities of interest.

4.2 CNSC Public Consultation and Engagement

The *NSCA* mandates the CNSC to disseminate objective scientific, technical and regulatory information to the public concerning its activities and the activities it regulates. CNSC staff fulfill this mandate in a variety of ways, including hosting in-person and virtual information sessions and through annual regulatory reports.

4.2.1 Discussion

Participant Funding Program

The Canadian Nuclear Safety Commission's (CNSC) established the Participant Funding Program (PFP) to:

1. enhance individual, not-for-profit organization and Indigenous Nations and Communities participation in the CNSC's environmental assessment (EA) and licensing processes for major nuclear facilities;
2. assist individuals, not-for-profit organizations and Indigenous Nations and Communities to bring value-added information to the Commission through informed and topic-specific interventions related to EAs and licensing.

The CNSC made available up to $100,000 through its Participant Funding Program (PFP) to support Indigenous Nations and communities, members of the public and interested parties in providing value added information to the Commission through informed and topic-specific interventions. This funding was offered to review OPG's application and associated documents, and in participating in the Commission hearing process by providing topic-specific interventions to the Commission.

The deadline for applications was May 24, 2024. A Funding Review Committee (FRC), independent from the CNSC, was established to review the funding applications received by the CNSC's PFP Administrator and make recommendations on the allocation of funding to eligible applicants. Considering that the FRC determined that the applications received will bring added value to the Commission, the number of applications and the high level of interest in OPG's application to renew the Darlington NGS's licence to operate, the FRC was given the flexibility to recommend funding beyond $100,000 originally offered. Based on recommendations from the FRC, the CNSC awarded a total of **$143,719.05** in funding to the following recipients, who are required to submit a written and/or oral intervention to the Commission Registry by May 8, 2025 for the Commission's consideration:

Applicant	Maximum amount of available funding
Canadian Association of Nuclear Host Communities	$20,400
Mississaugas of Scugog Island First Nation	$34,330.23

Canadian Environmental Law Association	$20,000
Saugeen Ojibway Nation	$18,855.80
Nuclear Transparency Project	$6,250
Paul Sedran	$1,500
Curve Lake First Nation	$25,278
Hiawatha First Nation	$17,105.02
Total	**$143,719.05**

The CNSC continues to actively promote ongoing communication and dissemination of regulatory and scientific information through social media channels, webinars, mail-outs, outreach in the local communities and postings on the CNSC web site. The CNSC offers assistance to interested members of the public and Indigenous Nations and communities through the PFP, to prepare for and participate in the Commission's hearing process. This funding is available for all Commission meetings and hearings, including for the annual Regulatory Oversight Reports and will assist in ensuring that Indigenous Nations and communities and members of the public are able to fully engage with the Commission over the proposed licensing period.

4.2.2 Conclusion

CNSC staff continue to inform Indigenous Nations and communities and the public of our regulatory activities through regular website updates, publicly webcast Commission proceedings, social media, public webinars, mail out flyers and regular discussion with key audiences near the Darlington NGS.

CNSC staff encourage the public and Indigenous communities to participate in Commission proceedings. PFP is offered to assist interested members of the public and Indigenous Nations and communities to prepare for and participate in Commission proceedings.

4.3 Licensee Public Information and Engagement

A Public Information and Disclosure Program (PIDP) is a regulatory requirement for licence applicants and licensees of Class I nuclear facilities, uranium mines and mills and certain Class II nuclear facilities. These requirements are found in REGDOC-3.2.1, *Public Information and Disclosure*.

The primary goal of the PIDP is to ensure that information related to the health, safety and security of persons and the environment, and other issues associated with the lifecycle of nuclear facilities are effectively communicated to the public. The program must include a commitment to, and protocol for ongoing, timely communication of information related to the licensed facility during the course of the licence period.

CNSC's expectations of a licensee's public information program and disclosure protocol are commensurate with the level of risk of the facility, as well as the level of public interest in the licensed activities. The program and protocol may be further influenced by the complexity of the nuclear facility and activities, and the risks to public health and safety and the environment perceived to be associated with the facility and activities.

4.3.1 Discussion

Currently, OPG has a fleet-wide public information and disclosure protocol which addresses all licenced facilities. To ensure compliance, OPG's PIDP program is assessed regularly by CNSC staff (annually and periodically) and has been found to consistently and appropriately communicate with the public regarding events and activities of interest at Darlington NGS.

Licensees are expected to review their PIDPs regularly and to update as required. Revisions and change notifications sent to the CNSC are assessed to understand the rationale for and impact of the change and to ensure ongoing compliance. Updates may include improvements or modifications to any element of the program, such as target audiences, mode and frequency of communication, lessons learned from audience feedback or a shift in areas of interest expressed by target audiences.

REGDOC 3.2.1 is currently under review and the updated version will be implemented within the next two years. OPG will be required to comply with any changes to the regulatory requirements.

Staff will continue to assess OPGs PIDP (program and protocol) throughout the lifecycle of the licensed facility(ies) to ensure compliance and ongoing improvements which must continue to provide information to the public in a timely and appropriate way.

For this licence renewal application, OPG has demonstrated that both the public information program and its disclosure protocol build upon past activities to address the communication needs of their target audiences.

Should OPG be granted a 30-year license by Commission, an updated PIDP from OPG would be required to address the long-term communications objectives and explain how the program will be updated throughout the licensing period.

4.3.2 Conclusion

CNSC staff's review of the Darlington NGS licence renewal application confirms that OPG continues to regularly and proactively communicate with members of the public in a timely and easily accessible way.

5. Other Matters of Regulatory Interest

5.1 Cost Recovery

Paragraph 24(2)(c) of the *NSCA* requires that a licence application is accompanied by the prescribed fee. The CNSC *Cost Recovery Fees Regulations* (CRFR) set out the specific requirements based on the activities to be licensed. An applicant for a

Class I facility licence is subject to Part 2 of CRFR, which is based on Regulatory Activity Plan fees.

5.1.1 Discussion

CNSC staff have determined that OPG is in good standing with respect to CRFR requirements for the Darlington NGS.

OPG's licence renewal application for the Darlington NGS is not a new application, and as such OPG is not required to submit the initial fee of $25,000 as described in paragraph 7(1)(a), which are only for new applicants. In this case, OPG is subject to subsection 5(2), which relates to quarterly invoices sent to licensees.

5.1.2 Conclusion

After reviewing CNSC records, CNSC staff conclude that OPG is in good standing with respect to CRFR requirements for the Darlington NGS. Based on OPG's previous performance, there are no concerns regarding the payment of future cost recovery fees.

5.2 Financial Guarantees

Under subsection 24(5) of the *NSCA*; a licence may contain any term or condition that the Commission considers necessary for the purposes of this Act, including a condition that the applicant provide a financial guarantee in a form that is acceptable to the Commission. *General Nuclear Safety and Control Regulations*, paragraph 3(1)(l) stipulates that, "an application for a licence shall contain a description of any proposed financial guarantee related to the activity for which a licence application is submitted." The financial guarantee for decommissioning is established to fund the activities described in the Preliminary Decommissioning Plan (PDP). These requirements are found in REGDOC-3.3.1, *Financial Guarantees for Decommissioning of Nuclear Facilities and Termination of Licensed Activities*.

5.2.1 Discussion

OPG maintains a consolidated financial guarantee for decommissioning its Ontario assets, including the Darlington NGS. The Commission accepted OPG's revised consolidated financial guarantee for the 2023-2027 period on December 6, 2022.

In accordance with the PROL and as described in section G.5 of the proposed Darlington NGS LCH, OPG is required to revise decommissioning plans, including the associated cost estimates and financial guarantee, on a five-year cycle. OPG's next financial guarantee submission is due by Dec. 31, 2026.

OPG's financial guarantee includes segregated funds established pursuant to the Ontario Nuclear Funds Agreement between OPG and the Province of Ontario, as well as the trust fund for the management of used nuclear fuel established pursuant to the *Nuclear Fuel Waste Act*. The total required amount for each year in the 2023-2027 period is projected to be satisfied without the need for a provincial guarantee because the projected value of the Nuclear Funds exceeds the decommissioning liability.

OPG is required to submit annual reports on its financial guarantee. As of 2023, the current CNSC funding requirement is $20,480 million and the total financial guaranteed value is $23,998 million. CNSC staff's review of OPG's 2023 report and applicable financial statements confirmed that OPG's available funds are sufficient to cover the required financial guarantee.

OPG's current financial guarantee is based on assumed commercial operations of Darlington NGS until the end of 2056. CNSC staff are satisfied that the financial guarantee amount remains sufficient.

5.2.2 Conclusion

OPG maintains a financial guarantee for Darlington NGS in accordance with regulatory requirements, which was accepted by the Commission in 2022. CNSC staff conclude that OPG's current financial guarantee is adequate for the future decommissioning of the Darlington NGS covered under the OPG's consolidated financial guarantee.

5.3 Nuclear Liability Insurance

The *Nuclear Liability and Compensation Act* (NLCA), which came into force on January 1, 2017, requires nuclear installations to carry financial security for third-party (civil) liability in the event of a nuclear incident as defined under section 2 of the NLCA.

The NLCA is administered by Natural Resources Canada (NRCan). The Darlington NGS site is currently designated, pursuant to section 7 of the NLCA, as a nuclear installation in Item 5, Column 1 of the Schedule of the Nuclear Liability and Compensation Regulations (NLCR).

5.3.1 Discussion

The Darlington NGS site contains two facilities that are authorized to contain nuclear material as defined in the NLCA, that is, a four-unit power reactor facility and a solid radioactive waste management facility. These facilities are listed in item 5, column 4 in the Schedule of the NLCR. Section 4 of the NLCR describes classes of nuclear installations and ranks the risk of each class. Because the four-unit power reactor facility is the facility with the highest risk, Darlington NGS installation falls under the "Power Reactor Class" pursuant to paragraph 4(2)(a) of the NLCR, and OPG's liability amount is prescribed at 1 billion dollars pursuant to paragraph 24(1)(d) of the NLCA.

5.3.2 Conclusion

CNSC staff have confirmed with Natural Resources and Energy Canada staff that, as of October 7th, 2024, OPG is in compliance with its obligation under the NLCA and has the requisite third-party (civil) liability financial security for the Darlington NGS.

5.4 Fisheries Act Authorization

5.4.1 Discussion

Fisheries and Oceans Canada (DFO) issued a Fisheries Act Authorization (FAA) to OPG for the Darlington NGS on June 24, 2015. DFO is responsible to lead all reviews related to the existing FAA. As per the existing DFO-CNSC MOU, CNSC staff are involved in technical reviews related to this FAA and provide comments to DFO for DFO's consideration.

To meet the offsetting requirements of the FAA (compensation for residual harm to fish and fish habitat), OPG submitted a letter of credit to DFO (to cover the costs of implementing the offsetting plan), and has carried out a coastal wetland habitat restoration at the Big Island-East Marsh in the Bay of Quinte in 2013 and 2014, as part of a Habitat Bank Program established in agreement between OPG and DFO. The FAA includes a condition requiring OPG to report to the staff of DFO on the offset plan. OPG continues to comply with all conditions of the FAA related to monitoring and reporting of offsetting measures.

The existing FAA includes the following condition: "The current location of the Cooling Water System intake and the design features (e.g., porous veneer intake) shall be maintained in proper working order". To date, there have been no reportable events related to the Cooling Water System intake.

Impingement and entrainment monitoring was conducted in 2015 and 2016 and will be conducted again in 2024 and 2025 and reports will be submitted to DFO by December 31, 2026.

5.4.2 Conclusion

CNSC staff conclude that OPG has met and continues to meet all conditions of the Fisheries Act Authorization t. The issuance of a licence under the NSCA is not contingent on a licensee having a Fisheries Act Authorization, however, it is the duty of the licensee to ensure that they are in compliance with other Acts of Parliament.

5.5 Nuclear Substances and Prescribed Equipment

5.5.1 Discussion

Appendix E of the application lists the Nuclear Substances and Radiation Devices licences, and Class II Nuclear Facilities and Prescribed Equipment licences that control nuclear substances and prescribed equipment which are located on site, but not encompassed by the PROL at Darlington NGS. OPG has chosen this approach to be able to use such devices and equipment to support activities at non-nuclear generating stations and sites across the province.

Licensing and compliance verification activities for said devices and activities are carried out by CNSC staff in the Directorate of Nuclear Substance Regulation, following a mature regulatory program

OPG is required to submit an Annual Compliance Report for each of the Nuclear Substances and Radiation Devices licences, and Class II Nuclear Facilities and Prescribed Equipment licences listed in Appendix E. These reports are reviewed by staff to ensure that the reported activities are permitted under the applicable licence, and that all notifications were made during the reporting period.

Currently, there are no outstanding licensing or compliance actions related to these licences at Darlington NGS.

5.5.2 Conclusion

The use of nuclear substances and radiation devices at the Darlington NGS by OPG complies with regulatory requirements.

5.6 Delegation of Authority

The Commission may include in a licence any condition it considers necessary for the purposes of the NSCA. The Commission may delegate authority to CNSC staff with respect to the administration of licence conditions, or portions thereof.

There are 2 proposed licence conditions in the Darlington NGS PROL that contain the phrase “the Commission or a person authorized by the Commission”:

• LC [3.2] - The licensee shall not restart a reactor after a serious process failure without the prior written approval of the Commission, or the prior written consent of a person authorized by the Commission.
• LC [15.4] The licensee shall obtain the approval of the Commission, or consent of a person authorized by the Commission, prior to the removal of established regulatory hold points.

CNSC staff recommend the Commission delegate its authority for the purposes described in the above licence conditions to the following staff:

- Director, Darlington Regulatory Program Division
- Director General, Directorate of Power Reactor Regulation
- Executive Vice-President and Chief Regulatory Operations Officer, Regulatory Operations Branch

6. Overall Conclusions and Recommendations

CNSC staff reviewed OPG’s licence application and supporting documents and determined that OPG’s application meets regulatory requirements and establishes an adequate technical basis for continued operation, as well as outlining their commitment to support continued, meaningful dialogue with Indigenous Nations and communities and members of the public.

CNSC staff assessed OPG’s performance during the current licence term and confirmed that they demonstrated stable safety performance that was satisfactory.

CNSC staff confirmed that there were no major gaps identified in the periodic safety review and that OPG will continue to implement safety enhancements, as outlined in the integrated implementation plan.

With respect to paragraphs 24(4)(*a*) and (*b*) of the NSCA, CNSC staff find that the applicant provided adequate evidence that OPG:

1. is qualified to carry on the activity that the licence will authorize the licensee to carry on; and
2. will, in carrying out that activity, make adequate provision for the protection of the environment, the health and safety of persons and the maintenance of national security and measures required to implement international obligations to which Canada has agreed.

Therefore, CNSC staff recommend that the Commission:

1. renew the Darlington NGS PROL, authorizing OPG to carry out the licenced activities listed in Part IV of the proposed licence,
2. delegate the authority to CNSC staff as set out in section 5.6 of this CMD.

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Glossary

For definitions of terms used in this document, see REGDOC-3.6, *Glossary of CNSC Terminology*, which includes terms and definitions used in the *Nuclear Safety and Control Act* and the *Regulations* made under it, and in CNSC regulatory documents and other publications.

Additional terms and acronyms used in this CMD are listed below.

Acronym	Term
Ac-228	Actinium
ACR	Annual Compliance Reports
AECB	Atomic Energy and Control Board
AF	Accident Frequency
AIA	Authorized Inspection Agency
ALARA	As Low as Reasonably Achievable
APOP	Abnormal Plant Operating Procedures
ASR	Accident Severity Rate
BATEA	Best Available Technology and Techniques, Economically Achievable
BDBA	Beyond Design Basis Accident
BE	Below Expectations
Be-7	Beryllium
BOP	Balance of Plant
C-14	Carbon-14
CAA	Composite Analysis Approach
CANDU	Canada Deuterium Uranium
CAS	Central Alarm Station
CBOP	Continuous Behaviour Observation Program
CCR	Code Compliance Review
CCW	Condenser Cooling Water
CEPA	Canadian Environmental Protection Act
CMD	Commission Member Document
CNSC	Canadian Nuclear Safety Commission
CO	Carbon Monoxide
CO_2	Carbon Dioxide
Co-60	Cobalt-60
COG	CANDU Owners Group
CRE	Collective Radiation Exposure
CRFR	Cost Recovery Fees Regulations
CRO	Control Room Operator

CROIT	Control Room Operator in Training
CRO/SS	Control Room Operator and Shift Supervisors
CRT	COVID Response Team
Cs-137	Cesium
CSA	Canadian Standards Association
CSI	CANDU Safety Issue
DBT	Design Basis Threat
DFO	Fisheries and Oceans Canada
DRL	Derived Release Limit
EA	Environmental Assessment
EcoRA	Ecological Risk Assessment
EDG	Emergency Diesel Generators
EIR	Event Initial Report
EITER	Equipment Important to Emergency Response
EME	Emergency Mitigating Equipment
EMP	Environmental Monitoring Program
EMS	Environmental Management System
EOC	Emergency Operations Centre
EOP	Emergency Operating Procedures
EPP	Equipment Program Plan
EPR	Environmental Protection Review
EPREV	Emergency Preparedness Review
EPRR	Environmental Protection Review Report
EPS	Electrical Power Systems
EQ	Environmental Qualification
ERA	Environmental Risk Assessment
ERRIS	Effluent Regulation Reporting Information System
ERT	Emergency Response Team
FAA	Fisheries Act Authorization
FG	Financial Guarantee
FHA	Fire Hazard Assessment

FIRS	Foundation Input Response Spectra
FRC	Funding Review Committee
FS	Fully Satisfactory
FSSA	Fire Safe Shutdown Analysis
GAR	Global Assessment Report
GEM	Gaseous Effluent Monitor
GHG	Greenhouse Gas Emission
GNSCR	General Nuclear Safety and Control Regulations
H-3	Tritium
HEL	High Energy Line
HHRA	Human Health Risk Assessment
HPP	Human Performance Program
IAA	Impact Assessment Act
IAEA	International Atomic Energy Agency
ICS	Incident Command Section
I&C	Instrumentation and Control
IEMP	Independent Environmental Monitoring Program
IIP	Integrated Implementation Plan
ISAR	Industrial Safety Accident Rate
K-40	Potassium
LCH	Licence Conditions Handbook
LCMP	Life Cycle Management Plan
LEM	Liquid Effluent Monitor
LLOCA+LOECC	Large Loss of Coolant Accident and Loss of Emergency Core Cooling
LOF	Loss of Flow
LORC	Loss of Reactivity Control
LTAM	Long Term Asset Management
MSC	Minimum Shift Complement
MSL	Mean Sea Level
mSv	Millisievert
MWe	Megawatts

NGS	Nuclear Generating Station
NLCA	Nuclear Liability and Compensation Act
NMAR	Nuclear Material Accounting Reporting
NPRI	National Pollutant Release Inventory
NO_2	Nitrogen Dioxide
NPP	Nuclear Power Plant
NPT	Treaty on the Non-Proliferation of Nuclear Weapons
NRCan	Natural Resources Canada
NRF	Nuclear Response Force
NSCA	Nuclear Safety and Control Act
NSR	Nuclear Security Regulations
OEOC	Off-Site Emergency Operations Centre
OHSA	Occupational Health and Safety Act
OPEX	Operating Experience
OP&Ps	Operating Policies and Principles
PCE	Personnel Contamination Event
PDP	Preliminary Decommissioning Plan
PFP	Participant Funding Program
PFU	Predicted Future Unavailability
PHT	Primary Heat Transport
PIDP	Public Information and Disclosure Program
PIP	Periodic Inspection Plan
PIR	Problem Identification and Resolution
PM	Particulate Matter
PMCR	Preventive Maintenance Completion Ratio
PROL	Power Reactor Operating Licence
PSA	Probabilistic Safety Assessment
PSR	Periodic Safety Review
PTHA	Probabilistic Tsunami Hazard Assessment
RBMP	Reactor Building Management Plan
RCMP	Royal Canadian Mounted Police
R&D	Research and Development

REMP	Radiation Environmental Protection Program
RP	Radiation Protection
SA	Satisfactory
SAM	Severe Accident Management
SAMG	Severe Accident Management Guidelines
SAT	Systematic Approach to Training
SCA	Safety and Control Area
SCTs	Safety Critical Targets
SHP	Senior Health Physicist
SIS	Systems Important to Safety
SLOCA	Small Loss of Coolant Accident
SO_2	Sulphur Dioxide
SOE	Safe Operating Envelope
SPI	Safety Performance Indicator
SR	Safety Report
SRWMF	Solid Radioactive Waste Management Facility
SS	Shift Supervisors
SSC	Structures, Systems and Components
SST	Station Service Transformer
TLD	Thermoluminescent Dosimeter
ToR	Terms of Reference
TPR	Third Party Review
TRA	Threat and Risk Assessment
VOC	Volatile Organic Compounds
VP	Vice President
WBC	Whole Body Counts

A. Safety Performance Rating Levels

Satisfactory (SA)

Licensee meets all of the following criteria:

- Performance meets CNSC staff expectations
- Licensee non-compliances or performance issues, if any, are not risk-significant
- Any non-compliances or performance issues have been, or are being, adequately corrected

Below Expectations (BE)

One or more of the following criteria apply:

- Performance does not meet CNSC staff expectations
- Licensee has risk-significant non-compliance(s) or performance issue(s)
- Non-compliances or performance issues are not being adequately corrected

Unacceptable (UA)

One or both of the following criteria apply:

- Risk associated with a non-compliance or performance issue is unreasonable
- At least one significant non-compliance or performance issue exists with no associated corrective action

Note: Starting in 2019, facility performance assessment ratings were simplified and the "Fully Satisfactory (FS)" was removed. It is important to recognize that a facility that received an SCA performance rating of FS prior to 2019 and then SA in following years, does not necessarily indicate a reduction in performance.

B. Basis for the Recommendation(s)

B.1 Regulatory Basis

The recommendations presented in this CMD are based on compliance objectives and expectations associated with the relevant SCAs and other matters. The regulatory basis for the matters that are relevant to this CMD are as follows.

Management System

The regulatory foundation for the recommendation(s) associated with Management System includes the following:

- REGDOC-2.1.1, *Management System*
- CSA N286-12, *Management System Requirements for Nuclear Facilities*

Human Performance Management

The regulatory foundation for the recommendation(s) associated with Human Performance Management includes the following:

- CSA N286, *Management system requirements for nuclear facilities (2017)*
- RD-204, *Certification of Persons Working at Nuclear Power Plants (including transitional provisions) (2008)*
- RD-363, *Nuclear Security Officer Medical, Physical, and Psychological Fitness (2008)*
- EG1, *Requirements and Guidelines for Written and Oral Certification Examinations for Shift Personnel at Nuclear Power Plants* (2005)
- EG2, *Requirements and Guidelines for Simulator-Based Certification Examinations for Shift Personnel at Nuclear Power Plants* (2004)
- *Requirements for the Requalification Testing of Certified Shift Personnel at Nuclear Power Plants, Rev. 2* (2009)
- REGDOC-2.2.1, *Human Factors (2019)*
- REGDOC-2.2.2, *Personnel Training (2016)*
- REGDOC-2.2.3, *Personnel certification, Volume III Certification of Persons Working at Nuclear Power Plants (2019)*
- REGDOC-2.2.4, *Fitness for Duty: Managing Worker Fatigue (2017)*
- REGDOC-2.2.4, *Fitness for Duty, Volume II: Managing Alcohol and Drug Use, Version 3 (2021)*
- REGDOC-2.2.4, *Fitness for Duty, Volume III: Nuclear Security Officer Medical, Physical, and Psychological Fitness (2018)*
- REGDOC-2.2.5, *Minimum Staff Complement (2019)*

Operating Performance

The regulatory foundation for the recommendation(s) associated with Operating Performance includes the following:

- REGDOC-2.3.2, *Accident Management: Severe Accident Management Programs for Nuclear Reactors (2013)*
- CSA Standard N290.15, *Requirements for the safe operating envelope for nuclear power plants (2010)*
- REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants, Version 2 (2014)*

Safety Analysis

The regulatory foundation for the recommendation(s) associated with Safety Analysis includes the following:

- REGDOC-2.4.1, *Deterministic Safety Analysis (2014)*
- REGDOC-2.4.2, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants (2014)*
- CSA Standard N286.7, *Quality assurance of analytical, scientific and design computer programs for nuclear power plants (1999)*
- REGDOC-3.1.1, *Reporting Requirements: Nuclear Power Plants, Version 2 (2014)*

Physical Design

The regulatory foundation for the recommendation(s) associated with Physical Design includes the following:

- CSA Standard 290.13:18, (R2023), *Environmental qualification of equipment for nuclear power plants, Reaffirmed in 2023*
- CSA Standard N290.5, *Requirements for electrical power and instrument air systems of CANDU nuclear power plants (2016)*
- CSA Standard N286, *Management system requirements for nuclear facilities (2012)*
- CSA Standard N285.0, *General requirements for pressure retaining systems and components in CANDU nuclear power plants, 2008 & update No.2; 2012 & Update 1*
- REGDOC 2.5.2, *Design of Reactor Facilities: Nuclear Power Plants (2023)*
- CSA Standard N291, *Requirements for safety related structures for CANDU nuclear power plants (update no. 2, 2011)*
- CSA Standard N289.1-08, *General requirements for seismic, design and qualification of CANDU nuclear power plants*
- N290.12-14, *Human factors in design for nuclear power plants*

- REGDOC-2.2.1, *Human Factors*
- REGDOC-2.5.1, *General Design Considerations: Human Factors*

Fitness for Service

The regulatory foundation for the recommendation(s) associated with Fitness for Service includes the following:

- REGDOC-2.6.2, *Maintenance Programs for Nuclear Power Plants*
- REGDOC-2.6.1, *Reliability Programs for Nuclear Power Plants*
- REGDOC-2.3.6, *Aging Management*

The following standards were identified in Attachment 2 of the application for licence renewal:

- CSA Standard N285.4, *Periodic inspection of CANDU nuclear power plant components*
- CSA Standard N285.5, *Periodic inspection of CANDU nuclear power plant containment components*
- CSA Standard N285.8, *Technical requirements for in-service evaluation of zirconium alloy pressure tubes in CANDU reactors*
- CSA Standard N287.7, *In-service examination and testing requirements for concrete containment structures for CANDU nuclear power plants*

Radiation Protection

The regulatory foundation for the recommendation(s) associated with Radiation Protection includes the following:

- *Radiation Protection Regulations, SOR/2000-203* (Last amended January 1, 2021)
- REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants, version 2 (2014)*

Conventional Health and Safety

The regulatory foundation for the recommendation(s) associated with Conventional Health and Safety includes the following:

- CSA Standard N293, *Fire protection for CANDU nuclear power plants (R2017)*
- REGDOC-3.1.1 *Reporting Requirements for Nuclear Power Plants, Version 2 (2014)*
- REGDOC-2.8.1, *Conventional Health and Safety (July 2019)*

Environmental Protection

The regulatory foundation for the recommendation(s) associated with Environmental Protection includes the following:

- REGDOC-2.9.1, *Environmental Protection: Environmental Principles, Assessments and Protection Measures, version 1.1 (2017)*
- CSA Standard N288.0-22, *Environmental management of nuclear facilities: Common requirements of the CSA N288 series of Standards*
- CSA Standard N288.1-14, *Guidelines for calculating DRLs for radioactive material in airborne and liquid effluents for normal operation for nuclear facilities*
- CSA Standard N288.4-19, *Environmental Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills*
- CSA Standard N288.5-22, *Effluent Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills*
- CSA Standard N288.7-15, *Groundwater protection programs at Class I nuclear facilities and uranium mines and mills*
- CSA Standard N288.8-17, *Establishing and implementing action levels for releases to the environment from nuclear facilities*

Emergency Management and Fire Protection

The regulatory foundation for the recommendation(s) associated with Emergency Management and Fire Protection includes the following:

- REGDOC-2.10.1, Version 2, *Nuclear Emergency Preparedness and Response (2016)*
- CSA Standard N293-12 R2017, *Fire protection for CANDU nuclear power plants*
- REGDOC-3.2.1, *Public Information and Disclosure*
- CSA Standard N1600, *General requirements for nuclear emergency management programs (2014)*

Waste Management

The regulatory foundation for the recommendation(s) associated with Waste Management includes the following:

- CSA Standard N292.3, *Management of low and intermediate-level radioactive waste (2008)*
- CSA Standard N294, *Decommissioning of facilities containing nuclear substances (2019)*

Security

The regulatory foundation for the recommendation(s) associated with Security includes the following:

- REGDOC-2.12.1, *High Security Facilities, Volume I: Nuclear Response Force, Version 2 (2018)*

- REGDOC-2.12.1, *High Security Facilities, Volume II: Criteria for Nuclear Security Systems and Devices (2018)*
- REGDOC-2.12.2, *Site Access Security Clearance (2013)*
- REGDOC-2.12.3, *Security of Nuclear Substances: Sealed Sources and Category I, II and II Nuclear Material, Version 2.1 (2020)*
- CSA Standard N290.7, *Cyber-security for nuclear power plants and small reactor facilities*
- REGDOC-2.2.4, *Fitness for Duty: Managing Worker Fatigue (2017)*
- REGDOC-2.2.4, *Fitness for Duty, Volume II: Managing Alcohol and Drug Us, Version 3 (2021)*
- REGDOC-2.2.4, *Fitness for Duty, Volume III: Nuclear Security Officer Medical, Physical and Psychological Fitness (2018)*
- REGDOC-2.2.5, *Minimum Shift Complement (2019)*

Safeguards and Non-Proliferation

The regulatory foundation for the recommendation(s) associated with Safeguards and Non-proliferation includes the following:

- REGDOC-2.13.1, *Safeguards and Nuclear Material Accountancy (2018)*
- REGDOC-2.13.2, *Import and Export (2018)*

Packaging and Transport

The regulatory foundation for the recommendation(s) associated with Packaging and Transport includes the following:

- *Transportation of Dangerous Goods Regulations* (TDGR)
- *Packaging and Transport of Nuclear Substances Regulations, 2015* (PTNSR)

B.2 Summary of CNSC Assessment of Application

CNSC's staff assessment of OPGs licence application included a completeness check, a sufficiency check, and a technical assessment against regulatory requirements. The completeness check verified whether the application included the prescribed information in accordance with the *Nuclear Safety and Control Act* and applicable regulations. For all facilities (i.e., Class I and Class II facilities), it is important to consider and address all licence application requirements within the applicable CNSC regulations.

The sufficiency check verified whether the application included sufficient and quality information in order for CNSC staff to conduct the technical assessment. The technical assessment verified whether the application included adequate safety and control measures to address CNSC requirements. Documents originally submitted as part of the application may have been revised, updated, or replaced over the course of the assessment to address CNSC requirements.

Pursuant to Section 3 of the *General Nuclear Safety and Control Regulations* **Licences – General Application Requirements**	**Location in Application or Supporting Document(s) as Noted by OPG**	**Complete?**	**Sufficient?**	**Adequate?**
(1) An application for a licence shall contain the following information:				
(a) the applicant's name and business address;	Cover letter	Y	Y	Y
(b) the activity to be licensed and its purpose;	Appendix C	Y	Y	Y
(c) the name, maximum quantity, and form of any nuclear substance to be encompassed by the licence;	Appendix C	Y	Y	Y
(d) a description of any nuclear facility, prescribed equipment, or prescribed information to be encompassed by the licence;	Section 1.1	Y	Y	Y
(e) the proposed measures to ensure compliance with the *Radiation Protection Regulations*, the *Nuclear Security Regulations* and the *Packaging and Transport of Nuclear Substances Regulations, 2015;*	Section 2.7, 2.12 and 2.14	Y	Y	Y
(f) any proposed action level for the purpose of section 6 of the *Radiation Protection Regulations*;	Sections 2.7 and 2.9	Y	Y	Y

Pursuant to Section 3 of the *General Nuclear Safety and Control Regulations* **Licences – General Application Requirements**	**Location in Application or Supporting Document(s) as Noted by OPG**	**Complete?**	**Sufficient?**	**Adequate?**
(g) the proposed measures to control access to the site of the activity to be licensed and the nuclear substance, prescribed equipment, or prescribed information;	Section 2.12	Y	Y	Y
(h) the proposed measures to prevent loss or illegal use, possession, or removal of the nuclear substance, prescribed equipment, or prescribed information;	Sections 2.12 and 2.13	Y	Y/	Y
(i) a description and the results of any test, analysis or calculation performed to substantiate the information included in the application;	Sections 1.1 and 2.4	Y	Y	Y
(j) the name, quantity, form, origin and volume of any radioactive waste or hazardous waste that may result from the activity to be licensed, including waste that may be stored, managed, processed, or disposed of at the site of the activity to be licensed, and the proposed method for managing and disposing of that waste;	Section 2.11, Appendix C and Appendix D	Y	Y	Y

Pursuant to Section 3 of the *General Nuclear Safety and Control Regulations* **Licences – General Application Requirements**	**Location in Application or Supporting Document(s) as Noted by OPG**	**Complete?**	**Sufficient?**	**Adequate?**
(k) the applicant's organizational management structure insofar as it may bear on the applicant's compliance with the NSCA and the regulations made under it, including the internal allocation of functions, responsibilities and authority;	Section 2.1	Y	Y	Y
(l) a description of any proposed financial guarantee relating to the activity to be licensed;	Section 4.3	Y	Y	Y
(m) any other information required by the NSCA or the regulations made under it for the activity to be licensed and the nuclear substance, nuclear facility, prescribed equipment or prescribed information to be encompassed by the licence.	Throughout	Y	Y	Y

C. Safety and Control Area Framework

C.1 Safety and Control Areas Defined

The safety and control areas identified in section 2.2 and discussed in summary in sections 3.1 through 3.14 are comprised of specific areas of regulatory interest which vary between facility types.

The following table provides a high-level definition of each SCA. The specific areas within each SCA are to be identified by the CMD preparation team in the respective areas within section 3 of this CMD

SAFETY AND CONTROL AREA FRAMEWORK		
Functional Area	**Safety and Control Area**	**Definition**
Management	Management System	Covers the framework which establishes the processes and programs required to ensure an organization achieves its safety objectives and continuously monitors its performance against these objectives and fostering a healthy safety culture.
	Human Performance Management	Covers activities that enable effective human performance through the development and implementation of processes that ensure that a sufficient number of licensee personnel are in all relevant job areas and have the necessary knowledge, skills, procedures and tools in place to safely carry out their duties.
	Operating Performance	Includes an overall review of the conduct of the licensed activities and the activities that enable effective performance.
Facility and Equipment	Safety Analysis	Covers maintenance of the safety analysis that supports that overall safety case for the facility. Safety analysis is a systematic evaluation of the potential hazards associated with the conduct of a proposed activity or facility and considers the effectiveness of preventive measures and strategies in reducing the effects of such hazards.
	Physical Design	Relates to activities that impact on the ability of systems, components and structures to meet and maintain their design basis given new information arising over time and taking changes in the external environment into account.

SAFETY AND CONTROL AREA FRAMEWORK		
Functional Area	**Safety and Control Area**	**Definition**
	Fitness for Service	Covers activities that impact on the physical condition of systems, components and structures to ensure that they remain effective over time. This area includes programs that ensure all equipment is available to perform its intended design function when called upon to do so.
Core Control Processes	Radiation Protection	Covers the implementation of a radiation protection program in accordance with the *Radiation Protection Regulations*. This program must ensure that contamination levels and radiation doses received by individuals are monitored and controlled and maintained ALARA.
	Conventional Health and Safety	Covers the implementation of a program to manage workplace safety hazards and to protect workers.
	Environmental Protection	Covers programs that identify, control and monitor all releases of radioactive and hazardous substances and effects on the environment from facilities or as the result of licensed activities.
	Emergency Management and Fire Protection	Covers emergency plans and emergency preparedness programs which exist for emergencies and for non-routine conditions. This also includes any results of participation in exercises.
	Waste Management	Covers internal waste-related programs which form part of the facility's operations up to the point where the waste is removed from the facility to a separate waste management facility. This area also covers the planning for decommissioning.
	Security	Covers the programs required to implement and support the security requirements stipulated in the regulations, the licence, orders, or expectations for the facility or activity.

SAFETY AND CONTROL AREA FRAMEWORK		
Functional Area	**Safety and Control Area**	**Definition**
	Safeguards and Non-Proliferation	Covers the programs and activities required for the successful implementation of the obligations arising from the Canada/International Atomic Energy Agency (IAEA) safeguards agreements, as well as all other measures arising from the *Treaty on the Non-Proliferation of Nuclear Weapons*.
	Packaging and Transport	Covers programs for the safe packaging and transport of nuclear substances and radiation devices to and from the licensed facility.

C.2 Specific Areas for this Facility Type

The following table identifies the specific areas that comprise each SCA for nuclear power plants:

SPECIFIC AREAS FOR THIS FACILITY TYPE		
Functional Area	**Safety and Control Area**	**Specific Areas**
Management	Management System	▪ Management System ▪ Organization ▪ Performance Assessment, Improvement and Management Review ▪ Operating Experience (OPEX), Problem Identification and Resolution (PI&R) ▪ Change Management ▪ Safety Culture ▪ Configuration Management ▪ Records Management ▪ Supply and Contractor Management ▪ Business Continuity
	Human Performance Management	▪ Human Performance Programs ▪ Personnel Training ▪ Personnel Certification ▪ Work Organization and Job Design ▪ Fitness for Duty
	Operating Performance	▪ Conduct of Licensed Activity ▪ Procedures ▪ Reporting and Trending ▪ Outage Management Performance ▪ Safe Operating Envelope ▪ Severe Accident Management and Recovery ▪ Accident Management and Recovery
Facility and Equipment	Safety Analysis	▪ Deterministic Safety Analysis ▪ Hazard Analysis

SPECIFIC AREAS FOR THIS FACILITY TYPE		
Functional Area	**Safety and Control Area**	**Specific Areas**
		▪ Probabilistic Safety Analysis ▪ Criticality Safety ▪ Severe Accident Analysis ▪ Management of Safety Issues (including R&D Programs)
	Physical Design	▪ Design Governance ▪ Site Characterization ▪ Facility Design ▪ Structure Design ▪ System Design ▪ Components Design
	Fitness for Service	▪ Equipment Fitness for Service/Equipment Performance ▪ Maintenance ▪ Structural Integrity ▪ Aging Management ▪ Chemistry Control ▪ Periodic Inspection and Testing
Core Control Processes	Radiation Protection	▪ Application of ALARA ▪ Worker Dose Control ▪ Radiation Protection Program Performance ▪ Radiological Hazard Control
	Conventional Health and Safety	▪ Performance ▪ Practices ▪ Awareness
	Environmental Protection	▪ Effluent and Emissions Control (releases) ▪ Environmental Management System (EMS) ▪ Assessment and Monitoring ▪ Protection of People ▪ Environmental Risk Assessment

SPECIFIC AREAS FOR THIS FACILITY TYPE		
Functional Area	**Safety and Control Area**	**Specific Areas**
	Emergency Management and Fire Protection	▪ Conventional Emergency Preparedness and Response ▪ Nuclear Emergency Preparedness and Response ▪ Fire Emergency Preparedness and Response
	Waste Management	▪ Waste Characterization ▪ Waste Minimization ▪ Waste Management Practices ▪ Decommissioning Plans
	Security	▪ Facilities and Equipment ▪ Response Arrangements ▪ Security Practices ▪ Drills and Exercises ▪ Cyber security
	Safeguards and Non-Proliferation	▪ Nuclear Material Accountancy and Control ▪ Access and Assistance to the IAEA ▪ Operational and Design Information ▪ Safeguards Equipment, Containment and Surveillance ▪ Import and Export
	Packaging and Transport	▪ Package design and maintenance ▪ Packaging and transport ▪ Registration for use

PART 2

Part 2 of this CMD provides all relevant information pertaining directly to the licence, including:

1. The Environmental Protection Report
2. The current licence;
3. Proposed changes to the conditions, licensing period, or formatting of an existing licence;
4. The proposed licence; and
5. The draft licence conditions handbook.

Environmental Protection Report

Canada's Nuclear Regulator

Environmental Protection Review Report: **Darlington Nuclear Site**

January 2025

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Canadian Nuclear Safety Commission
Commission canadienne de sûreté nucléaire

Canada

Environmental Protection Review Report: Darlington Nuclear Site

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Revision History

The following table identifies the revision history of this document.

Revision number	Change	Summary of changes	Date
000	Initial release	N/A	January 2025
001			

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Executive summary

The Canadian Nuclear Safety Commission (CNSC) conducts environmental protection reviews (EPRs) for all nuclear facilities with potential interactions with the environment, in accordance with its mandate under the *Nuclear Safety and Control Act* (NSCA) to ensure the protection of the environment and the health and safety of persons. An EPR is a science-based environmental technical assessment conducted by CNSC staff. The fulfillment of other regulatory compliance oversight of the CNSC's mandate is met through other oversight activities.

This EPR report was written by CNSC staff as a stand-alone document, describing the scientific and evidence-based findings from CNSC staff's review of Ontario Power Generation's (OPG's) environmental protection measures. The periodic EPR report provides an assessment of documents related to the Darlington Nuclear Site (DN site), which consists of the Darlington Nuclear Generating Station (DNGS) and the Darlington Waste Management Facility (DWMF).

The DN site is located within the lands and waters of the Michi Saagiig Anishinaabeg, the Gunshot Treaty (1787-88), the Williams Treaties (1923), and the Williams Treaties First Nations Settlement Agreement (2018). Under its current power reactor operating licence, PROL 13.01/2025, OPG is permitted to operate the DNGS units for power production. Under the waste facility operating licence, WFOL-W4-355.00/2033, OPG is also permitted to operate the DWMF. This EPR does not encompass the proposed Darlington New Nuclear Project or the licences to prepare a site, the applications to modify the licence to prepare a site or the application for a licence to construct.

CNSC staff's EPR report focuses on items that are of Indigenous, public, and regulatory interest, such as potential environmental releases from normal operations, as well as the risk of releases of radiological nuclear and hazardous (non-radiological) substances to the receiving environment, valued ecosystem components (VECs) and species at risk. CNSC staff also endeavour to focus on items related to Indigenous Nations and communities Rights, values and culture, when information is shared with the CNSC.

This EPR report includes CNSC staff's assessment of documents submitted by the licensee to CNSC staff from 2016 to 2023 and the results of CNSC staff's compliance activities, including the following:

- engagement with Indigenous Nations and communities
- regulatory oversight activities
- the results of OPG's environmental monitoring, as reported in the environmental monitoring program reports
- OPG's 2020 environmental risk assessment for the DN site
- OPG's 2021 preliminary decommissioning plan for the DN site
- the results of the CNSC's Independent Environmental Monitoring Program
- the results from other environmental and groundwater monitoring programs and/or health studies (including studies completed by other levels of government) in proximity to the DN site

Based on their assessment and evaluation of OPG's documentation and data, CNSC staff have found that the potential risks from nuclear and hazardous releases to the atmospheric, terrestrial, aquatic and human environments from the DN site are low to negligible, and that any releases are at levels similar to natural background. Furthermore, human health is not impacted by operations at the DN site and the health outcomes are indistinguishable from health outcomes found in the general public. CNSC staff have also found that OPG continues to implement and maintain effective environmental protection measures that meet regulatory requirements and adequately protect the environment and the health and safety of persons. CNSC staff will continue to verify OPG's environmental protection programs through ongoing licensing and compliance activities.

CNSC staff's findings from this report may inform recommendations to the Commission in future licensing and regulatory decisions, as well as inform CNSC staff's ongoing and future compliance verification activities. CNSC staff's findings do not represent the Commission's conclusions. The Commission's decision-making will be informed by submissions from CNSC staff, the licensee, Indigenous Nations and communities, and the public, as well as through any interventions made during public hearings on Commission proceedings.

A pamphlet of this EPR report with a public friendly summary is available in Appendix A of this report. OPG also makes many summary documents, including reports containing environmental data, available on OPG's website. References used throughout this document are available upon request and requests can be sent to er-ee@cnsc-ccsn.gc.ca.

1.0 Introduction

1.1 Purpose

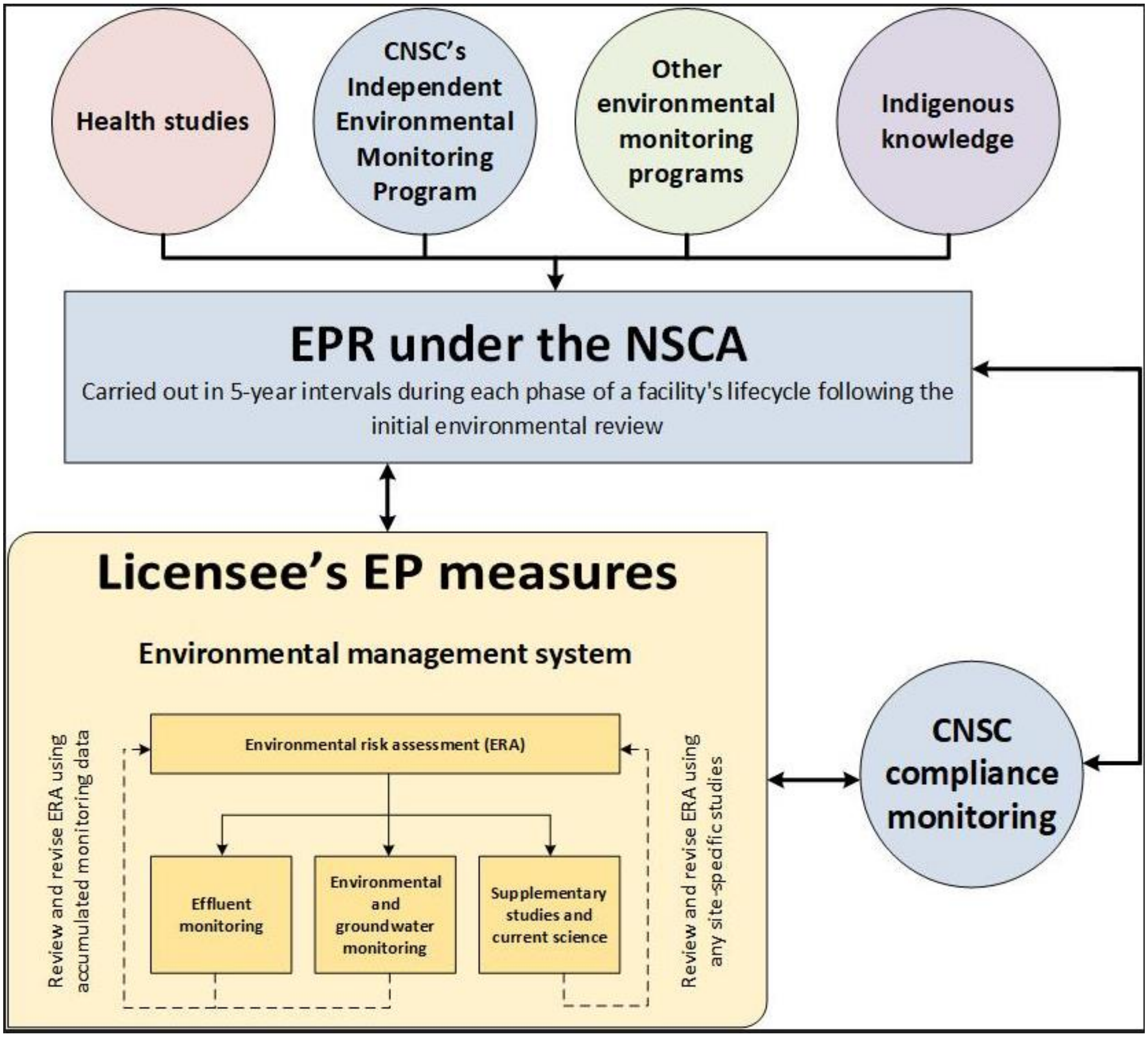
The Canadian Nuclear Safety Commission (CNSC) conducts environmental protection reviews (EPRs) for all nuclear facilities with potential interactions with the environment, in accordance with its mandate under the *Nuclear Safety and Control Act* (NSCA) [1]. CNSC staff assess the environmental and health effects of nuclear facilities and/or activities during every phase of a facility's lifecycle. As shown in figure 1.1, an EPR is a science-based environmental technical assessment conducted by CNSC staff to support the CNSC's mandate for the protection of the environment and human health and safety, as set out in the NSCA. The fulfillment of other aspects of the CNSC's mandate is met through other regulatory oversight activities and is outside the scope of this report. Each EPR report is typically conducted every 5 years and is informed by the licensee's environmental protection (EP) program and documentation submitted by the licensee as per regulatory reporting requirements.

As per the CNSC's Indigenous Knowledge Policy Framework [2], the CNSC recognizes the importance of considering and including Indigenous Knowledge in all aspects of its regulatory processes, including EPRs. CNSC staff are committed to working directly with Indigenous Nations and communities and knowledge holders on integrating their knowledge, values, land use information, and perspectives in the CNSC's EPR reports, where appropriate and when shared with the licensee and the CNSC.

The purpose of this EPR is to report the outcome of CNSC staff's assessment of the Ontario Power Generation Inc. (OPG)'s EP measures and CNSC staff's health science and environmental compliance activities for the Darlington Nuclear Site (DN site) – operations at both the Darlington Nuclear Generating Station (DNGS) and the Darlington Waste Management Facility (DWMF). This review serves to assess whether OPG's EP measures at the DN site meet regulatory requirements and adequately protects the environment and health and safety of persons.

While this EPR focuses on the EP measures of the DN site from 2016-2023, it should be noted that in May 2024, OPG submitted a licence application to renew the power reactor operating licence from December 1, 2025 to November 30, 2055 [3]. CNSC staff has prepared this EPR to inform the licensing decision of the Commission.

Figure 1.1: Environmental protection review framework



CNSC staff's findings may inform recommendations to the Commission in future licensing and regulatory decision making, as well as inform CNSC staff's ongoing and future compliance verification activities.

CNSC staff's findings do not represent the Commission's conclusions. The Commission is an independent, quasi-judicial administrative tribunal and court of record. The Commission's conclusions and decisions are informed by information submitted by the applicant or licensee, the CNSC staff, Indigenous Nations and communities, and the public, as well as through any interventions made during public hearings on Commission proceedings.

EPR reports are prepared to thoroughly document CNSC staff's technical assessment relating to a licensee's EP measures and are posted online for information and transparency. Posting EPR reports online, separately from the documents drafted during the licensing process, allows interested Indigenous Nations and communities and members of the public additional time to review information related to EP prior to any licensing hearings or Commission decisions. CNSC staff may use the EPR reports as reference material when engaging with interested Indigenous Nations and communities, members of the public and interested stakeholders. To assist with outreach and engagement for the DN site, a pamphlet of this EPR report with a public friendly summary is available in Appendix A of this report.

This EPR report is informed by documentation and information submitted by OPG, compliance activities completed by CNSC staff from 2016 to 2023, and other sources, such as:

- engagement with Indigenous Nations and communities (section 1.2)
- regulatory oversight activities (section 2.0)
- CNSC staff's review of OPG's *2021 Nuclear Site preliminary decommissioning plan* (PDP) [4] and the *2021 preliminary decommissioning plan for the Darlington Waste Management Facility* [5] (section 2.2)
- CNSC staff's review of OPG's environmental and groundwater monitoring program results for Darlington from 2016 to 2023 [6] [7] [8] [9] [10] [11] [12] [13] [14] [15] [16] [17] [18] [19] [20]
- data from studies related to assessments conducted for facilities and activities on the DN site (section 3.0)
- results of the CNSC's Independent Environmental Monitoring Program (IEMP), including discussions with Indigenous Nations and communities (section 4.0)
- health studies with relevance to the DN site (section 5.0)
- data from other environmental monitoring programs (EMPs) in proximity to the DN site (section 6.0)

This EPR report focuses on topics related to the facilities' environmental performance, including atmospheric (emission) and liquid (effluent) releases to the environment, and the potential transfer of constituents of potential concern (COPCs) through key environmental pathways and associated potential exposures and/or effects on valued ecosystem components (VECs), including human and non-human biota. VECs refer to environmental, biophysical or human features that may be impacted by a project. The value of a component relates not only to its role in the ecosystem, but also to the value people place on it (for example, it may have scientific, social, cultural, economic, historical, archaeological or aesthetic importance). The focus of this report is on radiological nuclear and hazardous substances associated with licensed activities undertaken at the DN site, with additional information provided on other topics of Indigenous, public and regulatory interest. CNSC staff also present information on relevant regional environmental and health monitoring, including studies conducted by the CNSC or other governmental organizations.

1.2 Facility overview

This section provides general information on the DN site, including a description of the site location and a basic history of site activities and licensing. This information is intended to provide context for later sections of this report, which discuss completed and ongoing environmental and associated regulatory oversight activities.

1.2.1 Site description

The DN is located within the lands and waters of the Michi Saagiig Anishinaabeg, the Gunshot Treaty (1787-88), the Williams Treaties (1923), and the Williams Treaties First Nations Settlement Agreement (2018). The facilities are located in the Municipality of Clarington, Ontario, (formerly the township of Darlington) on the north shore of Lake Ontario. The DN site is located approximately 5 kilometres (km) southwest of the community of Bowmanville, 10 km east-southeast of the City of Oshawa, and 70 km east of Toronto. The DN site is 485 hectares (ha) in area, with additional water lot areas extending into Lake Ontario to accommodate structures and features associated with the DNGS. The DN site lands are bounded by Highway 401 and Energy Drive West to the north and Lake Ontario to the south. To the west, the DN site is bounded by Solina Road and agricultural land. The St. Mary’s Cement Bowmanville plant occupies the land east of the DN site.

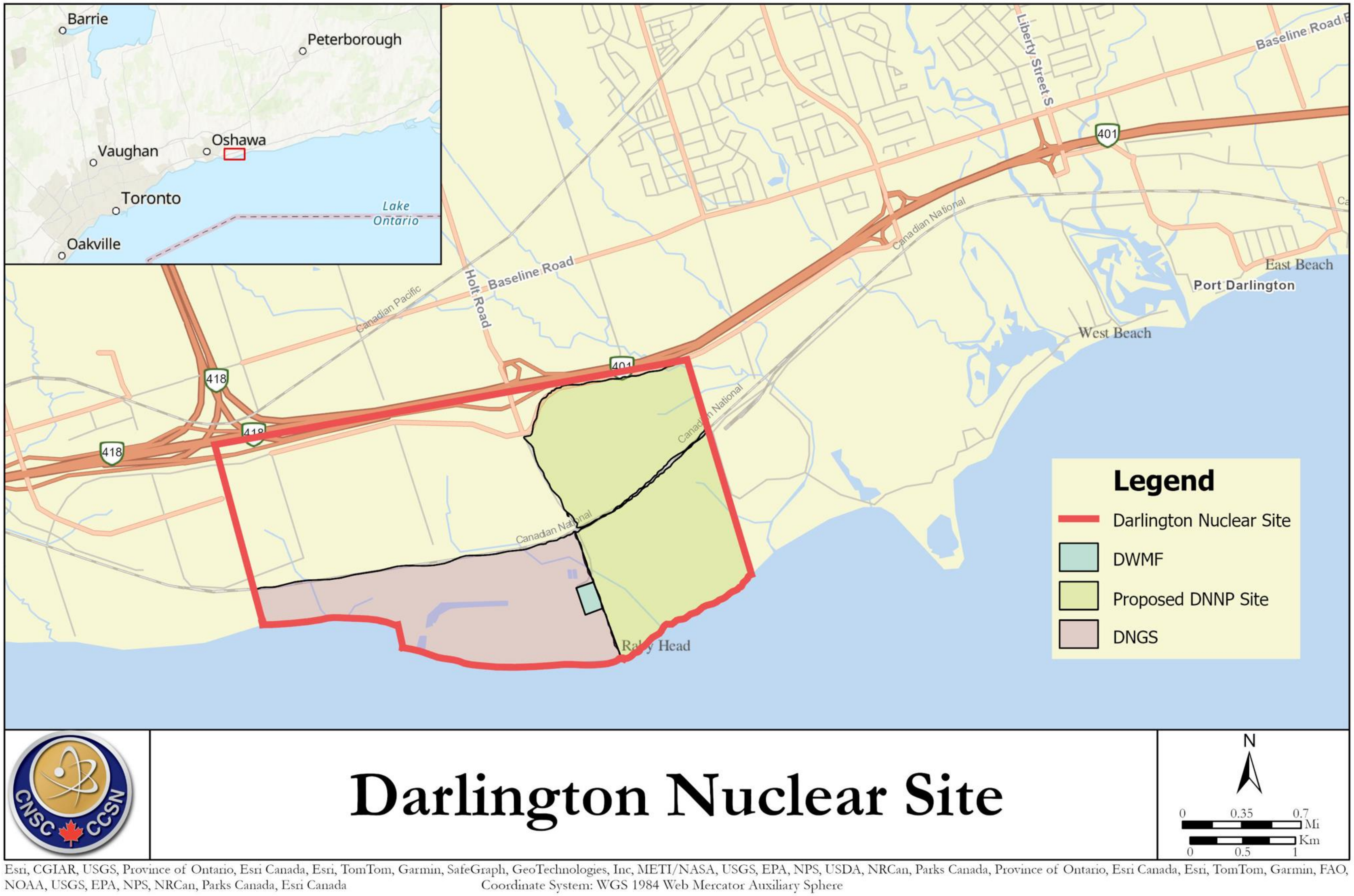
The DN site is owned and operated by the licensee, OPG. DNGS and the DWMF operate under separate licences issued by the Commission to OPG. This EPR Report includes CNSC staff’s assessment of the EP measures at both the DWMF and DNGS and does not encompass the proposed Darlington New Nuclear Project (DNNP) as this EPR report is meant to encompass the ongoing operations at the Darlington Nuclear site under the existing power reactor and waste facility operating licences.

The DN site houses the following nuclear facilities (figure 1.2):

- The DNGS, comprising 4 CANada Deuterium Uranium (CANDU) reactors and associated infrastructure and equipment
- The Tritium Removal Facility (TRF), where tritium is extracted from tritiated heavy water
- The DNNP lands
- The DWMF, located in a separate protected area to the east of the DNGS

The DN site also includes a visitor information centre, a Hydro One switching station (which connects DNGS to the Hydro One transmission corridor), technical and administrative support facilities and security facilities.

Figure 1.2: Aerial view of the Darlington Nuclear Site



1.2.2 Facility operations

The DNGS began operating in 1990, and the DWMF became operational in 2008. Under the power reactor operating licence for the DNGS, OPG possesses and uses nuclear substances and associated equipment to generate power. Under the waste facility operating licence for the DWMF, OPG operates the waste management facility and associated activities to manage waste generated from the DNGS.

1.2.2.1 Darlington Nuclear Generating Station

The DNGS consists of 4 CANDU pressurized heavy water nuclear reactor units and auxiliary systems that support their operation and the production of electricity. As of the writing of this report, two reactor units are in operation (Units 2 and 3), and two reactor units (Units 1 and 4) are undergoing refurbishment and life extension.

The DN site comprises many buildings of various sizes with a wide range of functions (see figure 1.2). An overview of the main features is described in table 1.1.

Table 1.1: Description of the Darlington Nuclear Generating Station's main components

Component	Definition
Reactor building	Reactor buildings contain 4 reactor vaults, a reactor auxiliary bay, steam generators and a containment envelope. The reactor vault contains the reactor core and assembly and the reactivity control devices. The reactor auxiliary bay contains the reactor auxiliary and secondary circuits for low temperature, pressure and radioactivity levels around each vault. The containment envelope encompasses the 4 reactor vaults, the fueling duct connected to each vault and a pressure relief duct which connects the fueling ducts to the vacuum building that condenses any releases of radioactive steam and prevents release outside of the station.
Primary Heat Transport and Generator Systems	The primary heat transport systems cool the reactor by circulating pressurized heavy water through the reactor fuel channels. The heat is transferred to light water through steam generators.
Powerhouse Building holding the Secondary Heat Transport and Turbine-Generator Systems	The Powerhouse holds four turbine halls, four auxiliary bays and a central service area as well as the secondary heat transport and turbine generator systems. The secondary heat transport system moves steam produced into the steam generators using heat from the primary heat transport system. This system rotates the

Component	Definition
	turbines and attached generators to rotate and generate power.
Heavy Water Management Building	The heavy water management building comprises of the heavy water supply, collection and transfer, cleanup and upgrading and the vapour recovery and resin handling systems. This system circulates heavy water through the reactor vessel, separately from the primary heat transport system.
Tritium Removal Facility	The Tritium Removal Facility houses the processes which remove tritium from the heavy water. Once extracted, the tritium is stored in stainless steel containers within a concrete vault.
Fuelling Facilities Auxiliary Areas	The fuelling facilities auxiliary areas, which store new fuel and two irradiated fuel bays, are located at each end of the station. Irradiated fuel bays are used to store and cool used fuel bundles. The used fuel bundles are stored in these fuel bays for at least 10 years before transferring to the DWMF.
Forebay, intake channel and discharge channels	The intake channels draw condenser cooling water (CCW) from the forebay into each unit. After the CCW is used in the condensers, the CCW is discharged into Lake Ontario through the drainage channel.

1.2.2.2 Darlington Waste Management Facility

The DWMF is located within its own fenced protected area and consists of 2 in-service storage buildings (each designed to house dry storage containers (DSCs)) and a DSC processing building. The DSC processing facility is used to prepare DSCs for storage. The used fuel Storage Buildings #1 and #2 provide interim site storage for the used fuel bundles of the DNGS until a disposal site for used fuel bundles becomes operational. Both DSC Storage Buildings #1 and #2 have the capacity to hold up to 500 DSCs, equivalent to roughly 9 years of operation for the DNGS.

The Retube Waste Storage Building (RWSB) stores intermediate-level wastes from the Darlington Refurbishment Project. The low-level and intermediate-level radioactive waste that is produced from the DN site is transferred to the Western Waste Management Facility (WWMF) located on the Bruce Nuclear Generating Station site in Tiverton, Ontario.

Table 1.2 defines the key structural components of the DWMF.

Table 1.2: Description of the Darlington Waste Management Facility's main components

Component	Definition
Dry storage container	A free-standing reinforced concrete container with an inner steel liner and an outer steel shell that is designed and constructed to safely transfer and store dry used fuel on-site.
Processing building	A secured building where empty dry storage containers are prepared before being sent to the DNGS for used fuel loading, and where loaded dry storage containers are processed before being transferred to storage buildings. Processing activities include welding, painting and testing. The processing building also includes an amenities area with utility rooms, offices, washrooms, a lunch room and other supporting facilities.
Dry storage container transporter	A specially designed multi-wheeled vehicle for the transfer of dry storage containers between the DNGS's irradiated fuel bays and the processing building, and from the processing building to storage buildings.
Retube Waste Storage Building	The retube waste storage building has the capacity to hold 490 dry storage modules containing intermediate level waste.

2.0 Regulatory oversight

The CNSC regulates nuclear facilities and activities in Canada to protect the environment and the health and safety of persons in a manner that is consistent with applicable legislation and regulations, environmental policies and Canada's international obligations. The CNSC assesses the effects of nuclear facilities and activities on human health and the environment during every phase of a facility's lifecycle. This section of the EPR report discusses the CNSC's regulatory oversight of OPG's EP measures for the DN site.

To meet the CNSC's regulatory requirements and according to the licensing basis for the DN site, OPG is responsible for implementing and maintaining EP measures that identify, control and (where necessary) monitor releases of nuclear and hazardous substances and their potential effects on human health and the environment. These EP measures must comply with, or have implementation plans in place to comply with, the regulatory requirements found in OPG's licence and licence condition handbook (LCH). The relevant regulatory requirements for OPG's DN site are outlined in this section of the report.

2.1 Environmental protection reviews and assessments

To date, 3 federal environmental assessments (EAs) and 2 EPRs (including this one) have been carried out for the DN site, as indicated in table 2.1. Subsection 2.1.1 provides a description of the EAs conducted under the *Canadian Environmental Assessment Act* (CEAA 1992) [21] predecessor to the *Canadian Environmental Assessment Act*, *2012* (CEAA 2012) [22]. Subsection 2.1.3 provides information on the EPRs conducted for the DN site. In 2019, the *Impact Assessment Act* (IAA) [23] came into force, replacing CEAA 2012. OPG's current activities at the DN site do not require an impact assessment under the IAA's *Physical Activities Regulations* [24]. The purpose of an assessment under any of these pieces of legislation is to identify the possible impacts of a proposed project or activity and to determine whether those effects can be adequately mitigated to protect the environment and the health and safety of persons.

Table 2.1: Federal environmental assessments for the Darlington Nuclear Site

Project	Regime	EA start date	EA decision date	EA follow-up monitoring program
Construction of the Darlington Used Fuel Dry Storage Facility	CEAA 1992	September 18, 2001	November 7, 2003	Completed
Darlington New Nuclear Project	CEAA 1992	May 17, 2007	May 8, 2012 April 22, 2024*	Yes
Refurbishment and Continued Operation of DNGS	CEAA 1992	June 24, 2011	March 14, 2013	Updated through the Integrated Implementation Plan

*The CNSC Commission determined that the new technology proposed by OPG is not fundamentally different from the technologies assessed in the original EA and a new EA would not be required [25].

2.1.1 Environmental assessments completed under *Canadian Environmental Assessment Act*

Environmental assessments help guide the decision-making process. Historical and ongoing EAs as well as follow-up monitoring programs are reviewed by CNSC staff. CNSC staff acknowledge that these environmental assessments listed below occurred prior to the re-affirmation of the Williams Treaties First Nations harvesting Rights as part of the 2018 Williams Treaties First Nations Settlement Agreement. CNSC staff are committed to working with the Williams Treaties First Nations with the goal of considering and reflecting their views, perspectives and knowledge in the ongoing oversight on the DN.

2.1.1.1 Construction of the Darlington Used Fuel Dry Storage Facility

In 2001, OPG communicated its intent to construct and operate a used fuel dry storage facility (UFDSF) at the DNGS, renamed to DWMF upon construction. The proposed UFDSF project involved the construction of the UFDSF facility, preparation of DSCs for storage, and placement and monitoring of the DSCs in the storage building. CNSC staff determined that OPG's proposal required a screening-level EA under CEAA 1992 [26], before the CNSC could consider OPG's application under the NSCA. In November 2003, following the Commission's consideration of the EA screening report [27] written by CNSC staff, the Commission concluded in the Reasons for Decision that the project was not likely to cause significant adverse environmental effects if the mitigation measures identified in the EA screening report were taken [28].

The EA process identified the need for an EA follow-up monitoring program (FUMP) [29], which was deemed complete by CNSC staff in 2012 [30]. Please note that OPG refers to FUMPs as an Environmental Monitoring and Environmental Assessment Follow-Up.

2.1.1.2 Darlington New Nuclear Project

In 2007, an EA was initiated under the CEAA 1992 for the proposed Darlington New Nuclear Project. This project encompassed the site preparation and eventual construction and operation of up to four additional nuclear reactors within the DN site. The Federal Minister of Environment referred the EA for the project to a joint review panel (JRP) for assessment [31].In 2011, the JRP submitted its EA Report to the Minister of the Environment, concluding that the "proposed project was not likely to cause significant adverse effects provided the mitigation measures proposed and commitments made by OPG and the Panel's recommendations are implemented" [31]. In May 2012, the Government of Canada accepted the intent of all of the JRP's recommendations. In August 2012, the JRP, as a panel of the Commission issued a 10-year site preparation licence for DNNP. This licence was renewed in 2022.

In December 2021, OPG announced its selection of the General Electric Hitachi BWRX-300 reactor for deployment at the DNNP site and applied for a licence to construct in October 2022. In April 2024, the Commission determined following a public hearing in January 2024 that the EA decision made by the JRP in 2011 [31] remains applicable to OPG's selected reactor technology and a new environmental assessment is not required [25].

A complete project timeline for the Darlington New Nuclear Project can be found on the CNSC's website: [Darlington New Nuclear Project timeline (cnsc-ccsn.gc.ca)]

2.1.1.3 Refurbishment and Continued Operation of DNGS

In 2011, an EA was conducted under the CEAA 1992 for the DNGS Refurbishment and Continued Operation Project [32]. The purpose of the project being to refurbish the DNGS to allow it to continue to operate until approximately 2055. The principle works and activities within the scope of the proposed project included the construction of the RWSB and other supporting buildings, the transportation of low and intermediate-level radioactive waste to an off-site management DWMF, and the refurbishment of the CANDU reactors. In 2012, the Commission issued the Record of Proceedings and Decision [33] and concluded that the proposed project was not likely to cause significant adverse effects.

2.1.2 Current environmental assessment follow-up monitoring program

EA follow-up monitoring programs are designed to validate the predicted environmental effects and the effectiveness of mitigation measures. The CNSC ensures that EA FUMPs that are within the CNSC's mandate are incorporated into licensing and compliance activities.

2.1.2.1 Darlington New Nuclear Project

As required by CEAA 1992, the CNSC, with the Fisheries and Oceans Canada (DFO) and Transport Canada as Responsible Authorities, required that OPG establish and implement an EA FUMP [34]. To meet this requirement, as well as other JRP recommendations accepted by the Government of Canada in the EA, OPG has created DNNP Commitments with associated deliverables.

As part of the DNNP Commitment D-P-12.1, which addresses the EA FUMP, OPG has provided an overall EA FUMP [35], as well as specific methodology reports covering a variety of environmental components; tracked through the completion of DNNP Deliverables D-P-12.2 through D-P-12.9 [36]. In the Commission's Record of Decision on the *Determination of Applicability of Darlington New Nuclear Project Environmental Assessment to OPG's Chosen Reactor Technology,* the Commission outlined the following recommendations related to the EA FUMP:

> "The Commission also recommends that in the OPG development and implementation of its EA follow-up program, OPG incorporate, to the extent possible, engagement with the Williams Treaties First Nations and the Métis Nation of Ontario on applicable items (e.g., measures to offset the loss of bank swallows nesting habitat), Indigenous Knowledge, and land use information and data in the program. The Commission expects that CNSC staff continues to support the Williams Treaties First Nations to gather traditional Indigenous Knowledge and land use information and data."

2.1.2.2 FUMP for the Refurbishment and Continued Operation of DNGS [37]

In the Record of Proceedings and Decision [33], an EA FUMP was required for the Darlington B Refurbishment and Continued Operation project. OPG developed an EA FUMP in consultation with the CNSC, ECCC and DFO and the public and Indigenous Nations were invited to review the program through a 30-day consultation period [38]. The actions to be completed for the

FUMP and the schedule for implementation and reporting are captured in the Integrated Implementation Plan (IIP) [39]. OPG continues to provide periodic updates on the status of the EA FUMP to the CNSC through the IIP process.

2.1.3 Previous environmental protection review completed under the *Nuclear Safety and Control Act*

2.1.3.1 Darlington Nuclear Generating Station Licence Renewal

In 2015, OPG applied for a 10-year licence to renew its DNGS Operating Licence. An EA under the NSCA was conducted for the licence application [40]. CNSC staff concluded that OPG has and would continue to make adequate provision for the protection of the environment and the health of persons. A two-part public Commission hearing on the licence application was held in August and November 2015 and the Commission approved OPG's application [41].

In May 2024, OPG submitted a licence application to renew the power reactor operating licence from December 1, 2025 to November 30, 2055 [3]. The Commission will hold a two-part public hearing in 2025. CNSC staff have prepared this EPR report to inform the licensing decision of the Commission.

2.1.3.2 Darlington Waste Management Facility Licence Renewal

In 2021, OPG applied for a 10-year licence to renew its DWMF Operating Licence. An EPR under the NSCA was conducted for the licence application [42]. CNSC staff concluded that OPG has and would continue to make adequate provision for the protection of the environment and the health of persons. A public Commission hearing on the licence application was held in January 2023 and the Commission approved OPG's application to renew the license until April 30, 2033 [43].

2.2 Planned end-state

The following section provides high-level information on the currently planned end-state of the DN site following decommissioning activities. This section is informed by OPG's PDP for the DN site. The PDP is important to consider as part of CNSC staff's ongoing oversight for the assessment of environmental and health effects of nuclear facilities and activities.

A PDP is required to be developed by the licensee and submitted to the CNSC for review and acceptance as early as possible in the facility's lifecycle or the conduct of the licensed activities. The PDP is progressively updated, where needed, to reflect the appropriate level of detail required for the respective licensed activities. The PDP is developed for planning purposes only and the associated cost estimate is used to set aside dedicated decommissioning funding in the form of a financial guarantee. The PDP does not authorize decommissioning and does not provide sufficient details for the assessment of environmental impacts during decommissioning. Prior to the commencement of any decommissioning activities and to support an application for a licence to decommission, a detailed decommissioning plan is required to be developed by the licensee and submitted to the CNSC for review and acceptance.

PDPs for nuclear facilities are updated by the licensee at least every 5 years, considering notable changes relevant to decommissioning, or as requested by the CNSC. The decommissioning strategy and end-state objectives for the DN site are documented in the Darlington Nuclear Site preliminary decommissioning plan [5] and the preliminary decommissioning plan for the Darlington Waste Management Facility [4].

OPG's PDP assumes that the reactor units will be shut down between 2050 to 2056 and the DNGS will be dismantled once decommissioning is approved. A deferred decommissioning strategy has been planned and flexibility is built into the process to cater to the final decision OPG may make with respect to shutdown dates. The DWMF will remain in operation after shutdown of the DNGS reactors and is expected to continue receiving, processing, and storing DSCs during stabilization and storage with surveillance, until all the fuel has been removed. This PDP is the proposed plan for decommissioning the DNGS and since it also addresses the interfaces of the DNGS with the DWMF, which is also located on the DN site, it is referred to as the site PDP. The purpose of the PDP is to define the areas to be decommissioned and the sequence of the principal decommissioning work for the DNGS. The PDP also demonstrates that decommissioning is feasible with existing technology, and it provides a basis for estimating the cost of decommissioning. The PDP describes the final end-state after dismantling, demolition and site restoration, which notes that the site will be free of industrial and nuclear hazards.

In January 2022, OPG submitted the updated DN site PDP. CNSC staff have reviewed the PDP and provided comments and requests to which OPG is required to respond. An updated DN site PDP is expected in 2027. It should be noted that OPG submitted an application to extend the commercial operation date of the DNGS from December 1, 2025 to November 30, 2055 [3]. This application is currently under review by CNSC staff and will require a Commission hearing for decision. Should the Commission grant a licence extension, OPG will be required to submit a revised PDP, including additional decommissioning activities and associated costs for the licence extension.

2.3 Environmental regulatory framework and protection measures

The CNSC has a comprehensive EP regulatory framework which includes the protection of people and the environment and considers both nuclear and hazardous substances, as well as physical stressors (such as noise). Public dose is included in the EP framework. The focus of this section of the EPR report is on the EP regulatory framework and the status of OPG's environmental protection program (EPP) for the DN site. The results from OPG's EPP are detailed in section 3.0 of this report.

OPG's EPP for the DN site was designed and implemented in accordance with REGDOC-2.9.1, *Environmental Protection: Environmental Principles, Assessments and Protection Measures* (2017) [44], as well as the CSA Group's environmental protection standards listed below. The implementation status for these documents is shown in table 2.2. The EPP includes derived release limits (DRLs) and public dose modelling.

Table 2.2: Status of environmental protection measures to implement regulatory documents and standards

Regulatory document or standard	Status
CSA N288.0-22, *Environmental management of nuclear facilities: Common requirements of the CSA N288 series of Standards* [45]	Implemented
CSA N288.1-14, *Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities* [46]	Implemented
CSA N288.1-20, *Guidelines for modelling radionuclide environmental transport, fate, and exposure associated with the normal operation of nuclear facilities* [47]	To be implemented following submissions of revised DRLs (2028)
CSA N288.4-19, *Environmental monitoring programs at nuclear facilities and uranium mines and mills* [48]	Implemented
CSA N288.5-22, *Effluent and emissions monitoring programs at nuclear facilities* [49]	Implemented
CSA N288.6-12, *Environmental risk assessment at Class I Nuclear facilities and uranium mines and mills* [50]	Implemented
CSA N288.6-22, *Environmental risk assessments at nuclear facilities and uranium mines and mills* [51]	To be implemented November 30, 2026
CSA N288.7-15, *Groundwater protection programs at Class 1 nuclear facilities and uranium mines and mills* [52]	Implemented
CSA N288.7-22, *Groundwater protection and monitoring programs for nuclear facilities and uranium mines and mills* [53]	Implementation Plan to be submitted by December 2, 2024
CSA N288.8-17, *Establishing and implementing action levels for releases to the environment from nuclear facilities* [54]	Implemented
CNSC REGDOC-2.9.1, *Environmental Protection: Environmental Principles, Assessments and Protection Measures, version 1.1* (2017) [44]	Implemented

CNSC staff confirm that OPG has implemented programs that are following the relevant EP regulatory documents and standards or has implementation plans in place.

Licensees are also required to regularly report on the results of their EPPs. Reporting requirements are specified in REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants* [55], REGDOC-3.1.2 *Reporting Requirements, Volume I: Non-Power Reactor Class I Nuclear Facilities and Uranium Mines and Mills* [56], the *Radiation Protection Regulations* [57] (e.g., for action level (AL) or dose limit exceedances), the licensees' approved programs and manuals, and the LCH [58].

OPG is required to submit quarterly safety performance indicator reports, annual reports on environmental protection for the NGS and quarterly reports and annual compliance reports as per REGDOC-3.1.1 [55] and REGDOC-3.1.2 [56]. These reports are reviewed by CNSC staff for compliance and verification, as well as trending. OPG publishes several of these reports on its website, such as web page Regulatory reporting - OPG [59].

CNSC staff regularly report on licensee performance to the Commission for activities conducted at the DN site. For example, CNSC staff's regulatory oversight reports (RORs) are a standard mechanism for updating the Commission, Indigenous Nations and communities, and the public on the operation and regulatory performance of licensed facilities. Previous RORs are available on the CNSC regulatory oversight reports web page [60]. CNSC staff may also report to the Commission on significant events, such as unplanned releases to the environment, through an event initial report.

2.3.1 Environmental protection measures

To meet the CNSC's regulatory requirements under REGDOC-2.9.1 (2017) [44], OPG is responsible for implementing and maintaining EP measures that identify, control and monitor releases of radioactive nuclear and hazardous substances from the DN site, as well as the effects of these substances on human health and the environment. EP measures are an important component of the overall requirement of licensees to make adequate provisions to protect the environment and the health of persons.

This subsection and the following ones under section 2.3 summarize OPG's EPP for the DN site and the status of each specific EP measure, relative to the requirements or guidance outlined in the latest regulatory document or CSA Group standard. Section 3.0 of this EPR report summarizes the results of these programs or measures against relevant regulatory limits and environmental quality objectives or guidelines, and discusses, where applicable, any interesting trends.

OPG is required to implement an environmental management system (EMS) that conforms to REGDOC-2.9.1 (2017) [44] and to submit an EPP for the DN site. OPG's EPP includes the following components to meet the requirements and guidance as outlined in REGDOC-2.9.1 (2017) [44]:

- EMS (subsection 2.3.2)
- environmental risk assessment (ERA) (subsection 2.3.3)
- effluent and emissions control and monitoring (section 2.3.5)
    - derived release limits and operating release limits
    - air emissions and liquid effluent monitoring
- environmental monitoring program (EMP) (section 2.3.6)
    - ambient air monitoring

- fruits and vegetables monitoring
- animal feed monitoring
- eggs and poultry monitoring
- milk monitoring
- soil and sand monitoring
- surface water monitoring (lake and water supply plants)
- well water monitoring
- groundwater monitoring
- sediment monitoring
- fish monitoring

Section 3.0 of this EPR report summarizes the results of these programs or measures against relevant regulatory limits and environmental quality objectives or guidelines, and discusses, where applicable, any notable trends.

2.3.2 Environmental management system

An EMS refers to the management of an organization's environmental policies, programs and procedures in a comprehensive, systematic, planned, and documented manner. It includes the organizational structure as well as the planning and resources to develop, implement and maintain an EP policy. The EMS serves as a management tool to integrate all of a licensee's EP measures in a documented, managed and auditable process in order to:

- identify and manage non-compliances and corrective actions within the activities through internal and external inspections and audits
- summarize and report on the performance of these activities both internally (licensee management) and externally (Indigenous Nations and communities, the public, interested stakeholders, and the Commission)
- train personnel involved in these activities
- ensure the availability of resources (that is, qualified personnel, organizational infrastructure, technology and financial resources)
- define and delegate roles, responsibilities, and authorities essential to effective management

OPG has established and implemented a corporate EMS for the DN site in accordance with REGDOC-2.9.1 (2017) [44] and is also registered and certified under the International Organization for Standardization (ISO) standard 14001:2015 (a standard that helps an organization achieve the intended outcomes of its EMS). CNSC staff review OPG's annual internal audits; management reviews; and environmental goals, targets and objectives to ensure compliance with REGDOC-2.9.1 (2017). While the CNSC does not consider ISO 14001 certification as part of the criteria for meeting the requirements of REGDOC-2.9.1, the results of these third-party audits are reviewed by CNSC staff as part of the compliance program. CNSC staff also review the status of OPG's annual goals, targets and objectives and the implementation of the EMS as part of their review of the annual reports on EP.

The results of these reviews demonstrate that OPG's EMS for the DN site meets the CNSC requirements as outlined in REGDOC-2.9.1 (2017) [44]. The implementation of the EMS ensures that OPG continues to improve environmental performance at the DN site.

2.3.3 Environmental risk assessment

An ERA of nuclear facilities is a systematic process used by licensees to identify, quantify and characterize the risk posed by contaminants and physical stressors in the environment on human and other biological receptors, including the magnitude and extent of the potential effects associated with a facility. The ERA serves as the basis for the development of site-specific EP measures and the results from the ERA updates determine whether the facility's effluent monitoring and EMP are effective. The results of these programs, in turn, inform and refine future revisions of the ERA.

In March 2021, OPG submitted their *2020 Environmental Risk Assessment for the DN site* [61] (2020 ERA) in accordance with the requirements set out in CSA N288.6-12 [50], and REGDOC 2.9.1 [44] which stipulates that licensees must review and revise their ERA every 5 years. OPG's ERA submission is site-wide and encompassed the entirety of the DN site, including the DWMF. The DN site-wide 2020 ERA included an ecological risk assessment (EcoRA) and a human health risk assessment (HHRA) for nuclear and hazardous contaminants and physical stressors. The 2020 ERA included risks associated with the DN site, which includes the DNGS and DWMF, based on effluent and environmental monitoring data for the period between 2016 to 2019.

The ERA was performed in a stepwise manner, as follows:

- quantify the releases (of COPCs) to the environment from current (see section 3.1) and future activities
- identify the environmental interactions of the current and expected releases of COPCs, and COPC exposure pathways in the environment
- identify predicted COPC exposure for ecological and human receptors
- identify potential effects to receptors
    - quantify the releases (of COPCs) to the environment from current (see section 3.1) and future activities
    - identify the environmental interactions of the current and expected releases of COPCs, and COPC exposure pathways in the environment
    - identify predicted COPC exposure for ecological and human receptors
    - identify potential effects to receptors
    - determine whether the environment and health and safety of persons is and will continue to be protected

CNSC staff reviewed the 2020 site-wide ERA and required additional information in order to verify whether the ERA was compliant with requirements in REGDOC 2.9.1 and CSA N288.6 [62]. In October 2021, OPG submitted a revised ERA report, taking into consideration CNSC staff comments [63]. CNSC staff reviewed OPG's revised ERA and found it to be compliant with CSA N288.6-12 [50].

OPG's findings from the revised 2020 ERA are summarized in table 2.3 below. CNSC staff reviewed the revised ERA and have found that no new risks have emerged since the previous

ERA and that unreasonable risks to human health and the environment attributable to DNGS and DWMF operations are unlikely.

The findings of the revised 2020 ERA are summarized in table 2.3. Adverse effects to ecological and human health due to releases of COPCs to the air and water from the DN site were found to be negligible.

Table 2.3: Summary of environmental risk assessment findings for the Darlington Nuclear Site [63]

Type	Members of the public	Aquatic and terrestrial biota
Radiological	The annual dose to the critical receptor was well below the public dose limit and there were no concerns	There were no exceedances of the radiation dose benchmarks for ecological receptors.
Hazardous	There are negligible releases of hazardous COPCs from the facility. No adverse impacts expected on members of the public.	There are negligible releases of hazardous COPCs from the facility. However, concentrations of certain metals in soil, in a localized area were above the soil quality criteria. However, no adverse population level impacts expected on aquatic and terrestrial biota.
Physical stressors*	There are no adverse impacts expected from physical stressors associated with operations at the facility.	There are no adverse impacts on biota expected from physical stressors associated with operations at the facility.

2.3.4 Effluent and emissions control and monitoring

Controls on environmental releases are established to provide protection to the environment and to respect the principles of sustainable development and pollution prevention. The effluent and emissions prevention and control measures are established based on industry best practice, the application of optimization of protection (such as in design) and of as low as reasonably achievable (ALARA) principles, the Canadian Council of Ministers of the Environment (CCME) guidelines, and results of the licensee's ERAs.

OPG has controls in place to minimize airborne emissions and waterborne effluents for radiological and non-radiological COPCs, and to ensure that releases are within regulatory limits and ALARA.

OPG has implemented an effluent and emission monitoring program in compliance with REGDOC-2.9.1 (2017) [44] and the relevant standards, including CSA N288.5-22, *Effluent and emissions monitoring programs at nuclear facilities* [49] and CSA N288.0-22, *Environmental management of nuclear facilities: Common requirements of the CSA N288 series of Standards* [45]. This program contains DRLs and ALs. The DRLs represent the maximum acceptable level of emitted contaminants from the processes at the DN site and are derived from the dose limit for members of the public (that is, 1 millisievert [mSv] per year). In addition, the DN site has established ALs that serve as an early warning of potential loss of control of the EPP.

Based on compliance activities, CNSC staff have found that the effluent and emission monitoring program currently in place for the DN site continues to protect human health and the environment.

2.3.5 Environmental monitoring program

The CNSC requires each licensee to design and implement an EMP that is specific to the monitoring and assessment requirements of the licensed facility and its surrounding environment. The program is required to:

- measure contaminants in the environmental media surrounding the facility or site
- determine the effects, if any, of the facility or site operations on people and the environment
- serve as a secondary support to effluent and emission monitoring programs to demonstrate the effectiveness of emission controls

More specifically, the program must gather the necessary environmental data to calculate the public dose and demonstrate compliance with the public dose limit found in the *Radiation Protection Regulations* [64] of 1 mSv per year. The program design must also address the potential environmental interactions identified at the facility or site. Radionuclides are the major focus at the DN site, though hazardous substances environmental compliance approval (ECA) are included within monitoring activities associated with liquid discharges and air emissions. OPG's EMP for the DN site consists of the following components:

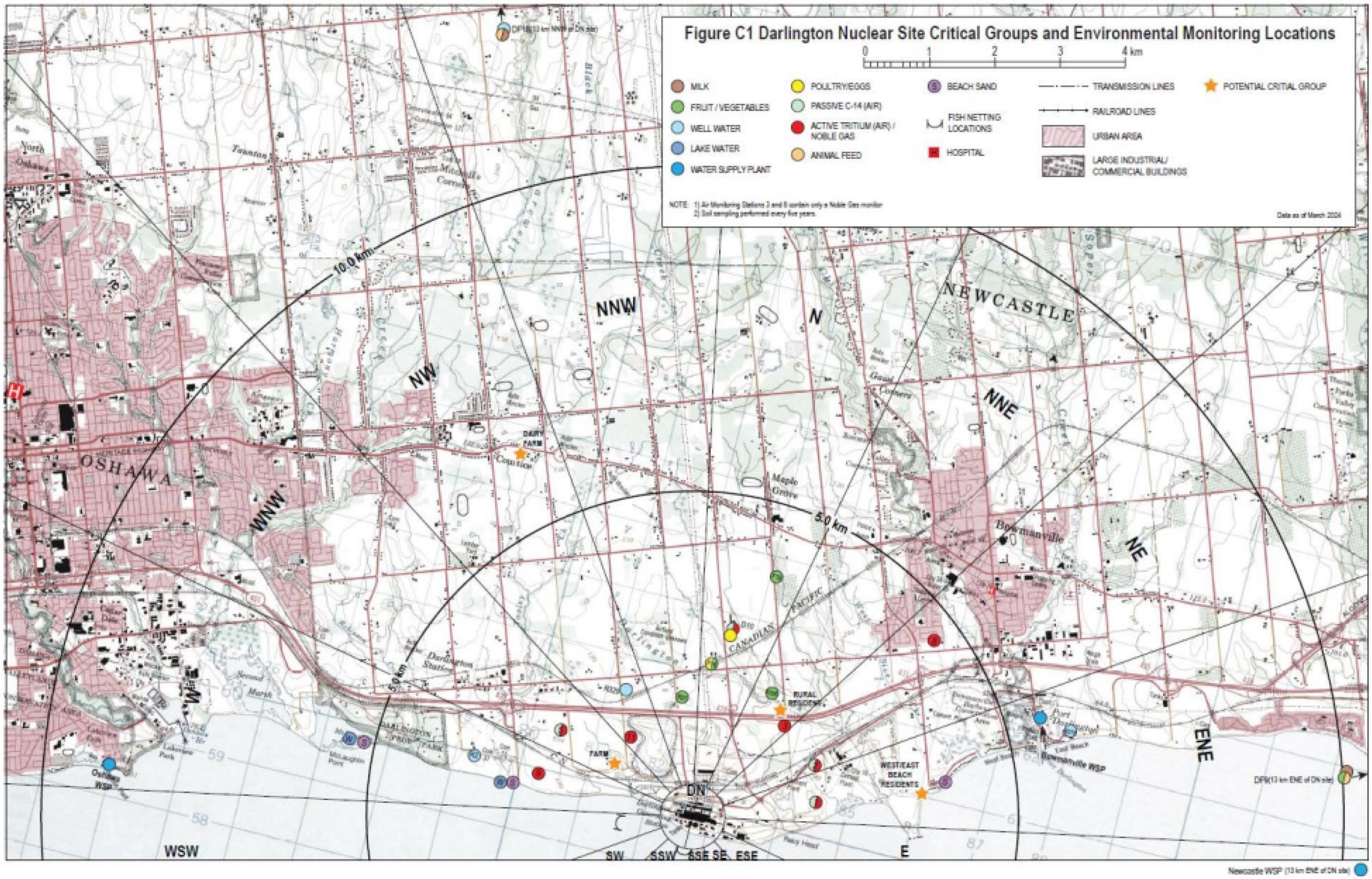
- ambient air monitoring
- fruits and vegetables monitoring
- animal feed monitoring
- eggs and poultry monitoring
- milk monitoring
- soil and sand monitoring
- surface water (lake and water supply plants)
- well water monitoring
- groundwater monitoring
- sediment monitoring
- fish monitoring

Monitoring frequency and parameters are specified in OPG EMP reports [59]. The sampling locations are shown on the map below figure 2.1.

OPG is required to maintain its EMP to comply with REGDOC-2.9.1 (2017) [44] and relevant standards, including CSA N288.4-19, *Environmental monitoring programs at nuclear facilities and uranium mines and mills* [48] and CSA N288.0-22, *Environmental management of nuclear facilities: Common requirements of the CSA N288 series of Standards* [45].

Based on compliance activities and technical assessments, CNSC staff have found that OPG is compliant with REGDOC-2.9.1 (2017) [44] and continues to implement and maintain an effective EMP for the DN site that adequately protects the environment and the health and safety of persons.

Figure 2.1: Darlington Nuclear Site Environment Monitoring Program sampling locations [10]



2.4 Requirements under other federal or provincial regulations

A core element of the CNSC's requirement for an EMS is the identification of all regulatory requirements applicable to the facility, whether pursuant to the NSCA or other federal or provincial legislation. The EMS must ensure that programs are in place to respect these requirements.

2.4.1 Greenhouse gas emissions

While there is a range of broadly applicable federal environmental regulations (for example, petroleum products storage tanks, environmental emergency regulations), the management of greenhouse gas (GHG) emissions has been identified as a national priority.

Under the federal *Canadian Environmental Protection Act, 1999* (CEPA 1999) [65], OPG is required to monitor and report on GHG emissions. Facilities that emit more than the emission reporting threshold (that is, 10,000 tonnes of CO_2 equivalent) on an annual basis must report their GHG emissions to ECCC. In the case of the DN, site CO_2 releases remained below the reporting threshold from 2019 to 2023 [6, 7, 8, 9, 10].

The CNSC maintains a collaborative working relationship with ECCC through a formal memorandum of understanding (MOU) [66], which includes a notification protocol. An exceedance of the GHG emissions reporting threshold would be included under this notification protocol. This ensures that a coordinated regulatory approach is achieved to meet all federal requirements associated with EP, including GHGs.

2.4.2 Ozone depleting substances

In accordance with the *Federal Halocarbon Regulations, 2022* [67], OPG is required to provide a semi-annual halocarbon release report to ECCC on the release of halocarbons of an amount greater than 10 kilograms (kg) but less than 100 kg from any system, container or equipment at the DN site. In the event of a release that surpasses 100 kg, OPG would be required to report the releases to ECCC within 24 hours and ECCC would inform the CNSC through the notification protocol of the CNSC-ECCC MOU. OPG would then be required to submit a follow-up report to ECCC within 30 days of the release detailing the circumstances leading to the release and the corrective and preventive actions taken to prevent a reoccurrence.

OPG has reports as required the information needed for the DN site for the assessed period (2019–2023).

2.4.3 Sulphur dioxide emissions

Under the authority of CEPA 1999 [65], OPG is also required to estimate the total sulphur dioxide (SO_2) emissions from the DN site and report to the National Pollutant Release Inventory (NPRI), provided that the reporting requirements are met. The sulphur dioxide emissions at the DN site remained below the NPRI reporting threshold for the assessed period (2019–2023). OPG is still reporting its sulphur dioxide releases in its annual environmental monitoring report [6, 7, 8, 9, 10].

2.4.4 Other environmental compliance approvals

Non-radiological liquid effluent is monitored in accordance with the provincial ECA requirements. Non-radiological liquid effluent from the radioactive liquid waste management system must comply with ECA requirements. COPCs not addressed by the ECA are assessed through the ERA to determine whether they merit additional regulatory oversight.

Non-radiological airborne emissions are required to be in compliance with provincial regulation O. Reg. 419/05 [68], which is met by complying with the ECA for Air and Noise. OPG did not report any non-compliances for its ECA. An Emissions Summary and Dispersion Modelling report is used to document and maintain compliance with O. Reg. 419/05 [68].

2.4.5 *Fisheries Act* Authorization

In October 2023, DFO and the CNSC signed a revised MOU outlining areas for cooperation and administration of the *Fisheries Act* [69], which aims to conserve and protect fish and fish habitat across Canada.

The CNSC-DFO MOU focuses on sections 34 and 35 of the *Fisheries Act*, which state that no person shall carry on any work, undertaking or activity that could cause the death of fish and/or harmful alteration, disruption or destruction of fish habitat, unless the Minister of DFO issues a Fisheries Act Authorization (FAA). This authorization, if granted, includes terms and conditions to avoid, mitigate, offset (that is, counterbalance impacts) and monitor the impacts on fish and fish habitat resulting from a specific project.

2.5 Canadian Nuclear Safety Commission and federal partners consideration of climate change

The CNSC's regulatory framework requires licensees and proponents to consider climate change primarily through requirements related to EAs and safety assessments. These assessments take place throughout the licensing lifecycle as part of the licence application, licence renewal and periodic safety review (PSR) process.

CNSC staff's consideration of climate change

e during these assessments may include examining whether climate change is considered in the analysis of external hazards and environmental parameters such as meteorological and hydrological parameters used in the design, evaluation and upgrade of a nuclear facility, and whether a licensee has applied the defence-in-depth principle in its design with sufficient safety margin.

Specifically, climate change considerations are included in the following mechanisms in the regulatory framework:

Environmental assessment

Previously under CEAA 2012 and currently under the IAA, proponents must assess the climate change impact on a project itself and thereby the surrounding environment, over the lifetime of the facility. As noted in section 2.1, the DN site has undergone numerous EAs that have demonstrated that, with mitigation measures implemented, climate change, as well as the anticipated increases in the magnitude and frequency of external hazards due to climate change, would not likely have impact on the project that would lead to residual adverse effect. The most recent EAs [32] [70] [71] for the DN site conducted in 2007 and 2011 assessed the impact of climate change and are discussed further in Section 3.2.7.

Periodic safety reviews

Licensees for nuclear power plants are required to conduct PSRs to evaluate the design, condition and operation of the facility. Probabilistic Safety Assessment (PSA), as one of the safety factors evaluated in the PSR, includes analysis of external hazards, such as flooding, and their impact on a facility. As part of the 5-year cyclical review process, CNSC staff review the PSA and ensure that up-to-date hazard information is included.

In OPG's latest hazard analysis report [72], flood hazards (including probable maximum flood due to a combination of probable maximum precipitation (PMP), 1:100 year lake level and storm surge) were screened out from additional probabilistic safety assessment, indicating that risk due to external flood hazards is low.

Environmental risk assessment

As described further in section 2.3.3, an ERA (updated in a 5-year review cycle) evaluates risk posed by contaminants and physical stressors to the environment under normal operating conditions, taking into consideration recent monitoring data (including meteorological parameters) and new scientific knowledge. The latest ERA update [63] graphically evaluated the monthly variability of temperature and precipitation, as well as the annual prevailing wind distribution, based on latest monitoring data. Thermal plume monitoring results were presented and OPG demonstrated that it is unlikely there are any effects arising from the thermal plume in the lake for juvenile or adult stages of any fish species. CNSC staff will continue to assess potential thermal impacts to aquatic receptors from site discharges keeping in mind any environmental changes due to climate change.

CNSC and ECCC collaboration

The CNSC and ECCC have an MOU [66] in place that includes collaboration related to climate change. For example, ECCC contributes expertise on projection of climate change and estimations of extreme rainfall intensity-duration-frequency curve and probable maximum precipitation (PMP) for various sites to CNSC staff. This informs CNSC staff's technical reviews.

ECCC also has the mandate to monitor and provide meteorological data to Canadians, to conduct scientific research regarding the mechanism and effects of climate change, and to develop science-based guidance on assessment of climate change for application when projects are subject to federal impact assessments. The Strategic Assessment of Climate Change guidance [73] includes specific guidance on net zero plans, calculation of GHG emissions/intensity and resiliency.

Further information on how the CNSC assesses the impacts of climate change on nuclear safety in Canada can be found at Climate Change Impact Considerations.

3.0 Status of the environment

This section provides a summary of the status of the environment around the DN site. It starts with a description of the nuclear and hazardous releases to the environment (section 3.1), followed by a description of the environment surrounding the DN site and an assessment of any potential effects on the different components of the environment as a result of exposure to these contaminants (section 3.2).

CNSC staff regularly review the potential effects on environmental components through annual reporting requirements and compliance verification activities, as detailed in other areas of this report. This information is reported to the Commission in the sections on EP in licensing commission member documents and annual RORs. The EMP reports submitted by OPG for the DN site are made publicly available and can be viewed on OPG's website: Regulatory reporting - OPG [59].

3.1 Releases to the environment

Radioactive nuclear and hazardous substances that have the potential to cause an adverse effects to ecological or human receptors are identified as COPCs. The ways in which COPCs could find their way to the different receptors considered by the ERA are called "exposure pathways."

Figure 3.1 illustrates a conceptual model of the environment around a nuclear site to show the relationship between releases (airborne emissions or waterborne effluent) and human and ecological receptors. This graphic is meant to provide an overall conceptual model of the releases, exposure pathways and receptors for the DN site and thus should not be interpreted as a complete depiction of the DN site and its surrounding environment.

Releases from the DWMF are significantly lower than those from the DNGS, and so emissions from the DWMF should be considered as a small fraction of the overall emissions and releases from the DN site. The specific releases and COPCs associated with the DN site are explained in detail in the following subsections.

Figure 3.1: Conceptual model of the environment around the Darlington Nuclear Site

3.1.1 Licensed release limits

OPG uses DRLs and ALs, approved by the CNSC, to control radiological effluent and emission releases from the site as discussed in section 2.3.5. A DRL for a given radionuclide is the release rate that would cause an individual of the most highly exposed group to receive a dose equal to the regulatory annual dose limit of 1 mSv.

3.1.2 Airborne emissions

OPG controls and monitors airborne emissions from the DN site to the environment under its effluent monitoring program. This program is based on CSA N288.5-22, *Effluent and emissions monitoring programs at nuclear facilities* [49] and includes monitoring of both nuclear and hazardous emissions.

3.1.2.1 DN site radiological airborne releases

As part of OPG's effluent monitoring program, releases to the atmosphere are collected and are routinely analyzed for tritium, elemental tritium, carbon-14 (C-14), iodine-131 (I-131), noble gases and particulates. The results are compared against DRLs developed by OPG and approved by the CNSC to ensure release limits to the environment will not exceed the annual regulatory public dose limit of 1 mSv. As shown in table 3.1, the average radiological emissions from the DN site remain at a very small fraction of the DRLs.

Table 3.1: Annual airborne releases from the Darlington Nuclear Site compared with applicable derived release limits (2019 – 2023) [6, 7, 8, 9, 10]

Parameter (Bq/yr)	**2019**	**2020**	**2021**	**2022**	**2023**	**DRLs** [58]
Tritium oxide	2.0×10^{14}	1.9×10^{14}	2.6×10^{14}	2.2×10^{14}	$\mathbf{5.3 \times 10^{14}}$	$\mathbf{3.91 \times 10^{16}}$
Elemental tritium*	2.5×10^{13}	1.5×10^{13}	1.7×10^{13}	9.2×10^{13}	$\mathbf{1.3 \times 10^{15}}$	$\mathbf{6.26 \times 10^{17}}$
Noble gas**	5.0×10^{13}	2.4×10^{13}	2.7×10^{13}	2.2×10^{13}	$\mathbf{4.4 \times 10^{13}}$	$\mathbf{3.46 \times 10^{16}}$
Iodine-131	1.4×10^{8}	1.5×10^{8}	1.5×10^{8}	1.4×10^{8}	$\mathbf{1.2 \times 10^{8}}$	$\mathbf{1.74 \times 10^{12}}$
Particulate gross beta-gamma	2.6×10^{7}	3.1×10^{7}	2.0×10^{7}	2.9×10^{7}	$\mathbf{2.8 \times 10^{7}}$	$\mathbf{5.51 \times 10^{11}}$
Carbon-14	9.7×10^{11}	8.3×10^{11}	1.2×10^{12}	1.2×10^{12}	$\mathbf{1.1 \times 10^{12}}$	$\mathbf{7.68 \times 10^{14}}$

* Emissions from Darlington Tritium Removal Facility
** Airborne noble gas emission units are in becquerel- Mega electron-volt (Bq-MeV)

3.1.2.2 DWMF radiological airborne releases

Under normal operating conditions, radiological airborne releases are unlikely to occur during transfer and storage of sealed and welded DSCs at the DWMF. However, there is a small potential for airborne emissions at the DWMF resulting from DSC processing operations, such as welding and vacuum drying. The DSC processing building has a dedicated High Efficiency Particulate Air (HEPA) air filtered active ventilation system. Airborne particulate contamination, if present, would be effectively removed by the HEPA filters in the active ventilation system. Past PWMF, WWMF and DWMF operating experience demonstrates that particulate emissions in exhaust from DSC processing operations have been typically below the Minimum Detectable Activity. OPG website, under regulatory reporting [74]

3.1.2.3 DN site non-radiological releases

The main sources of non-radiological releases at the DN site are the standby diesel generators onsite. These sources release small quantities of carbon monoxide, nitrogen oxides, sulphur dioxide. In addition, hydrazine, morpholine and ammonia are used in the feedwater system to prevent corrosion and are released in small quantities through controlled venting. Ozone-depleting substances are used in refrigeration systems, leaks are minimized through routine maintenance of equipment and inspections.

Non-radiological air emissions from the DN site are controlled in accordance with provincial ECA requirements. Dispersion modelling was used to predict the maximum concentrations of COPCs at the property line of the DN site. OPG did not report any ECA non-compliances to the provincial regulator or the CNSC on during the 2019-2023 period.

3.1.2.4 DWMF non-radiological releases

The potential for airborne hazardous substance releases at the DWMF is negligible. Paint touch-up operations for the DSCs involve a minimal amount of paint quantities and paint aerosols from the paint bays, which are removed through filters before exhausting into the active ventilation system. Welding fumes from DSC seal-welding operations are also exhausted through the HEPA filtered active ventilation system. The emissions from the welding operations are also negligible.

3.1.2.5 Findings

Based on CNSC staff's review of the results of the air emissions monitoring program at the DN site, CNSC staff have found that OPG's air emissions to the environment from the DN site have remained below the CNSC-approved licence limits throughout the reporting period (2019 to 2023). CNSC staff confirm that OPG continues to provide adequate protection of people and the environment from air emissions.

3.1.3 Waterborne effluent

OPG controls and monitors liquid (waterborne) effluent from the DN site to the environment under its implementation of the effluent monitoring program. This program is based on CSA N288.5-22, *Effluent and emissions monitoring programs at nuclear facilities* [49] and includes monitoring of radiological and hazardous releases.

The DN site is located on the north shore of Lake Ontario. Waterborne effluent from the DN site is discharged into the CCW system through either the intake forebay or directly into the CCW discharge duct. The two exceptions are effluent from the domestic sewage system which goes to the Courtice Water Pollution Control Plant, and stormwater which is discharged to Lake Ontario through the storm sewers or drainage swales/creeks.

3.1.3.1 Active Drainage System

The active drainage system collects active (radiological) effluent waste from the drains in the reactor building, the Reactor Auxiliary Bay, the Central Service Area, the Fuelling Facilities Auxiliary Areas, the chemical laboratory sink, the Heavy Water Management Building, and the Tritium Removal Facility. The active liquid waste is directed to the receiving tanks of the radioactive liquid waste management system. The activity in the liquid waste may include tritium, carbon-14, gross alpha and gross beta-gamma (such as cesium-134, cesium-137, cobalt-60 (Co-60) or strontium-90). The active drainage system includes filters and ion exchange columns to purify the waste. After treatment the waste is sampled and chemically analyzed to ensure it meets radioactive and chemical limits prior to discharge. The treatment can also include the addition of sodium bicarbonate and calcium bicarbonate for hardness adjustment and potassium hydroxide for pH adjustment, if required. Radioactivity monitors on the discharge piping automatically stop discharge flow if the detected activity is above specified limits.

3.1.3.2 Inactive Drainage System

Building effluents from inactive areas in all four units, and from the Central Service Area, are collected and combined in a common header prior to discharging to two lagoons (each approximately 4000 m^3) operated in series. Forced aeration occurs in the first lagoon to promote mixing and reaction between air and low levels of hydrazine. The effluent from the first lagoon overflows to the second lagoon, which allows sufficient retention time for settling. The lagoon water eventually discharges to the Forebay, to be circulated with CCW and eventually discharged.

3.1.3.3 Stormwater Management System

The Stormwater Management System, or Yard Drainage System, collects storm runoff from the entire DN site and discharges to Lake Ontario either directly through the storm sewer drainage system or through drainage swales/creeks/retention pond via culverts which eventually discharge to the Lake. Stormwater and foundation drainage is regulated by the Ministry of Environment, Conservation and Parks (MECP) under the *Environmental Protection Act* [75] and the *Ontario Water Resources Act* [76]. Site stormwater works are under the site ECA No. 0585-D4KP24 for industrial sewage works [77]. The stormwater works are designed as per the ECA requirement to ensure that stormwater is properly managed to prevent erosion, flooding, and degradation of receiving water bodies. In the case that the stormwater discharge at the facility were to exceed a provincial limit, OPG would be required to report this exceedance to the CNSC as required under REGDOC-3.2.1, *Public Information and Disclosure* [78]. To date, the CNSC has not received any reports of exceedances for stormwater discharge at the DN.

As part of OPG's effluent monitoring program, samples of waterborne effluent are collected and routinely analyzed for tritium, carbon-14 and gross beta/gamma. As per table 3.2, the annual radiological waterborne releases from the DN site remain a very small fraction of the licensed DRLs. From 2019 to 2023 there have been no DRL (regulatory limit) exceedances.

Table 3.2: Annual waterborne releases from the Darlington Nuclear Site compared with applicable release limits (2019 – 2023) [6, 7, 8, 9, 10]

Parameter (Bq/yr)	2019	2020	2021	2022	2023	DRL [58]
Tritium oxide	1.0×10^{14}	1.2×10^{14}	1.9×10^{14}	2.0×10^{14}	2.7×10^{14}	6.36×10^{18}
Gross beta/gamma	2.3×10^{10}	2.5×10^{10}	1.6×10^{10}	9.3×10^{9}	1.7×10^{10}	3.47×10^{13}
Carbon-14	3.8×10^{8}	3.8×10^{8}	1.9×10^{9}	9.7×10^{8}	2.2×10^{8}	6.97×10^{14}

3.1.3.4 Findings

CNSC staff have found that OPG's reported liquid effluent discharged to Lake Ontario from the DN site remained below the CNSC's approved licence limits throughout the reporting period 2019 to 2023.

CNSC staff are satisfied that OPG is taking the appropriate measures at the DN site, as mentioned above, to effectively control and reduce concentrations and loadings of nuclear and hazardous substances in waterborne effluent.

3.2 Environmental effects assessment

This section presents an overview of the assessment of predicted effects from licensed activities on the environment and the health and safety of persons. CNSC staff reviewed OPG's assessment of current and predicted effects on the environment and health and safety of persons due to licensed activities included in the ERA (see subsection 2.3.3) for the DN site.

To inform this section of the report, CNSC staff reviewed OPG's 2020 ERA [61, 63], as well as annual reports submitted between 2016 and 2022 inclusively [9, 10] [11-20] [79, 80].

While CNSC staff conducted a review for all environmental components, only a selection of components is presented in detail in the following subsections. The environmental components were selected based on regulatory requirements, facility type, and geographic context; some were also included because they have historically been of interest to the Commission, Indigenous Nations and communities and the public.

3.2.1 Atmospheric environment

An assessment of the atmospheric environment requires OPG to characterize both the meteorological conditions and the ambient air quality at the DN site.

3.2.1.1 Meteorological conditions

Meteorological conditions, such as temperature, wind speed, wind direction, and precipitation are monitored to assess the extent of the atmospheric dispersion of contaminants emitted to the atmosphere and the rates of contaminant deposition. Meteorological information is also used to determine predominant wind directions, which are used to identify critical receptor locations from the air pathway. Meteorological data were collected from stations within the site, and in local and regional areas, such as the Bowmanville climate station.

The DN site is in southern Ontario on the north shore of Lake Ontario. In Southern Ontario, the climate is influenced by the Great Lakes which results in uniform precipitation amounts year-round, delayed spring and autumn, and moderate temperatures in winter and summer.

3.2.1.2 Ambient air quality

Radiological

Samples of air are collected to monitor the environment around the DN site. These samples are analyzed for tritiated water (HTO), C-14, and noble gases (argon-41, xenon-133, xenon-135 and iridium-192) and the results are used in the calculation of public dose. Background samples are also collected for the dose calculations.

There are six active tritium-in-air samplers (measuring HTO) around the DN site which are collected and analyzed monthly. The background concentration of HTO in air is measured at Nanticoke, Ontario which is considered to be far from the influence of nuclear stations. The levels of HTO observed in the environment depend on station emissions, wind direction, wind speed, ambient humidity and seasonal variations. Fluctuations from year to year are expected even if site HTO emissions remain similar. There were no statistically significant trends over the past 10 years, and the highest annual average for HTO in air was in 2023 which was 5.0 Bq/m^3 [9]. In 2023, HTO in air measured at Nanticoke was <0.1 Bq/m^3. The annual average HTO in air measured at the background location in recent years has been at or below the active sampler detection limit

Carbon-14 in air is monitored at four boundary locations for the DN site. Samples are analyzed after each quarter. There were no statistically significant trends over the past 10 years, and the highest annual average for Carbon-14 in air in 2022 was 240 Bq/kg-C (see details in Section 3.2.6.1 for information on the risks) [4]. Carbon-14 is naturally occurring in the environment but is also a by-product of past nuclear weapons testing from the early 1960s. Carbon-14 background concentrations around the world are decreasing as weapons test carbon-14 levels naturally decay over time. The annual average carbon-14 in air concentration observed at the Nanticoke EMP background location in 2022 was 205 Bq/kg-C [9].

External gamma radiation doses from noble gases and iridium-192 are measured using sodium iodide spectrometers set up around DN site. There are 8 detectors around the DN site that monitor the dose rate continuously. Natural background dose has been subtracted from noble gas detector results. The annual boundary average noble gas dose rate is estimated from the monthly data from each detector. The DN boundary average dose rates for Ar-41, Xe-133, Xe-135, and Ir-192 are typically below the detection limits [9].

Chemicals in air

The main sources of atmospheric emissions result from boiler chemical emissions and fuel combustion. Boiler treatment chemicals including hydrazine, morpholine and degradation products are used within the feedwater system to prevent corrosion in the boilers. These chemicals are released to the atmosphere through controlled boiler venting. Combustion emissions result from the Auxiliary Heating Steam Facility, Standby Generators, Emergency Power Generators, and minor sources. These systems release carbon monoxide, nitrogen oxides, sulphur dioxide, suspended particulate matter, trace volatile organic compounds (VOCs) and polycyclic aromatic hydrocarbons (PAHs).

As part of their 2020 ERA, OPG reviewed the results of the 2016-2019 Emission Summary and Dispersion Modelling Reports (ESDM). All modelled contaminants remained below the criteria for air quality from 2016 to 2019 [63]. The estimated maximum 1-hour (hr) nitrogen oxides (NO_x) concentration at the property line was 526 micrograms per cubic metre ($\mu g/m^3$), exceeding the 1-hr ambient air quality criteria (AAQC) of 400 $\mu g/m^3$. This exceedance occurred in 2016, when a standby generator operated for up to 75 hrs during testing. This is a rare event as normally the standby generators operate within the 60 hr per annum limit, and in all years other than 2016, the modelled maximum Point of Impingement (POI)* values for NO_x are all below the AAQC. Since there was an occurrence where NO_x exceeded criteria, NO_x was carried forward as an air COPC as part of their ERA.

*A POI is the point at which a contaminant contacts the ground or a building

Physical Stressors

Physical stressors, such as noise, are relevant to both human receptors and ecological receptors. The noise environment of the DN site is one of an urban setting and is influenced by several noise sources including the DNGS, traffic on Highway 401, traffic on local roads, Canadian National rail line and local industry (e.g., St. Mary’s Cement Plant). OPG conducted an acoustic assessment in support of the DNNP in 2018/2019 [81]. Results of the monitoring determined that the DNGS is not audible above other noise sources at the receptor locations (figure 3.2). Noise impacts both at the point of reference locations and baseline close to the DN site are mainly attributed to traffic from highway 401. Partial influence was also noted from local traffic volume and operation of the DNGS, St. Mary’s Cement and Durham York Energy Center. These findings are consistent with those determined by Specialist in Energy Nuclear Environmental Services (SENES) in a previous acoustic assessment conducted in 2008 [82]. It is therefore not expected that the noise generated by DN site activities is having a distinguishable effect on human receptors near the DN site.

Figure 3.2: Locations of residential receptors potentially exposed to noise from DN site

3.2.1.3 Findings

CNSC staff evaluated the environmental monitoring data and the 2020 ERA and concluded that OPG's reported measurements of nuclear and hazardous substance contaminants in the atmospheric environment from the DN site have remained within expected trends. OPG continues to provide adequate protection of people and the environment from atmospheric releases, including noise. OPG initiated an NOx monitoring study at the DN site in late 2021. The first year of data will be summarized and assessed by CNSC staff in the upcoming DN ERA Addendum report.

3.2.2 Terrestrial environment

An assessment of potential effects on terrestrial biota at the DN site and the surrounding area involves characterizing the local habitat and species (including considering federal and provincial species at risk) and assessing the possibility of their exposure to nuclear and hazardous substances, as well as physical stressors that may be disruptive to ecological receptors.

The DN site-wide assessment [63] was divided into polygons (AB,C,D, and E), generally consistent with the previous DNGS EcoRA [83], with modifications to Polygon E to assess the DNNP lands separately from the existing DNGS. The assessment polygons are shown in figure 3.3. Exposure of the terrestrial biota to COPCs in soil would likely occur through direct contact and/or uptake/ingestion of foods/prey contaminated with soil. Therefore, soil quality in each of the polygons was assessed from the perspective of environmental risk.

3.2.2.1 Radiological

The primary transport pathway for radiological COPCs to soil is through deposition from air. Airborne effluent releases of certain radionuclides such as elemental tritium (HT) and noble gases are not expected to partition to soil. For all of the polygons assessed at the DN site, the radiological dose from soil concentrations of C-14, Co-60, Cs-134, Cs-137, HTO and I-131 are predicted to be well below the UNSCEAR [82, 83] radiation benchmark of 2.4 mGy/day for terrestrial biota. The maximum radiological dose to vegetation (grass in Polygon E) from exposure to soil was estimated to be 0.0004 mGy/day, while the maximum dose to the earthworm and the eastern cottontail (occupancy factor for both =1) was estimated to be 0.0002 mGy/day, for both species. These values are well below the UNSCEAR radiation benchmark of 2.4 mGy per day for terrestrial biota [84, 85]. Therefore, there was negligible radiological risk to terrestrial organisms from exposure to soil.

For the DWMF, the maximum dose rate to any ecological VC residing in proximity (that is, within 5 m) of the facility was estimated to be 0.024 mGy/day, assuming full capacity of the facility. This is also well below the UNSCEAR [84, 85] radiation benchmark of 2.4 mGy/day for terrestrial biota. From 2016 to 2019, the average measured dose rate at the DWMF property boundary was 0.002 mGy/day, while the average measured dose rate at the retube waste storage building (RWSB) perimeter was 0.0014 mGy/ day.

Figure 3.3: Area of assessment for the ecological risk assessment [83]

3.2.2.2 Hazardous

The 2020 DN site-wide ERA also evaluated environmental monitoring data available since 2016 to determine if potential changes in non-radiological soil quality would modify or alter the risk to the terrestrial environment [63]. These data were collected as part of an updated baseline monitoring program to support the DNNP site preparation licence renewal in 2019. To determine whether any non-radiological COPCs may pose a risk to ecological receptors, the soil concentrations of COPCs were screened against ecological screening benchmarks published by MECP [86] based either on protection of plants and soil organisms or protection of birds and mammals. Also consulted, were CCME Soil Quality Guidelines for Environmental Health and the Interim Canadian Soil Quality Criteria [87].

For all polygons, except Polygon E, the target hazard quotient (HQ) of 1 was not exceeded for all terrestrial biota. In Polygon C, while strontium was the principal COPC, the HQ of 1 was not exceeded and thus, no risks were predicted for biota For polygon E there were exceedances (i.e. HQ > 1) for arsenic, cobalt, copper, lead, molybdenum, nickel, and zinc concentration benchmarks for earthworm as well as exceedances (HQ >1) for arsenic, cobalt, copper, lead, molybdenum, nickel, tin, and zinc concentration benchmarks for terrestrial plants. The HQ target of 1 was also exceeded for copper, lead, selenium, and zinc for terrestrial birds, and for arsenic, cadmium, copper, molybdenum, selenium and zinc for terrestrial mammals.

It was determined that Polygon E, where all of the exceedances of metals were recorded is a localized area with a prevalence of soils impacted by industrial activities such as but not limited to yard waste and building materials storage. Predicted risks of metals in soil in Polygon E are summarized in table 3.3. Overall, however, it can be concluded that there is a low potential for risk to terrestrial biota from contaminated soils in Polygon E. Given that it is a localized area, and most fauna move around, population level impacts on terrestrial biota are not expected. Regardless, as a part of risk management of this area, OPG has commissioned a soil characterization study in 2021. Results of this study will be included in an upcoming DN ERA Addendum report to be expected in late September 2024 and will be used to determine next steps for management of soil from this area.

Table 3.3: Predicted risks (HQ >1) of chemical COPCs/metals in soil to terrestrial organisms in Polygon E [63]

COPC	Earthworm	Terrestrial plants	Eastern cottontail	Meadow vole	Common shrew	Raccoon	White-tailed deer	Terrestrial birds (bank swallow, yellow warbler)
Arsenic	✓	✓	✓	✓	✓	✓	-	-
Cadmium	-	-	-	-	✓	-	-	-
Chromium	-	-	-	-	-	-	-	-
Cobalt	✓	✓	-	-	-	-	-	-
Copper	✓	✓	✓	✓	✓	-	✓	✓
Cyanide (free)	-	-	-	-	-	-	-	-
Iron	-	-	-	-	-	-	-	-
Lead	✓	✓	-	-		-	-	✓
Molybdenum	✓	✓	-	-	✓	-	-	-
Nickel	✓	✓	-	-		-	-	-
PHC-F4	-	-	-	-		-	-	-
Selenium	-	✓	-	-	✓	✓	-	✓
Sodium	-	-	-	-	-	-	-	-
Strontium	-	-	-	-	-	-	-	-
Tin	-	✓	-	-	-	-	-	-
Zinc	✓		-	-	✓	-	-	✓

3.2.2.3 Terrestrial habitat and species

OPG has implemented an extensive biodiversity program at the DN site, which encompasses the DNGS and the DWMF. The biodiversity program at the DN site was first implemented in 1997 and annual biodiversity monitoring program reports are produced for the site [88, 89, 90, 91, 92, 93, 94, 95, 96]. The purpose of the program is to aid in protecting ecologically significant areas, rebuilding damaged habitats, and recovering at-risk species in Ontario habitats. The DN site has achieved Wildlife Habitat Council conservation certification, which is a program that certifies ecosystem restoration efforts in support of overall biodiversity enhancement and conservation efforts [97].

The DN site is home to a number of terrestrial flora and fauna (see table 3.4), some of which have also been designated as species of special concern under the federal *Species at Risk Act* (SARA) [98] or under the Province of Ontario's *Endangered Species Act* [99]. A number of terrestrial species at risk have been identified within the DN site study area during the 2011 to 2019 time period, including Monarch, Bank Swallow, Barn Swallow, Bobolink, Eastern Meadowlark, Wood Thrush, Canada Warbler, Little Brown Myotis, Northern Myotis, and Butternut. These species at risk were not selected as VCs, but each of these species was considered by reference to a representative species already assessed in the EcoRA. A list of terrestrial species which were selected as VCs is shown in table 3.5.

For the assessment of risks to terrestrial VCs, assessment endpoints, which are attributes that should be protected, were considered for each of the VC [100]. Consistent with CSA N288.6 [51], the assessment endpoint for all receptors (other than species at risk) in the EcoRA was population abundance. The assessment endpoint for the species at risk was the individual, given that effects on even a few individuals of the species at risk would be unacceptable.

Table 3.4: Terrestrial species located/present at the Darlington Site Study Area

Invertebrates	Terrestrial Birds	
Dragonflies	American Robin	Eastern Kingbird
Earthworms	Bank Swallow***	Black-capped Chickadee
Monarch Butterflies** (Caterpillars)	Song Sparrow	Grey Catbird
Terrestrial Plants	Yellow Warbler	Cedar Waxwing
Canada Blue Joint	Marsh Wren	American Redstart
Sugar Maple	Swamp Swallow	Common Yellowthroat
Butternut Tree**	House Wren	Savannah Sparrow
Terrestrial Mammals	Barn Swallow***	Red-winged Blackbird
Eastern Cottontail	Tree Swallow	Common Grackle
Meadow Vole	Mourning Dove	American Goldfinch
White-tailed Deer	Downy Woodpecker	American Crow
Common Shrew	Eastern Wood-Pewee*	Red-eyed Vireo
Raccoon	Willow Flycatcher	Olive-sided Flycatcher*
Red Fox	Great Crested Flycatcher	Bobolink***
Short-tailed Weasel	Eastern Meadowlark***	Wood Thrush***
Deer Mouse	Canada Warbler***	
Little Brown Myotis (bat)**		
Northern Myotis (bat)**		

*Species of special concern under federal SARA [96]

**Endangered under federal SARA [96]

***Threatened under SARA [96]

The VCs were selected to represent each major plant and animal group, reflecting the main ecological exposure pathways, feeding habits and habitats at or around the site. In making the selection, species that were ecologically similar to other species and could be represented by another species, were not selected in order to reduce redundancy in the exposure calculations.

Table 3.5: Terrestrial species selected as valued ecosystem components at the Darlington Site Study Area

Species considered	Major plant or animal group	Importance	Ecological significance	Exposed to and/or sensitive to receptor
Earthworms	Soil-dwelling detritivore	Present on site	Food source for ecological receptors	Exposed to airborne emissions through soil
Canada Blue Joint	Grasses	Present on site	Food source for terrestrial animals	Exposed to airborne emissions through soil and atmospheric deposition
Sugar Maple	Deciduous tree	Present on site	Important element in woodland community	Exposed to airborne emissions through soil and atmospheric deposition
American Robin	Ground feeding insectivore	Present on site	On-site breeder, common to upland community	Exposed to airborne emissions through food (terrestrial invertebrates) and soil
Bank Swallow	Aerial insectivore	Present on site	Breeds along Lake Ontario shoreline. Threatened species on both the federal and provincial level	Exposed to airborne emissions through food (terrestrial invertebrates) and soil
Song Sparrow	Tree/shrub feeding insectivore	Present on site	On-site breeder, common to upland successional habitat	Exposed to airborne emissions through food (terrestrial invertebrates) and soil
Yellow Warbler	Tree/shrub feeding insectivore	Present on site	On-site breeder, common to upland successional habitat	Exposed to airborne emissions through food (terrestrial invertebrates) and soil
Eastern Cottontail	Mammalian herbivore	Present on site	Common to upland habitat	Exposed to airborne emissions through food (plants) and soil
Meadow Vole	Mammalian herbivore	Present on site	On-site breeder, year-round presence, common to upland habitat, common prey	Exposed to airborne emissions through food (plants) and soil
White-tailed Deer	Mammalian herbivore	Present on site	Common to upland habitat	Exposed to airborne emissions through food (plants) and soil
Common Shrew	Mammalian insectivore	Present on site	Common in similar habitats to the site	Exposed to airborne emissions through food (plants) and soil
Raccoon	Mammalian omnivore	Present on site	Common to upland habitat	Exposed to airborne emissions through food and soil
Red Fox	Mammalian carnivore	Present on site	Common to upland habitat	Exposed to airborne emissions through food (small mammals) and soil
Short Tailed Weasel	Mammalian carnivore	Present on site	Common to upland habitat	Exposed to airborne emissions through food (small mammals) and soil

Terrestrial species at risk

In Ontario, the following legislation applies to species at risk: the provincial *Endangered Species Act 2007* [99] which stipulates/compiles a *Species at Risk in Ontario List* (SARO List) under O. Reg. 230/08 [101]; and the federal *Species at Risk Act* [98]. To comply with these laws, and as part of their 2020 ERA [61], OPG conducted a number of wildlife surveys from 2011 to 2019 to identify the species at risk potentially present on or around the DN site study area. Table 3.6 lists the terrestrial species at risk that were identified as potentially present around the DNGS and the DWMF, and that were assessed in the 2020 ERA. To be conservative, if a species was listed as threatened or endangered by either COSEWIC, SARA, or SARO, it was included for assessment. It should be noted that, as general prohibitions under SARA do not apply to species of special concern, and the CSA N288.6 did not specify species of Special Concern as ecologically significant, these species were not listed in table 3.6.

Exposure models for specific assessment of these species are typically lacking. Therefore, most of these species were assessed by reference to surrogate species already selected as VCs for the EcoRA (see table 3.5). Detailed justifications for selections of each of the surrogate species based on habitat, diet, and ecological niche considerations are presented in table 3.6.

Table 3.6: Surrogate species for Identified Species at Risk with Threatened or Endangered Status

Species at Risk (Common and Scientific name)	SARA (federally listed)	COSEWIC (federally listed)	SARO (provincially listed)	Surrogate Species	Last Observed
Terrestrial Invertebrates					
Monarch butterfly *Danaus plexippus*	-	Endangered	-	Earthworm (*Lumbricus terrestris*)	2019
Plants					
Butternut Tree (*Juglans cinerea*)	Endangered	Endangered	Endangered	Sugar Maple (*Acer saccharum*)	2019
Birds					
Bank Swallow (*Riparia riparia*)	Threatened	Threatened	Threatened	Bank Swallow (*Riparia riparia*)	2019
Barn Swallow (*Hirundo rustica*)	Threatened	Threatened	Threatened	Bank Swallow (*Riparia riparia*)	2019
Bobolink (*Dolichinyx oryzivorus*)	Threatened	Threatened	Threatened	American Robin (*Turdus migratorius*)	2019
Canada Warbler (*Cardellina canadensis*)	Threatened	Threatened	-	Bank Swallow (*Riparia riparia*)	2011
Eastern Meadowlark (*Strunella magna*)	Threatened	Threatened	Threatened	American Robin (*Turdus migratorius*)	2019
Wood Thrush (*Hylocichla mustelina*)	Threatened	Threatened	-	American Robin (*Turdus migratorius*)	2015
Mammals					
Little Brown Myotis (*Myotis lucifugus*)	Endangered	Endangered	Endangered	Common Shrew (*Sorex cinereus*)	2018
Northern Myotis (*Myotis septentrionalis*)	Endangered	Endangered	Endangered	Common Shrew (*Sorex cinereus*)	2018

Notes:

1. Bird species that were potentially breeding on-site were included. Least Bittern and Olive-Sider Flycatcher were not identified as species that were breeding on-site per surveys completed by Beacon Environmental [96]; therefore, not included in this table.
2. Only bat species that are roosting on-site were included.
3. The federal and provincial status of species on site may change. The status of these species was last verified in August 2020 from COSEWIC, federal SARA Schedule 1 Status, and provincial SARO (MECP).
4. Species with Special Concern Status were not included in this table, as the general prohibitions under SARA did not apply to Species of Special Concern, and the CSA N288.6 did not specify this status as ecologically significant.

None of these species at risk are known to reside in or frequently visit the area within or immediately surrounding the DNGS or DWMF site; specifically, Polygon E, where COPCs in the soil could pose a risk to individuals. It can be concluded that, there is low potential for risk to these species (except for plant species) given that they are generally rare and move around, , thereby reducing exposure to COPCs on-site. The risk to plants in this area is localized and does not impact wider plant community at the DN site

Two butternut trees, a plant species at risk, were observed at the DN site during field investigations in 2019 of which one was diseased with fungal canker and determined to be non-retainable. The other individual, however, was assessed to be retainable [102]. There were no additional specimens found in the vicinity of the existing butternut tree. This species at risk (assessed through a surrogate species) was determined to be not at risk from operations at the DNGS or the DWMF.

ERA predictions

OPG selected a total of 14 terrestrial receptors for the assessment based on knowledge of the DNGS and DWMF sites and its surrounding environment and relevant field observations (see table 3.5). The 10 species at risk identified as potentially occurring in the area (see table 3.6) were also included as terrestrial receptors, and assessed using surrogate species, with the exception of bank swallows. The selected terrestrial receptors listed in table 3.5 reflect a variety of diets or feeding habits, cover a variety of trophic levels, and are representative of the potential species present in the area.

Exposure to Radiological Nuclear Substances

The potential radiological effects to ecological receptors were assessed by comparing the estimated radiation dose received by each ecological receptor from radiological COPCs through all applicable pathways (namely external and internal exposure due to radionuclides in air, soil, water, sediment, and gamma radiation) to the recommended benchmark values (that is, dose limits to non-human biota).

The overall radiation dose to all terrestrial VECs in all Polygons, which included all internal and external doses from all exposure pathways, was significantly below the radiological dose benchmarks recommended in CSA 288.6-12 [50], that is, 100 μGy/h (2.4 mGy/d) for terrestrial receptors. This result indicates no potential for adverse effects and no need for further detailed assessment.

Exposure to Hazardous substances

The potential hazardous effects on ecological receptors were assessed by comparing the estimated exposure concentration received by each ecological receptor from hazardous COPCs through all applicable pathways (namely exposure to hazardous contaminants in air, soil, lichen, vegetation, water, sediment, benthic invertebrates, phytoplankton, zooplankton and aquatic vegetation) with the recommended benchmark values (that is, toxicity reference values for non-human biota).

In all of the terrestrial Polygons, except Polygon E, the HQs were well below 1, indicating negligible risk from hazardous COPCs to terrestrial organisms, including species at risk. In Polygon E, however, there were a number of exceedences of the HQ of 1, as shown in table 3.7. Specifically, the HQ for zinc and copper was exceeded for most of the terrestrial VCs, whereas chromium, iron, sodium, strontium, PHC F4 and cyanide did not pose a risk to all of the VECs assessed. Also, given that the potential risk to some of the terrestrial biota is localized to Polygon E, and most fauna move around, population level impacts on terrestrial biota at the DNGS and the DWMF are not expected. The risk to terrestrial plants in this area is localized and do not impact the wider plant community.

Exposure to physical stressors

While physical stressors are not subject to a formal screening process, it is recommended in the CSA N288.6 that thermal stressors, and entrainment and impingement should be assessed for aquatic biota (see section 3.2.3, Aquatic Environment), due to their widely recognized concern at nuclear power plants. However, other physical stressors in the terrestrial environment such as noise, wildlife strikes with vehicles, and bird/bat strikes on buildings were not evaluated further based on the negligible impacts expected from these stressors on wildlife at the DN site. This was supported by survey and monitoring studies done at the DN site.

Terrestrial environment monitoring

While the ERA did not recommend specific terrestrial environmental monitoring, as a risk management best practice, it was recommended that a soil characterization study of the yard waste and building materials storage area in Polygon E should be undertaken by OPG. OPG commissioned a soil characterization study in 2021. Results of this study will be included in an upcoming DN ERA Addendum report to be expected in late September 2024. The results of the soil characterization study will inform the next steps for management of soil from this area.

3.2.2.4 Findings

The most recent assessment of potential effects on terrestrial biota near the DN site was provided in the 2020 ERA [63]. As discussed in section 2.3.3, the ERA fully complied with the requirements of CSA N288.6-12 [50] and incorporated recent environmental monitoring data.

Based on the review of OPG’s 2020 ERA and the results of the EMP for the DN site, CNSC staff have found that the terrestrial environment remains protected from nuclear and hazardous releases, as well as physical stressors from the DN site. Although there are some localized areas of soil contamination, the risk to terrestrial receptors is considered low, and OPG has committed to further evaluation in order to inform next steps for management of soil in this area.

Table 3.7: Potential risks (HQ >1) of chemical COPCs/metals terrestrial biota in Polygon E (adapted from OPG, 2021)

	Earthworm	American Robin	Bank Swallow	Song Swallow	Yellow Warbler	Terrestrial Plants	Eastern Cottontail	Meadow Vole	White-tailed Deer	Common Shrew	Racoon	Red Fox	Short-tailed Weasel
Arsenic	✓	-	-	-	-	✓	✓	✓	-	✓	✓	-	-
Cadmium	-	-	-	-	-	-	-	-	-	✓	-	-	-
Chromium	-	-	-	-	-	-	-	-	-	-	-	-	-
Cobalt	✓	-	-	-	-	✓	-	-	-	-	-	-	-
Copper	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	-	-
Iron	✓	-	-	-	-	-	-	-	-	-	-	-	-
Lead	✓	✓	✓	✓	✓	✓	-	-	-			-	-
Molybdenum	✓	-	-	-	-	✓	-	-	-	✓		-	-
Nickel	✓	-	-	-	-	✓	-	-	-	✓	✓	-	-
Selenium	-	✓	✓	✓	✓	-	-	-	-	-	-	-	-
Sodium	-	-	-	-	-	-	-	-	-	-	-	-	-
Strontium	-	-	-	-	-	-	-	-	-	-	-	-	-
Tin	-	-	-	-	-	-	-	-	-	-	-	-	-
Zinc	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
PHC F4	-	-	-	-	-	-	-	-	-	-	-	-	-
Cyanide	-	-	-	-	-	-	-	-	-	-	-	-	-

3.2.3 Aquatic environment

An assessment of potential effects on aquatic biota at the DN site and the surrounding area involves characterizing the local habitat and species (including considering federal and provincial species at risk) and assessing the possibility of their exposure to nuclear and hazardous substances, as well as physical stressors that may be disruptive to ecological receptors.

3.2.3.1 Surface water quality

The DN site is located on the north shore of Lake Ontario. There is very little net flow along the northern shore of Lake Ontario, however the current in the nearshore region is overall easterly and is influenced by brief patterns of strong winds. Water withdrawal from the DNGS intake results in some localized effects, such as fish impingement as well as egg and larvae entrainment at the water intake. The discharge of cooling water also results in a thermal plume that can potentially affect localized fish populations. These effects are discussed more under the physical stressors section (section 3.2.2.3) of this report.

All waterborne effluent from DN is discharged into the CCW system either via the intake forebay or directly into the CCW discharge duct. The only exception is effluent from the domestic sewage system which is routed to the Courtice Water Pollution Control Plant, and stormwater which is discharged to Lake Ontario through storm sewers or drainage swales/creeks. The surface water screening performed by OPG in the 2020 ERA was based primarily on measurements of chemical COPCs in Lake Ontario water, as well as Coot's Pond and Treefrog Pond water. In addition, measured concentrations of chemical parameters in the CCW discharges from 2016 to 2019, and measured concentrations of chemical parameters in stormwater discharges to Lake Ontario in 2019 were screened to ensure that the list of chemical COPCs was complete.

Hazardous

Lake Ontario

Lake water samples were collected in 2019 to support DNNP site preparation licence renewal [103]. The maximum measured concentration for total aluminum in Lake Ontario (142 µg/L) exceeded the *Canadian Drinking Water Quality Guideline* (100 µg/L) [104], however the maximum dissolved aluminum concentration (21 µg/L) was below the *Provincial Water Quality Objective* (PWQO) [105] screening criteria (75 µg/L in dissolved phase). The dissolved phase of aluminum is expected to be more bioavailable and toxic than aluminum in the suspended phase, therefore as the dissolved aluminum did not exceed its screening criteria aluminum was not carried forward as a chemical COPC for ecological health.

The maximum concentrations of a few biological parameters, including total coliforms, fecal coliforms, and Escherichia coli exceeded their selected screening criteria (which were the lake water background concentrations). Available screening criteria include PWQO values, which were developed for the protection of recreational water uses, rather than ecological health. There are no established regulatory or toxicity benchmarks for coliforms for the protection of ecological health, as coliforms are not relevant to ecological health. Therefore, although these biological parameters have higher concentrations than the lake water background values, these biological parameters were not assessed further as COPCs for quantitative assessment.

The maximum concentrations of major ions (calcium, magnesium, potassium) exceeded the selected screening criteria (the Lake Ontario background concentrations). There is no evidence of adverse health effects from these major ions in drinking water [106], and were essentially non-toxic for environmental biota, therefore calcium, magnesium, and potassium were not carried forward as COPCs for further assessment in the EcoRA.

In addition, the maximum field pH value observed in Lake Ontario (9.21) was beyond the range of selected screening criteria. Similarly, the maximum concentrations of total suspended solids, total ammonia, un-ionized ammonia, barium, and zinc exceeded the selected screening criteria, and therefore were carried forward as COPCs for further assessment in the EcoRA.

The maximum measured concentration of phosphorus exceeded its ecological screening criteria. Phosphorus presents in the aquatic environment as phosphate, where it acts as a nutrient rather than a toxicant. The interim PWQO guideline was set to avoid nuisance concentrations of algae in lakes and is not relevant to ecological health, therefore phosphorus was not considered a COPC for ecological health.

Liquid effluent

Information from 2016 to 2019 on the concentrations of COPCs in liquid effluents was assessed by OPG to aid in COPC selection. The final discharge released from the CCW duct was assessed for this screening. In addition, effluent released from the CCW duct is diluted in Lake Ontario through the diffuser, therefore, the initial mixing zone in Lake Ontario represents a maximum potential exposure for ecological receptors. Effluent quality results were converted to estimated concentrations in the mixing zone using a dilution factor of 7 at the diffuser, which is representative of the dilution provided by the diffuser. Estimated mixing zone concentrations from 2016 to 2019 were screened against the same screening criteria as the lake water samples.

As part of the ECA requirements, the effluent from the CCW is sampled and analyzed for compliance with effluent limits for unionized ammonia, hydrazine, morpholine, pH, and total residual chlorine (TRC). ECCC has developed a *Federal Environmental Quality Guideline* (FEQG) for hydrazine of 2.6 µg/L for fresh water [107]. The maximum observed hydrazine concentration (6 µg/L) at the CCW duct was above the screening level of 2.6 µg/L. Similarly, the maximum measured morpholine and TRC concentrations in the CCW were greater than their respective screening criteria. However, the estimated maximum mixing zone concentrations for hydrazine, morpholine, and TRC were all below their selected screening criteria, therefore these parameters were not carried forward for further assessment in the EcoRA. Since the pH in effluent was within the range of the CCME guideline (pH range 6.5 to 9), pH was not carried forward as a COPC from the effluent screening.

Effluent monitoring is also required under the Ontario Provincial Environmental Compliance Approval, and the parameters measured in the radioactive liquid waste (RLW) and water treatment plant (WTP) effluents include phosphorus, total suspended solids (TSS), zinc, iron, oil and grease, and aluminum. Mixing zone calculations were conducted to obtain expected concentrations of COPCs in the CCW based on effluent discharge to the CCW from the RLW and the WTP and were based on a worst-case scenario, assuming effluent was discharged at the limits within the ECA. The calculated CCW concentrations, as well as the estimated mixing zone concentrations were compared against the ecological health screening criteria and were found to be well below these limits.

Based on the above there were no COPCs carried forward for further assessment in the EcoRA from the ECA effluent screening.

Stormwater

The Stormwater Management System, or Yard Drainage System, collects storm runoff from the entire DN site and discharges to Lake Ontario, either directly through the storm sewer drainage system, or through drainage swales/creeks via culverts which eventually discharge to Lake Ontario.

Stormwater chemical analyses from 2019 were compiled and maximum concentrations from this dataset were converted to equivalent loadings to Lake Ontario using the maximum measured peak flow rates at the time of sampling (except for temperature, conductivity and pH, for which the maximum values measured in stormwater were directly used for screening). These equivalent loadings were then converted to estimated Lake Ontario concentrations in a nearshore mixing zone. The estimated Lake Ontario concentrations were then screened against the same ecological screening benchmarks used in the lake water screening.

While the minimum pH value was within the MECP regulated range (6.5 to 8.5), the greatest pH value observed in the stormwater was 8.97, beyond the MECP pH range, however within the CCME water quality objective for pH for freshwater biota (6.5 to 9). Since the maximum measured pH was less than the CCME upper bound, and the stormwater would be diluted in Lake Ontario, pH was not considered further for assessment in the EcoRA.

The maximum estimated concentration of both total and dissolved barium in the lake water exceeded the selected screening criteria, therefore barium was carried forward for further assessment as a chemical COPC for lake water in the EcoRA. The maximum estimated barium concentration in lake water due to stormwater was 4.3 μg/L, which was lower than the maximum observed concentration of barium in Lake Ontario during the 2019 sampling events, which was 32.3 μg/L. Since measured barium concentrations in lake water are higher than those estimated from stormwater in Lake Ontario, the exposure assessment focused on measured barium concentrations in lake water as a conservative approach.

None of the polychlorinated biphenyls (PCBs) compounds were detected in the stormwater samples, therefore PCBs were not considered chemical COPCs for further assessment in the EcoRA. There are no regulatory or toxicity benchmarks for PCBs in surface water and PCBs do not partition to water due to their low solubility.

The concentration of oil and grease were also analyzed in the 2019 stormwater sampling event. The oil and grease test has been largely replaced by testing for petroleum hydrocarbons (PHCs). As the maximum estimated concentrations of the PHC compounds and fractions in lake water were well below their screening criteria, this parameter was not carried forward as a COPC for further assessment in the EcoRA.

Pond Water

Surface water samples were collected from Coot's Pond (in Polygon AB) and Treefrog Pond (in Polygon D) and the data were assessed in the 2009 EcoRA [83]. These ponds are not exposed to liquid effluent from DN, but Coot's Pond is exposed to stormwater runoff from the construction landfill. The ponds are also expected to be exposed to chemical contaminants in air, which could be deposited in surface water after release to the atmosphere from DN. A screening of the available data from the 2009 EcoRA [83] was conducted in the 2016 ERA [108]. In 2019, Ecometrix performed environmental studies to support the DNNP site preparation licence renewal. Quarterly surface water samples were collected from both Coot's Pond and Treefrog Pond [103]. Parameters analyzed in this study included most chemicals that partition to water of those modelled by OPG in air. A screening of available data from the 2019 environmental study was conducted to determine if any COPCs could be present in surface water in either of these ponds. This screening used the same criteria as the other surface water screenings for ecological health

The maximum concentration of a few major ions, including calcium, magnesium, and potassium exceeded the screening criteria in both Coot's Pond and Treefrog Pond. These major ions are not considered as toxicants for environmental receptors, therefore they were not carried forward as COPCs for pond water.

For Coot's Pond, pH, total and unionized ammonia, barium and iron exceeded the screening criteria and were identified as COPCs. For Treefrog Pond, total ammonia, barium and iron exceeded their selected screening criteria, and were identified as chemical COPCs.

The maximum concentrations of a few biological parameters, including total coliforms, fecal coliforms, and *Escherichia coli* exceeded their selected screening criteria in both Coot's Pond and Treefrog Pond. Available screening criteria include PWQO values, which were developed for the protection of recreational water uses, rather than ecological health [109]. There are no established regulatory or toxicity benchmarks for coliforms for the protection of ecological health, and these parameters are not relevant to ecological health, therefore these biological parameters were not carried forward as COPCs for this EcoRA.

The maximum concentration for total aluminum in Coot's Pond water was 369 µg/L, which exceeded its CWQG screening criterion. However, the maximum analyzed concentration for dissolved aluminum (in a filtered sample) was 25 µg/L, which was below the selected criterion (PWQO value) of 75 µg/L. As the dissolved aluminum was analyzed and did not exceed its screening criteria, aluminum was not carried forward as a chemical COPC for ecological health.

The maximum measured concentration of phosphorus in both ponds exceeded their ecological screening benchmark. Phosphorus exists in the environment as phosphate, where it acts as a nutrient rather than a toxicant, therefore phosphorus was not considered a COPC for ecological health.

Radiological

The liquid effluent radionuclide groups that are used for DRL calculation and public dose calculation at the DN site are HTO, mixed beta-gamma emitting radionuclides (gross beta-gamma), carbon-14 as dissolved carbonate/bicarbonate (C-14), and mixed alpha emitting radionuclides (gross alpha). Liquid effluent is monitored for radionuclides. Over the period from 2016 to 2019, dose contribution from gross alpha activities in water were at least two orders of magnitude less than all other radionuclide groups. As such, the contribution of gross alpha to total radioactive emissions is considered to be minimal. Gross alpha was therefore not considered to be a COPC for the EcoRA.

The following radiological stressors measured in the aquatic environment were used in the assessment of ecological health, for Lake Ontario and for the on-Site ponds:

- C-14, which is released to both air and surface water by reactor operations at the DN site;
- Co-60, which represents gross beta-gamma released to the atmosphere by the DN site;
- Cs-134, which represent gross beta-gamma emissions released to surface water in liquid effluent from the DN site;
- HT, which is released to the atmosphere by the TRF and in very small amounts from the powerhouse at the DN site;
- HTO, which is released to both air and water by the reactor operations at the DN site; and
- I-131, which was included for consistency with other EcoRAs conducted for the DN site and is not expected to be a primary contributor to radiological dose for ecological VCs.

3.2.3.2 Sediment quality

Sediment in Lake Ontario was characterized as part of the baseline data collection for the ecological risk assessment in the DNNP EA [82]. From 2016 to 2019, two additional sampling studies were carried out. In 2018, a sediment characterization study consisted of two sampling events at the Darlington Harbour area and near-shore locations immediately west of the Darlington Harbour. In 2019, sediment samples were collected at the Lake Ontario near-shore and off-shore to support DNNP site preparation licence renewal. The updated 2018 to 2019 sediment data were screened against relevant screening criteria to select chemical COPCs for the EcoRA.

Hazardous

Lake Ontario Sediment

Lake Ontario in the vicinity of the DN site is not a depositional environment, therefore any chemical parameters in sediments in Lake Ontario due to DN’s influence are likely to be due to liquid effluents, and screening of Lake Ontario water and liquid effluents for COPCs are expected to be protective of aquatic life. However, the sediment monitoring data were also screened by OPG as an additional line of evidence for the selection of COPCs.

Some nutrients, metals, and PHCs exceeded their selected criteria (total Kjeldahl nitrogen (TKN), phosphorus, cesium, strontium, and PHC F3 fraction). Several PAHs also exceeded their *Canadian Sediment Quality Guidelines* (CSQG) (benzo(a)pyrene, chrysene, dibenzo(a,h) anthracene, phenanthrene, and pyrene). Among parameters that exceeded the screening criteria, the elevated TKN and phosphorus are likely due to agricultural inputs into Lake Ontario, and not due to DNGS operations. The above-mentioned nutrient, metal, PHC, and PAH parameters with exceedances were assessed as chemical COPCs for further assessment in the EcoRA.

The maximum concentration of calcium in lake sediment also exceeded the selected screening criterion, which was derived from the background calcium concentration in Lake Ontario sediment. Calcium is a natural component of sediment and not a toxicant to ecological life, therefore it was not assessed as a chemical COPC for further assessment in the EcoRA.

The detection limits of a few PCBs and pesticides (including heptachlor, aroclor 1016, aroclor 1248, aroclor 1260), and total PCBs are higher than their selected screening criteria, therefore making it difficult to deduce if there are any true exceedances. All PCB concentrations in the 2018 to 2019 sampling events were below detection indicating low PCB levels. There is no known source of PCBs at the DN site since PCBs were banned in the late 1970s, well before DNGS was constructed, therefore these parameters were not assessed further as chemical COPCs in sediment as they were below detection limits and most likely not present or a risk to receptors.

Pond Sediment

The on-site ponds, including Coot's Pond and Treefrog Pond, are depositional environments. Other than stormwater runoff, these ponds do not receive liquid effluents from DN, so the only potential transport pathway for COPCs from DN to these ponds is through airborne deposition of air emissions from operations at the DN site. Among the contaminants that OPG modelled in air, NO_x were defined as chemical COPCs in air. NO_x is unlikely to deposit on surface water and partition to sediments. None of the other modelled contaminants in air were at concentrations of concern, so potential deposition of these chemicals to the ponds was not expected to lead to environmental risks.

During the 2019 environmental studies to support DNNP site preparation licence renewal [103], sediment samples were collected at Coot's Pond and Treefrog Pond and the monitoring results were screened against selected screening criteria protective of ecological health. As Lake Ontario background concentrations were not appropriate to represent the background in the ponds, parameters without regulatory and toxicological benchmarks were screened against the upper range of crustal abundance in the United States [110].

For Coot's Pond, TKN, total organic carbon (TOC), phosphorus, cadmium, chromium, copper, iron, manganese, nickel, vanadium, and zinc were carried forward as chemical COPCs in sediment. For Treefrog Pond, TKN, TOC, phosphorus, cadmium, copper, selenium, and vanadium were carried forward as chemical COPCs for ecological health in sediment.

Both Coot's Pond and Treefrog Pond are nutrient enriched, as there were elevated concentrations of ammonia and phosphorus in pond water. Therefore, exceedances of TKN, TOC and phosphorus are likely due to agricultural runoff rather than operations at the DN site.

Radiological

Since the primary pathway for radionuclides to be transported to Lake Ontario sediment is through partitioning from liquid effluents, the same radionuclides were selected for sediment as were selected for surface water. This is conservative, since Lake Ontario in the vicinity of DN is not a depositional environment, and COPCs are unlikely to accumulate in lake sediment.

Coot's Pond and Treefrog Pond are depositional environments, and these ponds do not receive liquid discharge from DNGS, therefore the main input of radiological contaminants is from airborne deposition from DN emissions and subsequent partitioning to sediment. While gross-beta gamma released to surface water is represented by Cs-134, sediment data are available for Cs-137 and Co-60 as well, therefore they have been included as COPCs and are evaluated in the exposure assessment.

The final list of radionuclides for both Lake Ontario and pond sediment was C-14, Cs-134, Cs-137+, Co-60, HTO, and I-131.

3.2.3.3 Aquatic habitat and species

Aquatic habitat

Aquatic habitat at the DN site includes tributary watercourses and ponds on the DN site, and the adjacent areas of Lake Ontario. Aquatic habitats support a variety of aquatic plant and animal communities and may include periphyton, phytoplankton, benthic invertebrates, zooplankton and fishes. Aquatic macrophytes are included as part of the vegetation communities section. The key aquatic features on the DN site include the main branch of Darlington Creek and the intermittent upper portions of tributaries to Darlington Creek, the artificially constructed Dragonfly, Treefrog and Polliwog Ponds, the intermittent upper portion of a tributary to Lake Ontario at the eastern toe of the Northwest Landfill Area slope, and Coot's Pond (a stormwater runoff and settling pond that lies south of the construction waste landfill).

The artificially constructed ponds (Dragonfly, Treefrog and Polliwog Ponds) and the intermittent tributaries to Darlington Creek and Lake Ontario do not support fish and are not considered direct fish habitat.

Aquatic species

More than 90 fish species are known to inhabit Lake Ontario, almost all of which use the nearshore waters for spawning, rearing, feeding and migration. Although the community is diverse, fish density tends to be low. Fish community studies conducted near the DN site indicated that the fish species commonly present included alewife (Alosa pseudoharengus), round goby (*Neogobius melanostomus*), round whitefish (*Prosopium cylindraceum*), lake trout (*Salvelinus namaycush*), Spottail Shiner (*Notropis hudsonius*), White Sucker (*Catostomus commersonii*), brown trout (*Salmo trutta*), walleye (*Sander vitreus*), rainbow smelt (*Osmerus mordax*), and salmonid species. The nearshore environment of Lake Ontario is characterized by hard substrates and is a high energy environment. Therefore, it supports a limited density and diversity of benthic invertebrates, which are mainly found in shallow areas. Invasive zebra mussels (*Dreissena polymorpha*), and quagga mussels (*Dreissena bugensis*), have colonized the nearshore area of Lake Ontario and influence local benthic habitat and productivity. In 2016 and 2018, all the mussels identified were quagga mussels, which has essentially replaced zebra mussel in the nearshore environment of Lake Ontario.

Darlington Creek near the DN site supports a warmwater fish community. Historical data compiled for the creek confirmed the presence of ten species between 1998 to 2009 (common carp [*Cyprinus carpio*], white sucker, brook stickleback [*Culaea inconstans*], pumpkinseed [*Lepomis gibbosus*], bluntnose minnow [*Pimephales notatus*], fathead minnow [*Pimephales promelas*], blacknose dace [*Rhinichthys obtusus*], longnose dace [*Rhinichthys cataractae*], creek chub [*Semotilus atromaculatus*], and rainbow trout [*Oncorhynchus mykiss*]). The intermittent tributaries to Darlington Creek on the DN site lack permanent aquatic habitat and do not support fish and are often dry. Their primary habitat function is the conveyance of water and nutrients to downstream habitats.

Coot's Pond is a stormwater runoff and settling pond. Coot's Pond was intended to be fish-free to encourage amphibian production, however Northern Redbelly Dace has become established in the pond. Northern Redbelly Dace are common inhabitants of wetlands and beaver ponds. The pond was inhabited by emergent and submergent aquatic vegetation, and habitat quality is sufficient to support a wide array of benthic invertebrates. Coots Pond has emergent and submerged aquatic vegetation and possesses wetland and open-water pond habitats. Giant Bur-reed dominates an area on the west side of Coot's Pond.

Treefrog, Polliwog and Dragonfly ponds are small wetland ponds that are not well connected to on-site watercourses and do not support fish. Dragonfly and Polliwog Ponds have been observed to dry up completely during summer, while Treefrog Pond remains wet.

The main exposure pathway for the aquatic community is through direct contact with water and sediment at the DN site outfall. As indicated in section 3.2.2 Terrestrial environment, some terrestrial species (such as riparian birds and mammals, amphibians and reptiles) were assessed as aquatic species for the purpose of the radiological and non-radiological exposure assessments.

Aquatic species at risk

In Ontario, the following legislation applies to species at risk: the provincial *Endangered Species Act* [99] and the federal SARA [98]. Four fish species at risk, with a provincial or federal ranking of special concern, threatened, endangered or extinct were recorded at the DN site (American eel, Atlantic salmon, lake sturgeon, and deepwater sculpin). However, lake sturgeon has not been observed since 1998 and is considered no longer present in the area. Atlantic salmon were observed within the area as recently as 2019; however, Atlantic salmon found in Lake Ontario are likely individuals from the Lake Ontario Atlantic Salmon Restoration Program and are not considered individuals of the native Lake Ontario Population. American eel was observed in impingement monitoring programs and is therefore considered in the ERA. An entrainment study at DNGS in 2015-2016 found nine deepwater sculpin larvae and estimated 724, 746 larvae are entrained annually. One deepwater sculpin larva was collected from larval tows in 2018. Data from bottom trawl surveys conducted from 1996 through to 2016 suggest that deepwater sculpin populations in Lake Ontario have recovered and current densities and biomass may be similar to those of other Great Lakes.

Table 3.8: Status of aquatic species at risk present around the DN site

Species	SARA status [98]	SARO status [99]
Fish		
American Eel	Threatened	Endangered
Lake Sturgeon	Threatened	Endangered
Atlantic Salmon	Extinct (2010)	Not listed
Deepwater Sculpin	Special Concern	Not at Risk

ERA predictions

The most recent assessment of potential effects on aquatic biota near the DN site was provided in the 2020 ERA [62]. As discussed in subsection 2.3.3, the ERA fully complied with the requirements of CSA N288.6-12, *Environmental risk assessments at Class I nuclear facilities and uranium mines and mills* [50] and incorporated recent environmental monitoring data.

OPG selected a total of 14 aquatic receptors for the assessment based on knowledge of the DN site and its surrounding environment, and relevant field observations. The chosen aquatic receptors include the categories of benthic invertebrates, aquatic plants, amphibians and reptiles, benthic fish, pelagic fish, riparian birds and riparian mammals. The chosen ecological receptors reflect a variety of diets or feeding habits, cover a variety of trophic levels, and are representative of the potential species present in the area and include species identified as important to Indigenous Nations and communities.

Exposure to nuclear substances

The potential radiological effects on ecological receptors were assessed by comparing the estimated radiation dose received by each ecological receptor from radiological COPCs through all applicable pathways (namely external and internal exposure due to radionuclides in air, soil, water, sediment, and gamma radiation) to the recommended benchmark values (that is, dose limits to non-human biota).

The overall radiation dose, which included all internal and external doses from all exposure pathways, were significantly below the radiological dose benchmarks recommended in CSA 288.6-12 [50] (that is, 400 µGy/h or 9.6 mGy/d for aquatic receptors). This result indicates negligible potential for adverse effects and no need for further detailed assessment.

Exposure to hazardous substances

The potential hazardous effects on ecological receptors were assessed by comparing the estimated exposure concentration received by each ecological receptor from hazardous COPCs through all applicable pathways (namely exposure to hazardous contaminants in air, soil, lichen, vegetation, water, sediment, benthic invertebrates, phytoplankton, zooplankton and aquatic vegetation) to the recommended benchmark values (that is, toxicity reference values for non-human biota). Benchmarks were then compared against exposure levels for aquatic and riparian receptors to calculate a HQ, which is the ratio of the concentration of the COPC (in surface water or sediment) to the most conservative toxicological benchmarks. A HQ that is ≤ 1, meaning the concentration of COPCs in surface water or sediment is less than or equal to the benchmark, indicates there is no potential risk to aquatic or riparian receptors from exposure. The interpretation of HQ results also takes into consideration the distribution of areas with a HQ>1, the mobility and home range of the affected receptor, and whether the exposure point concentrations can be attributed to DN operations.

Lake Ontario

There was no exceedance of the HQ target of 1 for riparian birds in Lake Ontario, and there are no mammals considered as ecological receptors in this polygon.

Maximum surface water concentrations for the site study area in Lake Ontario exceeded the benchmarks for ammonia for fish, however the upper confidence limit of the mean (UCLM) water concentration did not exceed the fish benchmark. Fish are more mobile, therefore using the UCLM for HQ water concentrations for ammonia are more representative of fish exposure than maximum concentrations. In addition, the elevated ammonia concentration in Lake Ontario is not likely resulting from the DN operations, therefore fish are not at toxicological risk from DN operations.

Maximum sediment concentrations for Lake Ontario exceeded the sediment benchmark for TKN for benthic invertebrates. Both the maximum and the UCLM sediment concentration of phosphorus exceeded the sediment benchmark. Since benthic invertebrates cannot move around a few benthic invertebrates may experience prolonged exposure at the maximum, therefore assessing the risk using the maximum sediment concentrations is appropriate. No significant risk is expected from TKN, phosphorus, and PHC F3 in the sediment for benthic invertebrates, however there is uncertainty surrounding the risk associated with TKN and phosphorus. There is evident input of agricultural runoff in Lake Ontario in the area, and these two parameters are not likely elevated due to operation at DN. In addition, there is no available benchmark for PHC F3 in sediment for benthic invertebrates. Sediment in Lake Ontario is transient, and the invertebrate community is mainly epifaunal. This suggests that the sediment exposure pathway is unlikely to be the primary exposure route for benthic invertebrates in Lake Ontario.

Cesium and strontium were identified as sediment COPCs as they exceeded the upper limit background concentrations in Lake Ontario sediment. There is no available benchmark for cesium and strontium for aquatic and riparian ecological receptors. However, the maximum concentrations of these two elements fall within the range of background concentrations for data collected from the continental USA [110] between 0.25-25 mg/kg and 5-3000 mg/kg for cesium and strontium, respectively, therefore cesium and strontium are not likely to cause toxic effects on ecological receptors in Lake Ontario.

Toxic effects of PHCs are not expected for birds. While, toxicity reference values are not available for PHC F3 and PAH compounds (including benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, phenanthrene, and pyrene) for birds, these compounds are readily metabolized by vertebrates, and are not anticipated to accumulate in birds and mammals, especially at environmental concentrations [111]. The major pathway for riparian birds to be exposed to PAHs is through ingestion of benthic invertebrates and sediment. The maximum PAH concentrations in the Lake Ontario site study area exceeded the CCME sediment quality guideline during one sampling event at Darlington Harbour, however no exceedances were identified in all other sampling events. As the Lake Ontario sediment is not depositional, and the invertebrate community is mainly epifaunal, the risk for riparian birds to be exposed to toxic level of PAHs is very low.

No adverse effects from pH are expected in Lake Ontario. The UCLM pH measured in Lake Ontario was 8.4 and although the maximum pH observed (9.2) exceeded the MECP water quality objective and the CCME water quality objective, the area is considered to be productive. This is evident from the DNNP EA [82] and recent aquatic community studies [103, 112], which document diverse populations of fish, phytoplankton and zooplankton, as well as benthic invertebrates.

Since the American eel is a species at risk, the assessment endpoint is the health of the individual. The fish benchmarks were exceeded for maximum water concentrations of ammonia, but not for UCLM water concentrations. Since fish are mobile, the UCLM water concentration is more appropriate than the maximum for assessment of toxicological risk to the American eel. The American eel is not at toxicological risk from DN operations.

Ponds

In Coot’s Pond (Polygon AB), maximum ammonia (un-ionized) concentrations in surface water exceeded the fish (northern redbelly dace) and turtle/frog benchmarks. Maximum and UCLM sediment concentrations in Coot’s Pond exceeded the sediment target benchmarks for TKN, TOC, cadmium, chromium, copper, iron, manganese, nickel, phosphorus, vanadium, and zinc for benthic invertebrates. There was no exceedance of the HQ target of 1 for birds and mammals.

The UCLM pH measured at Coot's Pond was 9.0 and the aquatic environment is productive, so no adverse effects from pH are expected at Coot's Pond. Although the maximum pH observed in Coot's Pond (9.6) exceeded the MECP wand CCME water quality objective for pH, the productive nature of Coot's Pond is evident from recent biodiversity studies [102, 112].

Although potential risks were identified to aquatic receptors at Coot's Pond from a number of COPCs, the source of these COPCs in Coot's Pond is not the result of emissions from the DN site but is attributable to the pond having been designed as a settling pond for stormwater runoff, and to being adjacent to a licensed landfill section of the site. OPG has an ECA for the landfill and conducts and reports on quarterly monitoring and semi-annual inspections. There is no pathway from DN liquid effluent to Coot's Pond. There is potential for DN air emissions to deposit at the pond, however the chemical signature in Coot's Pond is characteristic of landfill runoff. The elevated TKN, TOC, ammonia and phosphorus concentrations in the sediment also suggest agricultural inputs in Coot's Pond.

The maximum concentrations of strontium in soil in the Coot's Pond area falls within the range of background concentrations for the continental USA [110]. Strontium competes with calcium but it does not have a toxic effect on bone in chicks. Since there were no data to determine strontium benchmarks for birds, the mammal benchmark was used as a surrogate, and there were no exceedances.

Adverse health effects for birds and mammals are not expected from elevated levels of iron in surface water and sediment. Iron is generally present in surface water as salts in its trivalent form (Fe^{3+}) when the pH is above 7 [113] and is therefore not in a bioavailable form. In the sediment, iron is mainly present in the form of particulates, and is not bioavailable. Absorption of iron in the body (mammals and birds) is regulated, and very little is metabolised.

No risks were identified to ecological receptors in the Treefrog Pond area. Where data were available, the HQ target of 1 was not exceeded for aquatic and terrestrial biota in Polygon D.

Exposure to physical stressors

Impingement

Impingement of fish and entrainment of fish eggs and larvae within the DN site occurs from the use of lake water for CCW. Owing to intake design refinements and its later construction date, DN employs a more advanced intake structure which impinges fewer fish than at Pickering Nuclear Generating Station. Fish impingement sampling was conducted at the DN site May 2010 and April 2011. Thirteen fish species were observed, with alewife and round goby representing 97% of the counts and biomass. The estimated annual total was 274,931 fish impinged and 2,362 kg of fish biomass. Impinged American eels were reported to the Ministry of Natural Resources and Forestry (MNRF) annually as a condition of the Endangered Species Act (ESA) permit. From 2016 to 2019, the number of incidental impinged American eel at DNGS was reported at 13 (April 2016 - March 2017), 24 (April 2017- March 2018), 5 (April 2018 - March 2019), and 0 (April 2019 - March 2020).

As recommended in CSA N288.6-12 [50], various "equivalent loss" metrics can be calculated from the counts of fish impinged. These metrics include equivalent age 1, equivalent fishery yield, and production foregone and are more relevant to describing the effect on fish population than the raw counts. Equivalent age 1 values were calculated by OPG for most fish species. Production foregone was calculated for most fish species and represent the loss of future biomass due to the foregone growth of the fish taken at the station. The production foregone over all species considered was 905 kg, mainly from alewife, round goby and rainbow smelt. Adding this to the biomass of fish lost at the time of impingement (2355 kg) a total biomass loss of 3260 kg was calculated. Lost fishery yield was calculated only for species with commercial or recreational fisheries. This metric represents the loss of future fishery yield (expressed as biomass) that will not be harvested as a result of fish taken at the station. The lost fishery yield was 89 kg and consisted almost exclusively of rainbow smelt.

The alewife population in Lake Ontario in 2009 was estimated at 134 million age 1 and older fish, with a biomass of 5298 metric tonnes [114]. The take of alewife at DN in 2010-2011 was equivalent to 56,515 age 1 fish, or 0.04% of the population. The total biomass lost, including production foregone, was 1571 kg, or 0.03% of the population biomass. These losses are considered to be negligible.

The rainbow smelt population in Lake Ontario in 2009 was estimated at 311 million age 1 and older fish, with a biomass of 1714 metric tonnes [114]. The take of rainbow smelt at DN in 2010-2011 was 5857 fish, or 0.002% of the population. The total biomass lost, including production foregone, was 145 kg, or 0.008% of the population biomass. These losses are also considered to be negligible.

The invasive round goby has increased rapidly in Lake Ontario since appearing in 2002, with a concurrent decline in the native benthic prey species such as the slimy sculpin [115]. Based on bottom trawl surveys on the U.S. side of the lake, round goby density was approximately $0.03/m^2$, with a biomass of $0.2\ g/m^2$ [115]. For a lake area of $18{,}960\ km^2$, Lake Ontario may contain around 568 million round goby, and a biomass of around 3.8 million kg. The take of round goby at DN in 2010-2011 was 151,510 fish, or 0.27% of the population. The total biomass lost, including production foregone, was 1,515 kg, or 0.04% of the population. These losses are considered to be negligible.

Overall, fish losses due to impingement at DN were considered negligible when considering the Lake Ontario populations of the impinged organisms. OPG has a DFO Fisheries Authorization for the impingement and entrainment of fish at DNGS and OPG will continue to meet the conditions of the Fisheries Act Authorization, which includes conducting two years of impingement monitoring at DNGS in 2024 and 2025. Note that the DFO Fisheries Act Authorization does not allow for impingement and entrainment of federal species at risk (SARA Schedule 1) and provides conditions for monitoring and reporting should a SARA Schedule 1 species become impinged or entrained. Impingement and entrainment of provincial species at risk (SARO) is covered under the ESA and associated regulations.

Entrainment

Fish egg/larvae entrainment sampling was conducted in 2004 (June - August), 2006 (March - September) [116], 2010, and 2015/2016. The most recent sampling effort was a follow up program to the EA for DN refurbishment and continued operation, where more intensive studies of fish (eggs and larvae) and macro benthic invertebrate entrainment were completed. The estimated annual entrainment was comprised of 94,482,521 eggs and 10,983,411 larvae. This number was higher than the 2004 and 2006 studies, likely because of the more robust sampling method used. The estimated annual biomass lost to entrainment in the 2015/2016 study was 589 kg, comprised mainly of round goby, walleye, and deepwater sculpin. Walleye was the only entrained species subject to fishing and the lost fishery yield for walleye was 149 kg. Deepwater sculpin is a species of special concern under the federal SARA and although its larvae were entrained, no eggs were captured in the 2015/2016 study. It was noted that the deepwater sculpin population in Lake Ontario is recovering [117] and may be near its carrying capacity in Lake Ontario [118].

Overall, losses from fish entrainment were considered too low to measurably affect Lake Ontario fish populations [103]. Benthic invertebrates were entrained in all months of the study period with a total of approximately 22,301 individuals collected. The estimated annual entrainment of benthic invertebrates was 1,548,288,043, with the highest numbers entrained for *Echinogammarus* and other amphipods (91% of the benthic invertebrate total). From the 2016 epifauna and infauna sampling, it was shown that the benthic invertebrate community in the vicinity of the DNGS does not differ from communities in the reference location in a manner that reflects a station-related effect, therefore, entrainment at the DNGS is not considered to be negatively impacting local benthic invertebrate populations. OPG will continue to meet the conditions of the Fisheries Act Authorization, which includes conducting entrainment monitoring at DNGS in 2024 and 2025.

Thermal plume

No adverse thermal effects have been demonstrated and none are anticipated based on numerous thermal effects monitoring studies and survival-to-hatch modelling predictions conducted by OPG [119]. Following the DN Refurbishment EA, an assessment of thermal effects from the warm cooling water discharged by DN was conducted in 2011 and 2012 at 31 locations in and around the discharge as well at reference locations. These data indicate that a temperature difference (ΔT) of 3°C between ambient lake temperatures and thermal plume temperatures is a rare occurrence within the mixing zone of the plume, and never occurs outside this zone.

Round Whitefish has been the species of focus for the thermal assessment as it is known to be particularly sensitive to water temperature changes during spawning and larval development and is expected to be present in the diffuser area from January through March. The assessment of Round Whitefish is considered representative and protective of most coldwater fish species. An optimal temperature range for Round Whitefish embryos survival has been assessed to be 1°C to 5°C [120], with hatch timing and size-at-hatch strongly influenced by average incubation temperatures, and very low survival-to-hatch at 10°C [121]. In 2014 the CANDU Owners Group (COG) funded new studies of Round Whitefish embryo survival using a naturally varying base temperature. The COG study found that a reduction to 90% survival required a temperature difference within the plume (i.e. ΔT) of 3.7°C above ambient [122]. In a more recent 2017 COG study, a ΔT of 3°C between plume and ambient lake temperatures was recommended as a conservative benchmark for Round Whitefish, lower than the previously suggested ΔT of 3.7 °C [123]. The ΔT values around the DN diffuser are well below this level. Round Whitefish survival for any sequence of temperatures measured over the embryonic period can be predicted using a survival-to-hatch model developed by OPG in conjunction with ECCC and CNSC using COG data. The predicted survival using measured data over the winter of 2011-2012 was greater than 95%. The largest predicted survival loss (as compared to the average survival at reference locations) was 1.1%, which is well below the 10% threshold for moderate risk of population-level effects warranting mitigation used by the CNSC in the Darlington Refurbishment EA.

In 2016, OPG with the assistance from Professor M. Pandey at the University of Waterloo, developed a hybrid thermal response model for early development of Round Whitefish to be included in the monitoring plan for the DNGS thermal study in 2017-2018 [124]. Additional model development was performed and predicted an average incubation temperature (corresponding to a 90% probability of survival) of 6.3 °C. Based on the result, a conservative temperature threshold of 6.0°C was applied as an action level in a follow-up thermal plume monitoring study conducted during the winter 2017-2018 during a refurbishment outage. If the average temperature between December 1st and March 31st increases above 6.0°C at the DN ADCP reference station, then the survival model would be used to determine the actual survival loss relative to the 2011-2012 average reference temperature. The average winter temperatures during this monitoring season were cooler than in 2011-2012 and were all lower than 6.0°C. Consistent with the previous monitoring event in 2011-2012, elevated plume temperatures were observed relative to reference locations during the period of early and late Round Whitefish embryo development, however temperature differences in the plume were well below the thermal benchmark ΔT of 3°C above ambient. Therefore, it was concluded that there was low risk of adverse effects to Round Whitefish due to the thermal plume.

Maximum weekly average temperatures (MWATs) calculated from measured temperatures within the vicinity of the DN thermal discharge were also compared to MWAT thermal benchmark criteria for other fish species known to occur in the area, including emerald shiner, Alewife, White Sucker and Lake Trout. The MWAT thermal benchmark criteria are species-specific values below which thermal conditions are considered suitable, either for growth of juveniles and adults, or for embryonic development [125]. The measured MWATs did not exceed any of the relevant MWAT thermal benchmark criteria [126]. It was concluded that no effects are expected on local fishes due to the influence of the DN thermal discharge [83, 127].

3.2.3.4 Aquatic environment monitoring

As part of the site's EMP, OPG regularly collects and analyzes radionuclide concentrations in municipal drinking water, well water, lake water, fish, beach sand and sediment around the DN site. These data can be found in OPG's annual compliance reports, which are assessed by CNSC staff and provide a comprehensive understanding of the aquatic environment surrounding the facility. Radionuclide concentrations in samples confirm that radionuclide concentrations are within expected trends, and therefore, human and ecological receptors near the facility are protected.

3.2.3.5 Findings

Based on the review of OPG's ERA and the results of the environmental program for the DN site, CNSC staff have found that the aquatic environment remains protected from nuclear and hazardous releases from the DN site, as well as from physical stressors. Although there were some exceedances of HQs for aquatic receptors, these exceedances were considered to be low risk as the interpretation of HQ results takes into consideration the distribution of areas with

HQ>1, the mobility and home range of the affected receptor, and whether the exposure point concentrations can be attributed to DN operations.

3.2.4 Hydrogeological environment

Assessment of the impacts on the hydrogeological environment consists of characterizing the baseline hydrogeological environment, in identifying potential onsite sources of groundwater contamination, determining the extent of contamination (if any) which could lead to an exposure pathway to human and/or non-human receptors, and determining the significance of any exposure from this pathway. Additionally, this assessment evaluated the effectiveness of current control measures in place in protecting the environment.

Groundwater protection is an element of the overall EP measures at the DN site. OPG has developed a groundwater monitoring program based on several focused area site assessment over many years. In 2012, a comprehensive Groundwater Monitoring Program Design was developed, which was gradually modified over the years.

In 2020, as part of OPG's implementation of CSA Standard N288.7-15, *Groundwater protection programs at Class I nuclear facilities and uranium mines and mills* [52], OPG established a Groundwater Protection Program (GWPP) that includes a Groundwater Monitoring program (GWMP) [128, 129], based on existing groundwater monitoring wells. The purpose of the GWPP is to minimize or prevent releases to and effects on groundwater, as well as to confirm that adequate measures are in place to control and/or monitor these releases [130]. The GWMP serves to provide timely indication of unusual or unforeseen groundwater conditions that may require corrective action or additional monitoring.

This section summarizes the hydrogeological conditions at the DN site, as well as the project's effects on groundwater quality and quantity.

3.2.4.1 Description of existing environment

The DN site is situated on the north shore of Lake Ontario between the Oak Ridges Moraine to the north and the Lake Ontario shoreline to the south. The Oak Ridges Moraine consists of interbedded layers of glacial till and sand and gravel and is a major source of groundwater recharge. The Iroquois Plain is situated south of the moraine and extends 8 to 12 km to Lake Ontario, and is largely underlain by glacial till, shoreline deposits, and glaciolacustrine deposits. The site generally consists of fill materials at surface followed (from top to bottom) by an upper till, interglacial deposits (grey silt or fine sand), and a lower till, on top of shale or limestone bedrock. Groundwater flow at the DN site is divided into three (3) main layers consisting of compacted sands and gravels (construction fill) which form the shallow overburden groundwater system, the interglacial deposits, and shallow bedrock groundwater system. Till units with relatively lower hydraulic conductivities act as aquitards, or confining layers, and restrict groundwater movement. Groundwater flow in these units is expected to be primarily vertically downward. Alternately, interglacial deposits between till units have moderate hydraulic conductivities and act as aquifers and transmit groundwater.

Groundwater flows from north to south towards Lake Ontario (as shown in figure 3.4) except for the northeast portion of the site which flows toward Darlington Creek and then to Lake Ontario. Groundwater flow in the shallow overburden is downward, whereas flow in the bedrock unit is predominantly upward, which serves to mitigate contaminant migration under the site in this unit. Groundwater flow in the protected area of the DN facility is complex, influenced not only by the general horizontal gradient towards the lake, but also by infrastructure features which include deep building excavations and dewatering activities. As can be observed by the westward flow of groundwater toward the reactor buildings in figure 3.4, the combined presence of these infrastructure features creates a hydraulic sink, meaning that groundwater within the station's area of influence discharges into the subdrainage systems (i.e., travels inwards) rather than towards the shoreline. This also suggests a slight alteration of groundwater flow pattern, which has been observed from 2013 to 2016 along with a lowering of groundwater levels, began to recover in 2017. Groundwater has since returned to previous levels as a result of discontinued dewatering activities [131]. All effluent collected through drainage systems is analyzed (and treated if necessary) to ensure it meets radiological and non-radiological limits prior to discharge to Lake Ontario.

Figure 3.4: Groundwater flow regime at the Darlington Nuclear Site

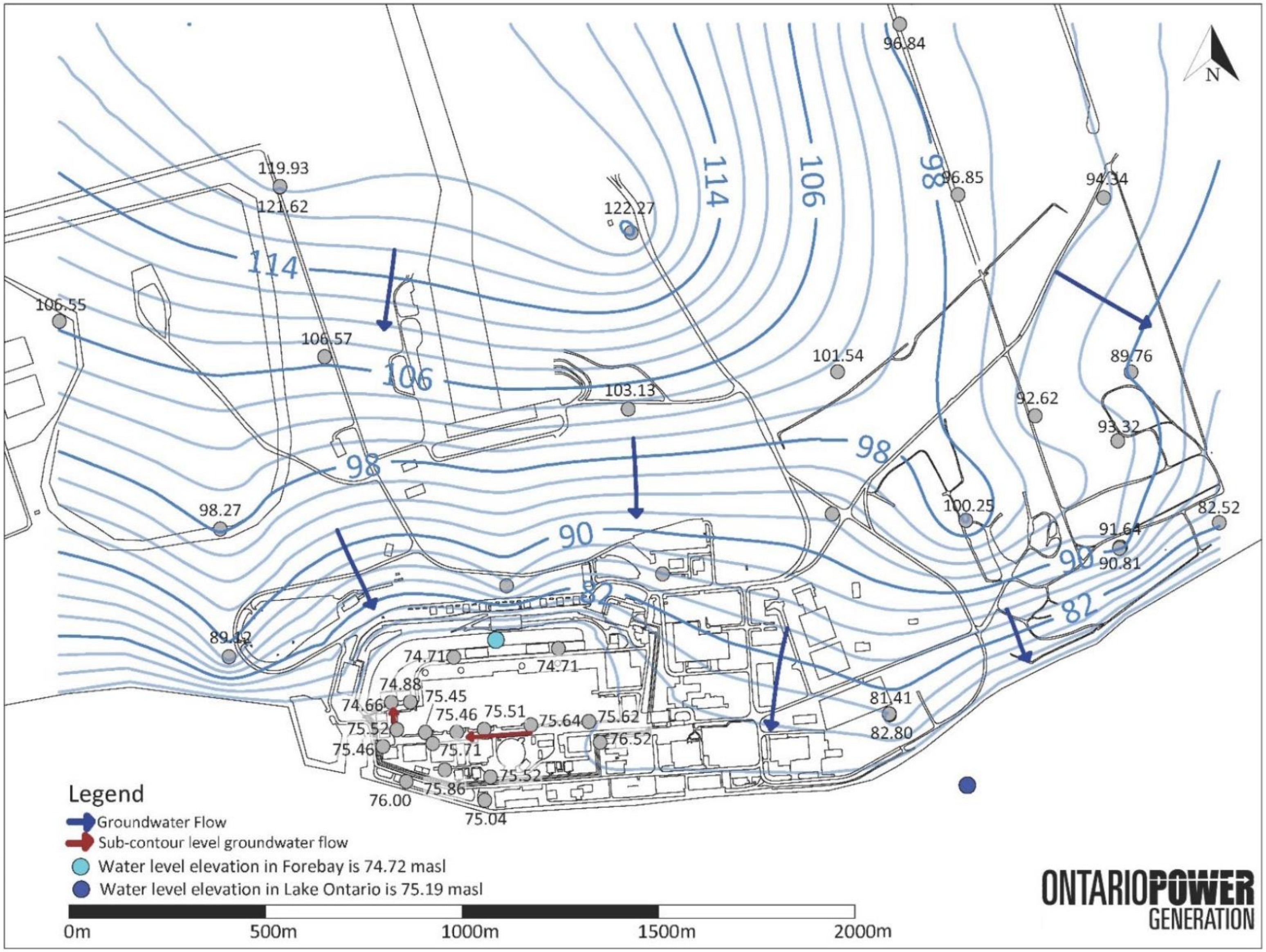
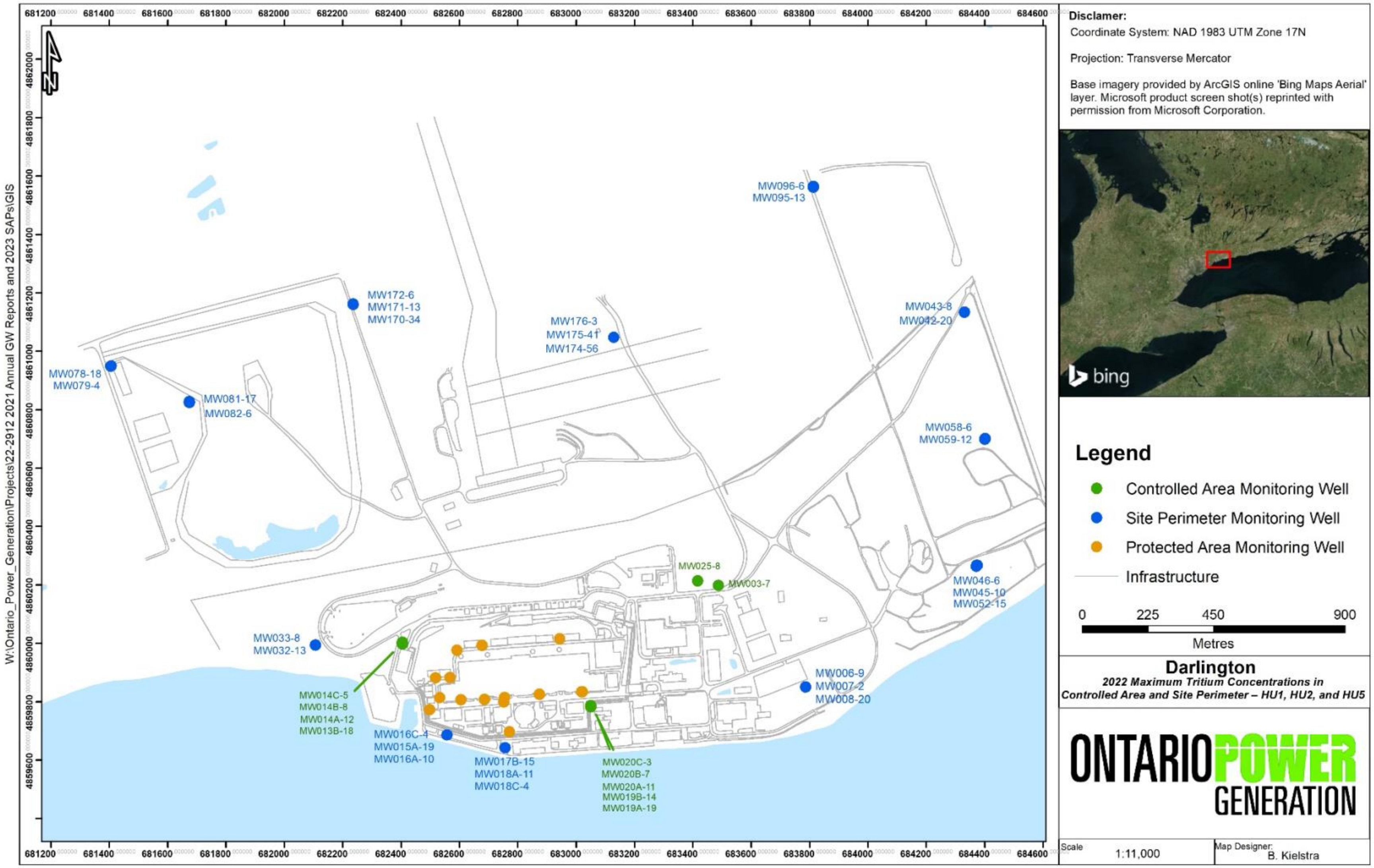


Figure 3.5: Monitoring locations – controlled area and site perimeter monitoring wells



3.2.4.2 Groundwater quantity and quality

As discussed in the 2020 ERA [61], the potential for exposure of human and ecological receptors to COPCs through groundwater pathways associated with the DN facility includes discharge into Lake Ontario at the site boundary, as well as deposition of airborne radionuclides through soil. Both pathways are monitored as part of the GWMP, as well as the EMP. Direct exposure is not considered as groundwater is not used as a source of drinking water on the DN site and is not considered potable. Groundwater is monitored for radiological and non-radiological contaminants from onsite monitoring wells (figure 3.5) before it migrates off-site, ultimately toward Lake Ontario. Groundwater sample collection frequencies range from quarterly to biennially for up to 141 [128], most of which are near the reactor buildings. OPG collects the following data from various onsite monitoring wells:

- groundwater levels in select monitoring wells;
- tritium in groundwater downgradient of the DNGS Powerhouse, active liquid waste (ALW) treatment and collection system, heavy water management building (HWMB), TRF and building effluent lagoon;
- PHCs including benzene/toluene/ethylbenzene/xylenes (BTEX) downgradient of the emergency power service/emergency power generator (EPS/EPG), fuel management systems, standby generator fuel management system and auxiliary heating steam facility;
- tritium in perimeter monitoring wells to establish tritium concentrations surrounding the DN site (“upgradient perimeter wells”), and tritium and PHC, including BTEX, concentrations at the Lake Ontario shoreline (“end-use wells”).
- monitor groundwater flow conditions and quality during the site preparation phase as well as the future phases of the DNNP.

The monitoring data for groundwater levels confirm that groundwater in all three hydro-stratigraphic units flow toward Lake Ontario. Water levels in the overburden and shallow bedrock units have remained consistent with historical values and do not indicate any significant changes. Groundwater levels in the Protected Area are the same as or marginally below the lake level, with the minimal level reported at the Forebay channel, representing possible inward flow caused by the hydraulic influence of the subsurface drains and sumps.

At the DN site, tritium concentration trends over time at monitored locations show that, in most cases, concentrations have remained nearly constant or decreased, which indicates stable or improved environmental performance. Elevated concentrations of tritium were previously observed in the vicinity of Unit 0 due to the 2009 injection water storage tank (IWST) D_2O spill. Tritium from the spill is migrating towards the westerly end of the forebay. With continuous drainage of groundwater into the Forebay water, tritium concentration in the area has declined substantially due to dilution and there is no adverse impact on human health and the environment resulting from the 2009 event.

In a few cases, tritium concentrations at certain locations in the Protected Area near the powerhouse (south of powerhouse – Units 3 and 4) fluctuated from a historical level of approximately 300 Bq/L -600 Bq/L to a peak of approximately 1000 Bq/L, and then declined with time, during the 2018 – 2022 period. In EPG fuel management building area, tritium in water table was observed to increase to 2,000 Bq/L in 2018, followed by a continuous decrease to historical range of 600 Bq/L. This has been interpreted as the result of a small component of groundwater influenced by the IWST tritium release migrating west towards the EPG area.

These unexpected increases were predominantly observed in shallow hydrostratigraphic units, reported to CNSC staff and addressed through detailed assessments as well as corrective actions, where necessary. There was no potential for adverse off-site impacts to humans or the environment, given that groundwater in the Protected Area is hydraulically contained on-site by the subsurface drains and sumps associated with the reactor buildings – this is demonstrated by groundwater elevation data, as well as the contaminant fate and transport model developed for the DN site [132]. Additionally, this is confirmed by groundwater monitoring, which over the past five years (2018-2022) demonstrates that no exceedances of the screening criterion for the protection of human health and aquatic life (i.e., 1×10^8 Bq/L tritium [129]), have been observed in perimeter wells at the DN site. Although water on-site is not considered potable, monitoring data over the past five years also demonstrates that there have been no exceedances of the 7,000 Bq/L drinking water quality standard identified by Health Canada [133] and the province of Ontario [134] in perimeter wells at the DN site. Tritium concentrations within the perimeter wells are stable and within historical ranges. Control area wells generally exhibit similar concentration of tritium to site boundary wells irrespective of their closer proximity to the reactors.

Most groundwater quality results were non-detectable with respect to PHCs and BTEX. Detectable concentrations of PHCs were found in the south vicinity of the Unit 2 in hydraulic units representing shallow bedrock. This was interpreted as naturally occurring hydrocarbons in the petroliferous calcareous shale, and thus not considered as COPCs. Concentrations of PHCs remain below detection limits and thus below provincial groundwater quality standards (e.g., province of Ontario [134]) at any shoreline wells. Where detected, concentrations of PHCs and BTEX met the MECP Table 3 Site Conditions Standards for PHCs and BTEX [134].

3.2.4.3 Findings

Based on a review of the ERA and the results from OPG's GWMP and EMP, CNSC staff conclude that OPG's reported radiological and non-radiological releases of COPCs to groundwater from the site perimeter concentrations have remained low and there are minimal adverse effects on groundwater quantity or quality from the DN site. While elevated concentrations of tritium are observed in monitoring wells in the protected area, these are effectively contained due to the hydraulic influence of subsurface drains and sumps. CNSC staff continually review results from the ERA, GWMP and EMP to ensure that the conclusion of no adverse effects remains valid.

3.2.5 Human environment

An assessment of the human environment at the DN site involves identifying representative persons located within or in proximity to the site and determining whether they could be exposed to nuclear or hazardous COPCs, such as through breathing the air; being on the land; drinking and swimming in surface water; and eating plants, fish and wildlife from the DN site area. Representative persons are those individuals who, because of their location and habits, are likely to receive the highest exposures to nuclear or hazardous substances from a particular source and, therefore, potentially have their health impacted by these exposures. In general, human receptors may be exposed to contaminants through 4 primary routes: dermal (skin), inhalation, incidental ingestion (soil), and ingestion of food and water.

OPG's revised 2020 ERA [63] included a HHRA to assess the risk to humans from both nuclear and hazardous substances released from activities at the DN site. The 7 potential critical groups were:

- urban residents (Oshawa/Courtice, Bowmanville, West/East Beach)
- agricultural farm
- dairy farm
- rural resident
- industrial/commercial workers
- sport fisher
- camper

These groups were used for the exposure assessment for both radiological and non-radiological COPCs. Indigenous peoples were considered in the selection of receptors for the HHRA. Information from engagement with Indigenous communities, councils and organizations gathered during preparation of the DN Refurbishment EA showed no evidence suggesting use of lands, water or resources for traditional purposes within the Local Study Area. It is possible that a few individuals may carry out these activities in a very limited fashion. However, these activities would be restricted by the urbanization, population density, and preponderance of private land in the area. Based on this, it was concluded that any influence from the DN site on the health of Indigenous peoples was likely to be bounded by the assessment of other potential critical groups located much closer to the DN site who consume foods local to DN as part of their diet.

To illustrate, the agricultural farm receptor obtains a large fraction of their annual fruit, vegetables, and animal produce locally within 1.5 km from the DN site. These receptors also obtain their water supply mostly from wells and use it for drinking, bathing, irrigation and livestock watering. While there may be dietary differences such as more wild game in the Indigenous diet, and more farm produce in the farm diet, both groups will have high local fractions, and overall dietary intakes will be similar. However, the atmospheric dispersion factor from DN to the nearest Indigenous community is orders of magnitude lower than that to the nearest farm receptor. Therefore, it is expected that Indigenous communities would receive doses that are far lower than doses received by the potential critical groups currently assessed in the ERA.

3.2.5.1 Exposure to nuclear substances

The CNSC's *Radiation Protection Regulations* [64] prescribe radiation dose limits to protect workers, the public, and Indigenous Nations and communities from exposure to radiation from licensed activities. Doses are either monitored by direct measurement or by estimation of the quantities and concentrations of any nuclear substance released as a result of the licensed activities. The annual effective dose limit for a member of the public is 1 mSv per year.

The DN site emits nuclear (and hazardous) substances into air and water during normal course of operations. The following exposure pathways were considered to assess doses to human receptors from radiological COPCs:

- inhalation of air and external exposure to air
- ingestion of water and external exposure to surface water
- incidental ingestion of soil and beach sand

- external exposure to soil and beach sand
- ingestion of food

The air- and water-borne radiological COPCs selected for the assessment of human health included: C-14, Co-60, Cs-134, HT, HTO, noble gases (argon-41, xenon-133 xenon-135), and mixed fission product radioiodines.

For the radiological exposure assessment, exposure point concentrations (EPCs) were either based on measured data from OPG's EMP reports or modelled from emissions data.

The radiological HHRA presents a summary of the annual doses to the three most exposed critical groups from 2016 to 2019 (Table 3.9). The critical receptor groups considered included: the dairy farms, the (agricultural) farms, and the West/East beach residents. For each receptor group, three age classes were assessed: infant, child, adult. Radiological dose calculations to human receptors were calculated using annual average measured and modelled concentrations in environmental media. The annual average doses during 2016 - 2019 for the critical receptors ranged from 0.1 to 0.8 microsieverts (µSv). The primary radionuclide pathways contributing to this total dose were inhalation and ingestion of HTO in air and in water, plants, and animal products; external exposure to noble gases; and ingestion of C-14 in plants and animal products. These dose estimates remained at most approximately 0.08% of the regulatory public dose limit of 1 mSv/year (1,000 µSv/year) and at most approximately 0.06% of the dose from background radiation (1.4 mSv/a) in the vicinity of the DN Site. Demonstration that these critical groups are protected implies that other receptor groups near the DN site with anticipated lower exposure are also protected.

Table 3.9: Summary of highest estimated public doses from 2016 to 2019 for the DN site [63]

Effective Dose to Critical Group (µSv/a)				
Public dose limit (µSv)	**2016**	**2017**	**2018**	**2019**
1,000	0.6	0.7	0.8	0.4

3.2.5.2 Exposure to hazardous substances

In OPG's HHRA [63] for the DN site, the exposure pathways for chemical COPCs were selected to be consistent with the radiological exposure pathways, with some incomplete pathways detailed further below. Based on the results of the COPC screening, the human exposure assessment was performed for the inhalation pathway for nitrogen oxides (NO_x), and the drinking water and fish ingestion pathway for hydrazine, lithium and zirconium. The following exposure pathways were considered:

- air inhalation and external exposure to air
- ingestion of surface water
- ingestion of aquatic animals

Human exposure to non-radiological contaminants in off-site soil was considered unlikely as any airborne releases from the DN site and subsequent off-site deposition of non-radiological particulates (metals) would be lost against the background soil levels. On-site workers, contractors, and visitors may potentially be exposed to on-site soil; however, these exposures would be considered and controlled through OPG's on-site Health and Safety Management System Program. With respect to groundwater, there are no groundwater supply wells downgradient of potential source areas on the DN site. As such, concentrations of potential chemical stressors in off-site drinking water wells would not be influenced by the DN site. Ingestion of terrestrial plants (forage and plant produce) and terrestrial animals were not considered complete pathways in the exposure assessment to human receptors for non-radiological COPCs. Dermal absorption of chemical COPCs was considered to be minimal in comparison to drinking water ingestion, and so determined to be an incomplete exposure pathway.

For the waterborne non-radiological COPCs, EPCs were screened based on CCW data from OPG's ECA from 2016 to 2019 (hydrazine), and Lake Ontario water samples collected at the DN site in 2019 (hydrazine, lithium and zirconium). For the airborne non-radiological COPCs, annual exposure at the potential critical group locations was based on NO_x release rates reported in OPG's 2016 to 2019 ESDM reports and dispersion factors.

For the risk characterization, potential risks to human receptors were characterized quantitatively in terms of HQs for non-carcinogens (NOx) and incremental lifetime cancer risks (ILCRs) for potential carcinogens (hydrazine). Consistent with CSA N288.6-12 [50], the acceptable risk levels are less than 0.2 for non-cancer risk (HQ) and less than a cancer risk of 10^{-6} (ILCR).

For air inhalation exposures, the estimated HQs of potential non-carcinogenic effects attributed to NO_x were below 0.2 for the potential critical receptor groups based on modelled annual average air concentrations. Short-term (1-hr) HQs were also determined for the sport fisher based on the 1-hr NO_x concentrations at the DN property boundary in 2016 (526 $\mu g/m^3$) and in 2018/2019 (205 $\mu g/m^3$). The short-term HQs were 4.65 and 1.8, respectively. Short-term HQs could not be calculated for the other receptor groups as short-term concentrations or dispersion factors were not available in the ESDM reports. The sport fisher is the closest receptor to the property boundary (i.e., fishing at the DN outfall). Since the other potential critical groups are farther away, it is anticipated that the HQs for the other receptors will be lower than that for the sport fisher. Regardless, an air quality monitoring study was initiated in 2021 at the DN site will be used to refine future risk estimates. The first year of data will be included in an DN ERA Addendum report expected in late September 2024.

With respect to surface water ingestion exposures, maximum measured and upper confidence limit on the arithmetic mean (UCLM) concentrations in lake water and maximum and mean measured concentrations in CCW effluent were diluted using dilution factors in order to estimate exposure point concentrations for the COPCs. The estimated HQs for lithium and zirconium were below 0.2 for all human receptors. For hydrazine, the risk for hydrazine was determined to be below the acceptable cancer risk level of 10^{-6} for all human receptors based on the UCLM hydrazine concentrations, either measured in the CCW or lake water. When based on the maximum hydrazine concentrations in the CCW, on the other hand, the ILCRs exceeded 10^{-6} (for the Oshawa/Courtice and Bowmanville urban residents, and camper receptors). However, maximum concentrations are not considered representative of long-term exposure and results should be interpreted based on the UCLM. As such, adverse effects to humans due to lithium, zirconium or hydrazine originating from the DN site via surface water ingestion are not expected.

Since several human receptors are potentially exposed to chemical COPCs through fish ingestion, the fish tissue concentrations for hydrazine, lithium and zirconium were estimated using bioaccumulation factors (BAFs) and dose calculations were done based on maximum and mean concentrations of hydrazine measured in the CCW. Estimated maximum and UCLM HQs for lithium and zirconium were below 0.2 for all receptors. As such, adverse effects to humans due to ingestion of lithium and zirconium in fish from the DN area are not expected. For hydrazine, the risks were below the acceptable risk level of 10^{-6} based on UCLM concentrations of hydrazine in fish. In comparison, if based on maximum concentrations of hydrazine in fish, the risk would be above the acceptable cancer risk level of 10^{-6} for the sport fisher and camper receptors. However, as previously mentioned, the maximum is not considered representative of long-term exposure, and results should be interpreted based instead on the UCLM. As such, adverse effects on humans due to hydrazine originating from the DN site through fish ingestion are not expected.

Physical stressors

Noise is the only physical stressor associated with the DN site that is of potential concern to human receptors. Based on an acoustic assessment, it was determined that noise generated by DN site activities would not be expected to have a distinguishable effect on human receptors located near the DN site (Sec. 3.2.1.2).

3.2.5.3 Findings

Based on assessments conducted for the DN site, including the review of the revised 2020 ERA [63], CNSC staff have found that impacts on the human environment from nuclear and hazardous substances released from the DN site are unlikely, and that people living and working near the facility remain protected.

3.2.6 Cumulative effects

The Government of Canada continues to work to add, gather, enhance and make publicly available the data and information needed to support understanding and consideration of cumulative effects on ecosystems, society and the economy, and associated effects on health and well-being. The nature and scope of cumulative effects considered varies depending on the specific statute [135]. Potential cumulative effects are assessed at the EA stage for projects, however a formal cumulative effects assessment is not a requirement within CNSC staff’s assessments for EPRs as it is not a requirement under the NSCA or other regulatory documents. Nonetheless, CNSC staff’s assessments do consider the accumulation of COPCs within the environment because of the facility or activity through the cyclical nature of ERAs, the monitoring data in annual reports, data from the IEMP, and results from any regional monitoring programs and health studies.

Licensees are required to meet onsite, and near-field monitoring requirements associated with their provincial approvals and the federal regulations, including full life-cycle requirements. These programs focus on single operations with scheduled reports on performance submitted to the regulators. These activities are further supplemented by the CNSC’s IEMP activities (see section 4.0), which focus on local areas where Indigenous Nations and communities and members of the public could reasonably be expected to conduct recreational or traditional activities (that is, off-site accessible areas).

The Government of Canada's overarching plan for cumulative effects is available through the About cumulative effects page.

3.2.7 Climate change considerations

As indicated in section 2.3, potential impacts of climate change on the DN site have been evaluated in the previous EAs and hazard analysis. A summary of projected climate change, assessment of potential impact of climate change, as well as regulator review is presented in this section.

3.2.7.1 Relevant Potential Changes in Climate in Ontario

CNSC staff consider the latest scientific information related to climate change to inform our regulatory oversight and technical reviews.

Scientific information that is considered includes the following reports:

- Canada's Changing Climate Report [136]and its supplement [137], predicts that increases in global mean temperature could result in numerous impacts in Canada, such as increasing severity of heatwaves, drought and wildfires, changing annual and winter precipitation, as well as increasing frequency and magnitude of daily extreme precipitation events.
- The State of the Great Lakes 2022 Report [138] provides Great Lakes (including Lake Ontario) specific climate trend information. Key findings in this regard are as follows:
    - Long term water temperature trends in Lake Ontario could not be assessed due to uncertainties in the data. However, it is concluded that there was a slight increasing trend of approximately 0.03℃ per year in the lower Great Lakes (Lake Erie and Lake Ontario) from 1980 to 2020.
    - Based on the 1950 to 2020 annual and seasonal total precipitation data for Lake Ontario, there is a slight increase of 2.3% per decade in the winter, 3.1% per decade in the summer, 4.5% per decade in the fall, and 2.7% per decade in annual precipitation overall.
    - Based on the 1918 to 2020 lake water level data, Lake Ontario water level has been unchanging, i.e., no statistically significant trend (increasing or decreasing) exists.
    - Based on maximum ice cover data, spanning from 1973 to 2020, there has been a decreasing trend of 0.24% per year. However, the 30-year trend (that is, 1990-2020) is showing an increase of 0.04% per year in ice cover for Lake Ontario.
- The State of Climate Change Science in the Great Lakes Basin: A Focus on Climatological, Hydrologic and Ecological Effects [139] synthesizes the state of climate change impacts in the Great Lakes basin and indicates that, over the last 60 years (1950-2010), the Great Lakes basin has experienced an increase in average annual air temperatures between 0.8-2.0℃, with this warming trend projected to continue.
- Lake Ontario Shoreline Management Plan [140] discusses climate change impacts on future coastal hazards. For the region surrounding DN site, the wave energy in Lake Ontario is projected to increase by about 20% towards the end of the century under a high emission scenario (RCP 8.5), which could lead to increase in future erosion rate by 20% in the absence of appropriate shoreline protection [140].

3.2.7.2 Darlington Nuclear Site Sensitivities to Changes in Climate

As per the 2011 EA [71] and 2013 EA Screening Report [32], OPG plans to continue the operation of DNGS Units 1-4 to 2055 and the placement of reactors into end of life shutdown state is estimated to start in 2048 and be completed by 2085 . These reports discussed the potential effects of climate change on activities related to the Continued Operation Phase of the project for the DNGS.

In the 2011 EAs, the physical structures and systems (Power Block, Ancillary Facilities, Breakwater, Condenser Cooling Water Systems, Stormwater Management System and Electric Power Systems) have been evaluated against climate parameters and assessed for potential sensitivity [32]. The climate change parameters that were considered in the 2011 EAs to have a potential interaction with the physical structures and systems are:

- Precipitation: annual precipitation is projected to increase (20% increase in annual precipitation across the Great Lakes Basin by 2080s under the highest emission scenario [139], and extreme precipitation is also projected to increase over the 21st century).
- Frequency and severity of extreme weather events: storms, not exclusively precipitation events (e.g., lightning, tornadoes, hurricanes) are expected to be more severe and occur more frequently– for example, more frequent extreme rainfall events are projected.
- Lake Ontario water temperature: water temperatures are expected to increase (0.9 to 6.7°C increase in surface water temperature by the 2080s [140]) due to warmer air temperatures.
- Lake Ontario water level: lower surface water levels of lakes are expected or projected, especially toward the end of this century (although low confidence). Recent study [141] however show the average lake water level to remain constant in agreement with [138] although more extreme highs and lows are possible in the future. Regardless, it must be noted that the level of Lake Ontario is regulated for navigation purposes.

Other climate parameters were considered by OPG [71] to have insignificant interactions with the site physical structures and systems and were found not to affect operations. These parameters include evaporation, soil moisture, and groundwater.

3.2.7.3 Evaluation of Climate Related Impacts

The climate parameter-physical structures or systems interactions identified as having a possible effect have been further evaluated in the 2011 EA [71] and Hazard Screening Analysis [72] for the DN site. The interactions deemed as warranting further evaluation were assessed to determine: (a) the sensitivity of the project physical structures or systems to the climate parameters; and (b) the risk level of any impact to the public or the environment. A summary of these analysis (interactions showing medium risk), as well as the review by CNSC staff, are described below.

Stormwater Management System

The effect of exceeding the design capacity of the stormwater system because of an increase in the frequency and/or severity of extreme precipitation events may include overflow of the system and some localized soil erosion. However, there will be no adverse effects to any structures or equipment at the DNGS nor any risk to the public or the environment as a result of a stormwater system overflow.

Further, any localized soil erosion from the stormwater system is easily repairable as part of the ongoing maintenance program. If the regional storm event, design storm used to size stormwater management system, is redefined, OPG will re-evaluate the stormwater management system and make appropriate modifications.

As part of the adaptive management strategy requirements for the DNGS, the physical structures and systems that could be affected by a change in environmental parameters (e.g., Stormwater Management System), due to changing climate, are monitored and modifications implemented, if required.

External Flooding Hazard

OPG have conducted analysis of flooding hazard due to different mechanisms or sources of flooding, including surface runoff resulting from PMP falling directly on the site, nearby streams and rivers, coastal flooding due to potential high lake levels combined with storm surge, wind waves, seiche (source of flooding in enclosed or semi-enclosed bodies of water), tsunami, and other causes [72]. The probable maximum flood (PMF) is used for flood hazard assessment at DN site and is based on a combination of PMP, a 1:100-year lake level (75.60 m) and storm surge (0.75 m). It should be noted that the water level in Lake Ontario is regulated between a high still-water level of 75.6 m and a low still-water level of 73.9 m [71]. The PMP is based on Ontario Ministry of Natural Resources and Forestry technical guidelines [142], and represents a 12-hour precipitation, equivalent to 420 mm of total rainfall, with 51% in the 6th hour, based on Table A.2 and A.4 of Appendix A [142]. This PMF has a very low probability of occurrence or exceedance, with an estimated return period of 1 in 1,000,000 years [72] [143] that is expected to bound potential effects of climate change. The hazard screening analysis [72] and probabilistic safety analysis [144] demonstrate that potential impact of flooding hazard at DN site is not significant.

3.2.7.4 Findings

The climate change parameters that may have an interaction with the DN site's physical structures, systems and components include precipitation, extreme weather events and Lake Ontario water temperature and water level.

CNSC staff have reviewed the climate change impact assessment as reported in previous environmental assessment reports for the DN site and compared the climate change parameters used in those reports with the latest projection [136, 137, 138]. In addition, CNSC staff review information relevant to climate change resiliency through the cyclical submissions of hazard analysis reports related to safety analysis, and environmental risk assessments.

CNSC staff concludes that, despite possible changes to the climate in the future, the effect of climate change parameters on physical structure, systems and components, and the associated risk to either the public or the environment, is expected to be low. CNSC staff notes facilities specific (e.g., DNGS) climate change resilience assessment based on most up to date localized historical observations and climate model projection data and up-to-date technical guides [145] to further reaffirm low impact of climate change at DN site.

4.0 Canadian Nuclear Safety Commission Independent Environmental Monitoring Program

The CNSC has implemented its Independent Environmental Monitoring Program as an additional verification that Indigenous Nations and communities, the public and the environment around licensed nuclear facilities are protected. It is separate from, but complementary to, the CNSC's ongoing compliance verification program. CNSC staff findings are supported by IEMP sampling, along with the licensee EP data and ERA predictions. The IEMP involves taking samples from publicly accessible areas around the facilities and analyzing the quantity of nuclear and hazardous contaminant substances in those samples. CNSC staff collect the samples and send them to the CNSC's laboratory for testing and analysis. The CNSC provides opportunities and funding for Indigenous Nations and communities that have an interest in the CNSC-regulated facilities to participate in IEMP sampling campaigns conducted in their traditional and/or treaty territories.

CNSC staff conducted IEMP sampling around the DN site in 2014, 2015, 2017, 2021 and 2023. Indigenous Nations and communities were contacted and engaged by CNSC staff ahead of the development of the site-specific sampling plan.

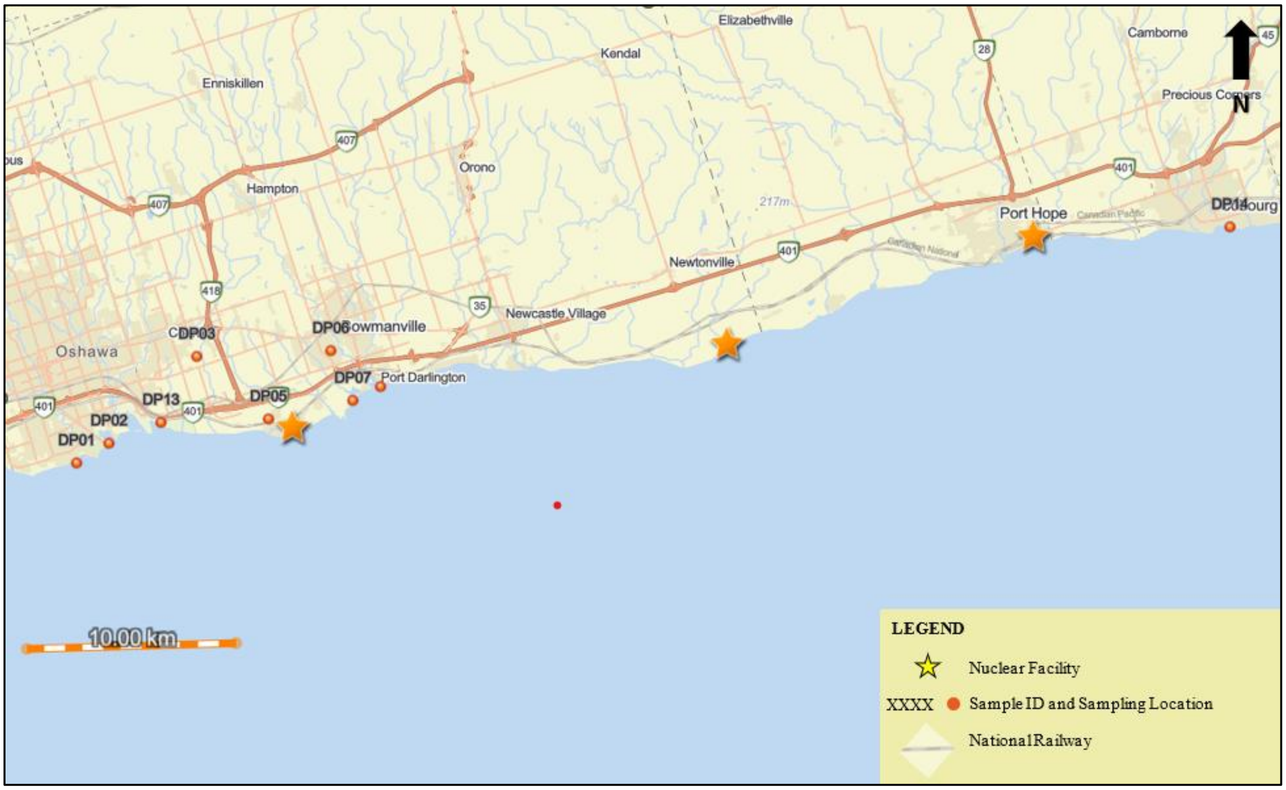
In 2023, the most recent IEMP sampling campaign, CNSC staff collected the following samples in publicly accessible areas outside the perimeter of the DN site:

- air (3 locations)
- water (4 locations)
- vegetation (5 locations)
- soil and sand (8 locations)
- food (1 locations)

Samples were analyzed by qualified laboratory specialists in the CNSC's Ottawa laboratory. Using appropriate protocols, CNSC staff measured radionuclides, such as gross alpha, gross beta, and tritium in samples. CNSC staff also measured hazardous substances in the water samples, such as hydrazine, aluminum, and zinc. These hazardous substances were included in the IEMP sampling campaign at the DN site following a request by the Commission at the 2015 Darlington Renewal Hearing [146].

Figure 4.1 provides an overview of the sampling locations for the 2023 IEMP sampling campaign around the DN site. The IEMP results are published on the CNSC's IEMP web page [147].

Figure 4.1: Overview of the 2023 sampling locations [148]



4.1 Indigenous participation in the Independent Environmental Monitoring Program

It is a priority for the CNSC that IEMP sampling reflects Indigenous land use, values, and knowledge, where possible. In addition to routine IEMP sampling activities, in 2023, the CNSC engaged with 3 First Nations who have Aboriginal and Treaty rights in the area of the DN Site: Mississaugas of Scugog Island First Nation (MSIFN), Curve Lake First Nation (CLFN), and Hiawatha First Nation (HFN).

In 2023, in advance of the IEMP sampling campaign at DN site, notification emails were sent to Williams Treaties First Nations, who have Aboriginal and Treaty Rights where the DN site is located as well as the Indigenous Nations and communities who have expressed interest in the DN site, inviting suggestions for species of interest, VCs, or potential sampling locations where traditional practices and activities may take place.

In 2023, the CNSC met with MSIFN, CLFN, and HFN. These meetings provided CNSC staff with the opportunity to collaborate with Indigenous Nations and communities, to learn about their individual histories and cultures, and to address questions related to the operations at OPG's DN site. The following sections summarize CNSC staff`s collaboration with each Indigenous Nation and community ahead of and during the 2023 sampling campaign.

4.1.1 Sampling with the Mississaugas of Scugog Island First Nation

The Mississaugas of Scugog Island First Nation reviewed the sampling plan in early 2023 and provided comments on species and locations of importance. CNSC staff considered MSIFN's comments in the IEMP sampling plan, however the specific species and locations could not be incorporated as they were located with the DN fence line, which is beyond the scope of the program. Three representatives from MSIFN joined the sampling team in the field in September 2023 and worked with CNSC staff to collect water, vegetation, and soil samples. The sampling team and MSIFN representatives discussed the IEMP and walked through techniques for sampling air, water, and soil, as well as packaging and chain of custody procedures.

4.1.2 Sampling with Curve Lake First Nation and Hiawatha First Nation

Representatives from Curve Lake First Nation and Hiawatha First Nation joined the CNSC field team to collect samples. CNSC staff started by explaining the program to CLFN and HFN representatives, as well as chain of custody procedures for the collected samples. CNSC staff then walked CLFN and HFN representatives through the air sampling process and equipment. CLFN and HFN representatives assisted in the collection of water, vegetation, sand, and soil samples. During the sampling campaign, CLFN and HFN representatives requested that CNSC staff test manoomin (wild rice) harvested from Chemong Lake east of CLFN and shared the spiritual and cultural importance of manoomin to their communities. CNSC field team members prepared a sample kit and walked participants through the instructions on how to get the manoomin sample packaged and sent to the lab. CNSC staff note that the manoomin sample was not from the edible portion of the plant, due to the timing of when it was harvested. CLFN and HFN have expressed their appreciation for the opportunity to sample manoomin and HFN is looking forward to bringing CNSC staff to collect manoomin samples near their community in the future. The CNSC is committed to working with Curve Lake First Nation and Hiawatha First Nation to ensure that the IEMP reflects their Indigenous traditional knowledge, land use and values, where possible.

4.2 Summary of Results

The levels of radioactivity measured in soil, sediment, water and vegetation were below available guidelines and CNSC screening levels. CNSC screening levels are based on conservative assumptions about the exposure that would result in a dose of 0.1 mSv per year (one-tenth of the regulatory public dose limit of 1 mSv per year). Results for all campaigns are published on the CNSC's IEMP web page [147].

The CNSC's IEMP in 2023 results are consistent with the results submitted by OPG, supporting the CNSC's assessment that the licensee's EP program is effective. The results add to the body of evidence that people and the environment in the vicinity of the DN site are protected and that there are no anticipated health impacts.

5.0 Health studies

The following section draws from the results of regional health studies, and national and international reports and publications to provide additional confidence that the health of people living near or working at the DN site in southern Ontario is protected from CNSC licensed activities.

The Durham Region Health Unit works collaboratively with the office of the Medical Officer of Health and other government and non-governmental health service providers to directly monitor the health of people living near the DN site. In regional health studies, disease rates around the facility are compared to similar populations to detect any potential health outcomes that may be of concern.

To complement the CNSC's regulatory oversight, CNSC staff continuously work toward strengthening relationships with the various health units and offices. CNSC staff also keep abreast of any new publications and data related to the health of populations living near, or working at, licensed nuclear facilities. Lastly, CNSC staff, at times, conduct health studies on select populations through their research on the effects of low dose (and low dose-rate) exposures. In addition to community information, Canadian and international publications are discussed below. For additional information on health studies related to nuclear facilities, visit the CNSC's web page on Health Studies [149, 147].

5.1 Population and community health studies and reports

The Municipality of Clarington is located in southeast Durham Region, bordering Oshawa, Scugog, and the county of Northumberland. Clarington is divided into 7 Health Neighbourhoods, ranging in population size from 9,000 to 15,800 as of 2016 (last update). The neighbourhoods of Darlington and Clarke are rural communities, with the remaining 5 classified as urban (see all 7 community profiles [150]. Information about this region is captured by the Durham Regional Health Unit and, more broadly, by the statistics reported by Cancer Care Ontario.

5.1.1 Durham Region Health Department

The Durham Region Health Department (DRHD) routinely monitors the health status of Durham Region using health indicators and health data from sources such as hospitals and laboratories, among other record-storing facilities and databases.

5.1.1.1 Darlington neighbourhood profile

The Darlington neighbourhood profile [150] breaks down socio-demographic information, as well as certain health indicators such as general health (including chronic and infectious disease rates), child health, and, health behaviours (such as smoking, immunization and cancer screening). The reported statistics were compared with the statistics for Durham Region and for Ontario, and were found to be similar overall. Some diseases were more prevalent while others were less prevalent, which is consistent with the natural fluctuation of disease.

Specifically, the Darlington health profile indicates that in 2016 (last update):

- the prevalence of asthma in children (16.4%) was similar to Durham Region and Ontario
- the prevalence of diabetes (8.9%) was lower compared with Durham Region and Ontario

- the prevalence of lung disease, including chronic obstructive pulmonary disease (COPD), (10.6%) was similar to Durham Region and higher than Ontario
- the prevalence of hypertension (high blood pressure) (20.8%) was lower compared with Durham Region and similar to Ontario

5.1.1.2 Determinants of health

Determinants of health are an important consideration in the overall health status of an individual, community, or population. These include a range of personal, social, economic, and environmental factors, such as income and social status, social support networks, education, employment and working conditions, personal health practices, health services, culture, among others. Through the Health Neighbourhoods initiative, the DRHD has identified seven Priority Neighbourhoods in Durham Region [151]. These communities have many health challenges, as shown by their rates and rankings on a variety of indicators and require added focus to build on health and well-being. The Priority Neighbourhoods are Downtown Ajax, Downtown Whitby, Lakeview (Oshawa), Gibb West (Oshawa), Downtown Oshawa, Central Park (Oshawa) and Beatrice North (Oshawa). These neighbourhoods have the lowest income levels of the 50 Health Neighbourhoods in Durham Region, which is an important determinant of health as people with higher incomes tend to have better physical and mental health. Smoking (adults), cardiovascular disease hospitalization (ages 45-64), and hepatitis C rates are also elevated, and life expectancy for males is lower in these neighbourhoods. None of the identified Priority Neighbourhoods are located in the municipality of Clarington.

5.1.1.3 Mortality and cancer data

The DRHD publishes regional health reports specific to mortality (last updated in 2017) [152]. In 2012, the average life expectancy in Durham Region was 80.9 years for males, and 84.5 years for females. On average, there were 3,500 deaths per year among Durham Region residents between 2008 and 2012. Ischemic heart disease (heart attacks) was the leading cause of death in Durham Region and Ontario from 2010 to 2012. Lung cancer and dementia (including Alzheimer's disease) were the second and third. These three causes accounted for nearly a third of deaths in Durham Region. Disease rates between males and females were comparable.

The DRHD also publishes a dashboard with cancer data for Durham Region (last updated in 2022) [153]. Between 2010 and 2018 there were 31,763 newly diagnosed cases of cancer and 10,795 cancer deaths among Durham Region residents. For that same time frame, there was a significant decrease in the incidence of lung, prostate, colorectal, bladder and ovarian cancers. There was a decrease in cancer mortality from lung and colorectal cancer, and an increase in cancer mortality from liver cancer. The most common cancers were breast (females) and prostate (males), lung, and colorectal, accounting for almost half of new cancer cases. This is similar to Ontario and Canadian rates [154, 155]. Cancer incidence rates were similar among Durham Region residents for most cancer sites; however, prostate, thyroid, melanoma and lung cancer rates were higher than overall Ontario rates, while colorectal cancer rates were lower than the provincial rates [153]. Similarly, cancer mortality rates were comparable among Durham Region residents for most cancer sites; however, bladder, breast, lung and non-Hodgkin Lymphoma rates were higher than Ontario rates as a whole, while colorectal and liver cancer rates were lower than Ontario rates. These findings are consistent with natural fluctuation of disease, which is influenced by many factors and determinants of health, including socio-demographic and lifestyle (e.g., smoking, alcohol consumption, overweight/obesity, etc.).

5.1.2 Cancer Care Ontario

Cancer Care Ontario is the Government of Ontario's principal cancer advisor, with a mandate to equip health professionals, organizations and policy makers with up-to-date cancer knowledge and tools to prevent cancer and deliver high-quality patient care.

5.1.2.1 Ontario Cancer Profiles

Cancer Care Ontario, through its Ontario Cancer Profiles [156], provides interactive map-based dashboards that display key public health indicators including cancer incidence, mortality, and risk factors by Public Health Unit (PHU). Information is also presented by Local Integration Health Network (LIHN); however, given its larger geographical area, this section will present PHU data. Cancer incidence and mortality trends are typically considered over long periods of time. For the longest and most recently reported period of 2014 to 2018, for all cancer types combined, Durham Region had incidence rates higher than the Ontario average, but cancer deaths similar to those of Ontario. Compared to the Ontario average, Durham Region had higher incidence rates of melanoma, prostate (males), lung and thyroid cancer, whereas rates of non-Hodgkin lymphoma and colorectal cancer were lower. While some incidence rates are higher in Durham Region than in Ontario, they are comparable to other geographically/demographically similar regions without nuclear sites (e.g., Niagara and Ottawa).

Incidence rates of different cancer types often vary by region and are influenced by many factors, including socio-demographic and lifestyle (e.g., overdue cancer screening, high alcohol intake, smoking and excess body weight/obesity). For the most recent reported period of 2018-2020, the DRDH had smoking and alcohol intake rates similar to, and overweight/obesity rates higher than Ontario. It is recognized that the opportunity to be healthy is not the same for everyone, and is affected by personal, social, economic and environmental factors. The DRHD supports the reduction of health inequalities across Durham Region and offers a wide range of health-enhancing programs [157].

5.1.2.2 Health status of Indigenous Peoples

Health status data for Indigenous Peoples are not reported separately by the DRHD. Although there is no cancer data specific to Indigenous Peoples in Durham Region, a 2017 report on cancer in First Nations people in Ontario [158] has shown that First Nations people living in Ontario had a higher incidence of lung cancer in females, and of colorectal, kidney, cervical and liver cancers than other people in Ontario over a 20-year period (1991-2010) [159]. Cancer mortality was also significantly higher in First Nations people than in other people in Ontario.

5.1.2.3 Primary factors that influence cancer and other diseases

In general, the incidence of cancer and other diseases are influenced by socio-demographic factors, the availability of early detection and screening, and the prevalence of risk and protective factors. Risk factors for cancer development include unhealthy behaviours (such as smoking, poor diet, alcohol use, physical inactivity), previous treatments, exposure to certain environmental and occupational carcinogens (such as ultraviolet rays, radon, asbestos, fine particulate matter), medical conditions and infectious agents (such as human papillomavirus), non-modifiable factors (such as family history) and genetic predispositions [155].

5.1.3 Findings

The review of health reports is an important aspect of ensuring that the health of people living near nuclear facilities is protected. The regional and community health reports and dashboards indicate that cancer incidence and mortality rates, and the prevalence of health indicators and risk factors related to cancer, are largely consistent with those of the population of Ontario as a whole.

5.2 Current scientific understanding of radiation health effects

The current scientific knowledge about the sources, effects and risks of ionizing radiation is reviewed and published by the international experts that make up the UNSCEAR [160]. This information comes from population studies, animal and cell studies, and clinical investigations. These studies build the foundation of knowledge about the relationship between radiation exposure and health effects, such as cancer. This knowledge, in turn, informs the recommendations of the International Commission on Radiological Protection (ICRP) [161], which focuses on establishing a robust radiation protection framework, to protect human health and the environment.

5.2.1 Canadian studies of radiation health effects

Epidemiological studies involving the DN site provide insight on populations living near or working at the DN site. The levels of exposure in local area residents and workers are low, and there is no evidence of adverse health effects resulting from past and present nuclear operations or activities in the region. These findings are consistent with the select important Canadian and international studies of radiation effects on human health in similar populations, described below.

5.2.1.1 Radiation Exposure and Cancer Incidence (1990 to 2008) Around Nuclear Power Plants in Ontario, Canada

In 2013, the CNSC conducted a study on radiation exposure and cancer incidence around Ontario nuclear power plants. The RADICON study determined the radiation doses to members of the public living within 25 km of the Pickering, Darlington, and Bruce nuclear power plants, and compared cancer cases among this subset of the population with cases among the general population of Ontario from 1990 to 2008 [162].

The main findings were that there was no consistent pattern of cancer and no evidence of childhood leukemia clusters around the three Ontario nuclear power plants. Some types of cancer were higher than expected, but others were lower or similar. Variations in all cancers combined and radiosensitive cancers were within the natural variation of cancer in Ontario.

5.2.1.2 Verifying Canadian Nuclear Energy Worker Radiation Risk: A Reanalysis of Cancer Mortality in Canadian Nuclear Energy Workers (1957–1994)

In 2011, the CNSC published a study entitled *Verifying Canadian Nuclear Energy Worker Radiation Risk: A Reanalysis of Cancer Mortality in Canadian Nuclear Energy Workers (1957–*

1994) [163]. CNSC staff also published this work in the scientific literature [164]. An analysis of 42,228 Canadian nuclear workers (including workers employed by DNGS) provided no evidence of increased risk of cancer mortality between 1964 and 1994. Canadian workers had lower all-cause and solid cancer mortality compared with the general Canadian population.

5.2.2 International studies of radiation health effects

The epidemiological evidence of radiation-related health effects comes from several main research populations. These populations include the lifespan studies of atomic bomb survivors [165, 166, 167, 168], people involved in the Chernobyl disaster [169, 170], patients treated with radiotherapy for cancer and non-cancer diseases [171], and miners exposed to radon and radon decay products [172, 173].

5.2.2.1 International Nuclear Worker Study

The largest and most relevant study is the International Nuclear Worker Study (INWORKS), a multinational cohort study that assessed cancer risk from 1943 to 2005 in 308,297 workers from the nuclear industry in France, the United Kingdom and the United States [174, 175, 176, 177, 178]. According to the 2023 INWORKS study [178], the risk of radiation-induced solid cancer mortality resulting from chronic exposure to low doses of radiation may be slightly higher than previously reported. The study supports a linear association between prolonged low dose external exposure to ionizing radiation and solid cancer mortality. These findings are consistent with the LSS, as well as the use of the linear non-threshold model that underpins the system of radiological protection and informs the CNSC regulatory dose limits.

The major findings consistent within all these studies are:

- Excess risk of cancer increases as radiation dose increases.
- Statistically significant population effects are typically observed at doses above approximately 100 mSv (either acutely or chronically exposed).
- At doses of 100 mSv (received acutely or chronically), the risk of developing cancer increases by approximately 0.5% above background cancer risk, which in Canada is approximately 45% [179], resulting in a total risk of 45.5%.

Importantly, the absence of statistically significant data does not indicate the absence of risk. To put these findings into perspective, for most nuclear energy workers from the facility, lifetime dose would fall under 100 mSv, given the average effective dose received is less than 5 mSv per year (2.8 mSv in 2023) [REF]. In comparison, members of the public living near DN site have typically received annual incremental doses less than 0.001 mSv per year (0.0007 mSv in 2023), resulting in negligible lifetime doses.

Doses to workers and members of the public from the operation of nuclear facilities are in addition to the average natural background radiation in Canada of 1.8 mSv per year, which varies regionally from around 1 to 4 mSv per year [168].

5.2.3 Findings

The existing body of knowledge on various populations is used by CNSC staff to help determine the health and safety of workers and persons living near the DN site, in the absence of substantial population-specific studies with radiation exposure data.

Experts worldwide study radiation health effects to provide objective scientific evidence, which supports licensee environmental and radiation protection programs, ensuring that workers and members of the public are protected. The current international understanding is that low doses of radiation are associated with low risks to health, indiscernible from the natural variation of disease. CNSC staff are confident that those living near, and working at, any nuclear facility in Canada are adequately protected.

5.3 Summary of health studies

Reviewing and conducting health studies and reports are important to help ensure the protection of people living near or working at nuclear facilities. Population and community health studies and reports indicate that cancer incidence and mortality rates, as well as the prevalence of specific health indicators and risk factors related to cancer, are largely consistent between populations around the DN site and the population of Ontario as a whole.

Health discrepancies are observed between Indigenous Peoples and other people in Ontario due in large part to the inequities they have faced historically and continue facing presently. Public health authorities can help improve these outcomes through policies and initiatives informed by holistic population health studies focusing on Indigenous health and wellbeing.

The current understanding of the risks associated with radiation exposures is supported by the publications by international agencies like UNSCEAR and the ICRP, as well as academics and researchers worldwide. Very low exposures of radiation (like those experienced by Durham Region residents and DN site employees) result in very low risks to health, indiscernible from the natural variation of disease.

In conclusion, the health studies and reports presented in this section provide a snapshot of the health of people living near the DN site. Based on CNSC staff's assessment of radiation and environmental exposures from the facility and available health data, CNSC staff are not aware of, and do not expect any adverse health outcomes attributable to the operation of the DN site.

6.0 Other environmental monitoring programs

Several monitoring programs are carried out by other levels or bodies of government, and are reviewed by CNSC staff to confirm that the environment and the health and safety of persons around the facility in question are protected. A summary of the findings of these programs is provided below.

6.1 National Pollutant Release Inventory

ECCC operates the NPRI [180], which is Canada's public inventory of pollutant releases, disposals, and transfers, tracking over 320 pollutants from over 7,000 facilities across the country. Reporting facilities include factories that manufacture a variety of goods; mines; oil and gas operations; power plants; and sewage treatment plants. Information that is collected includes:

- releases from facilities to air, water, or land
- disposals at facilities or other locations
- transfers to other locations for treatment and recycling
- facilities' activities, locations, and contacts
- pollution prevention plans and activities

CNSC staff conducted a search of the NPRI database, reviewed the data for the DN site (in other words, the DNGS), and did not notice any trends or unusual results. It is worth noting that radionuclides are not included in the inventory of pollutants in the NPRI database. However, the CNSC receives radionuclide loadings from CNSC licensees through other means, such as annual and quarterly reports. This information has been used in this report, but the complete dataset is available for download on the CNSC's Open Government Portal [181].

6.2 Drinking Water Surveillance Program

The Drinking Water Surveillance Program (DWSP) [182] provides water quality information for selected municipal drinking water systems for scientific and research purposes through the monitoring of analytes, including organic, inorganic and radiological parameters (such as, tritium, gross alpha and gross beta). The water supply plants in the DWSP in closest proximity to the DN site include, Bowmanville WTP, Newcastle WTP, Oshawa WTP, Whitby WTP, Ajax WTP.

The most recent dataset from the DWSP is for 2020. Radioactivity levels were measured for both Lake Ontario intake waters (raw) and water treated at the drinking water plant (treated water). In 2020, the results show that tritium, gross alpha and gross beta radioactivity levels have all been well below their respective drinking water standard or screening levels. The detailed data are available on the Drinking Water Surveillance Program website.

6.3 Ontario Ministry of Labour, Training and Skills Development Ontario Reactor Surveillance Program

The objective of the Ontario Reactor Surveillance Program (ORSP) [183] is to establish, operate and maintain a radiological surveillance network to assess radiological concentrations around designated major nuclear facilities in the province. The ORSP monitors the air, water and food around nuclear power plants for radioactivity. The purpose of the ORSP is to assure the public living and working in the vicinity of nuclear facilities that their health, safety, welfare and property are not affected by emissions from nuclear facilities.

The ORSP's core surveillance focuses on air and drinking water, with the most recently posted dataset from 2020. For the DN site, air is monitored at 8 locations and water is monitored at 5 locations within the Darlington Surveillance Area.

A derived survey criterion was calculated to represent radioactivity levels in specific media (such as water and air) that would result in a dose at or below 0.1 mSv/year, which is an order of magnitude lower than the regulatory public dose limit of 1 mSv. To supplement the core surveillance program associated with air (table 6.1) and drinking water (table 6.2), the ORSP also monitors precipitation, surface water, milk and vegetation.

In 2019, the ORSP concluded that the measured concentrations were well below the derived survey criteria that would result in a dose commitment of 0.1 mSv to the public from either inhalation or ingestion.

Table 6.1: 2020 Ontario Reactor Surveillance Program results for particulates in air (Be-7 and cesium-137) and tritium oxide

Sampling Location	No. of samples	Be-7 (µBq/m^3)	Cs-137 (µBq/m^3)	Tritium oxide (Bq/m^3)
Port Darlington WPCP	8	3,349	<80	0.50
Ajax WTP	11	4,133	<80	N/A
Oshawa WTP	11	4,055	<80	N/A
Courtice WCPC	12	4,344	<80	N/A
Nash Road P.S.	11	4,275	<80	N/A
Harmony Creek WPCP	11	3,966	<80	N/A
Clarington Fire Station #4	11	3,635	<80	N/A
Ken Hooper Fire Hall	11	4141	<80	N/A

Guideline/Reference Levels:

- Tritium: 340 Bq/m^3
- The concentrations of the γ-emitting nuclides (Be-7 and Cs-137) are below the minimum detectable concentration.

Table 6.2: Summary of 2020 Ontario Reactor Surveillance Program sampling of drinking water results

Sampling Location	No. of samples	Gamma emitters			Tritium (Bq/L)
		Co–60 (Bq/L)	Cs–134 (Bq/L)	Cs–137 (Bq/L)	
Ajax WTP	52 (Tritium) 4 (Gamma emitter)	<0.3	<0.3	<0.3	11.8
Bowmanville WTP	52 (Tritium) 4 (Gamma emitter)	<0.3	<0.3	<0.3	11.1
Newcastle WTP	52 (Tritium) 4 (Gamma emitter)	<0.3	<0.3	<0.3	11.0
Oshawa WTP	52 (Tritium) 4 (Gamma emitter)	<0.3	<0.3	<0.3	12.5
Whitby WTP	52 (Tritium) 4 (Gamma emitter)	<0.3	<0.3	<0.3	12.3

Guideline/Reference Levels:

- Cs-137: 10 Bq/L
- Cs-134: 7 Bq/L
- Co-60: 2 Bq/L
- Tritium oxide: 7,000 Bq/L

6.4 Health Canada's Fixed Point Surveillance Program and Canadian Radiological Monitoring

The Canadian Radiological Monitoring Network (CRMN) [184] routinely collects drinking water, precipitation, atmospheric water vapour, air particulate, and external gamma dose for radioactivity analysis at dozens of monitoring locations across the country. The closest CRMN monitoring location to the DN site is in Toronto. The results at the Toronto station for 2022 are consistent with data from previous years and are well below the public dose limit of 1 mSv per year.

The Fixed Point Surveillance (FPS) system [184] functions as a real-time radiation detection system designed to monitor the public dose from radioactive materials in the air, including atmospheric releases associated with nuclear facilities and activities both nationally and internationally. Monitoring stations continuously measure gamma radioactivity levels from ground-deposited (ground-shine) and airborne contaminants.

Health Canada measures the radiation dose rate as Air KERMA (Kinetic Energy Released in Matter). These measurements are conducted every 15 minutes at 79 sites of its FPS network across the country. Air KERMA is also measured for 3 radioactive noble gases associated with nuclear fission which may escape into the atmosphere during the normal operation of nuclear facilities. These 3 noble gases are Argon-41, Xenon-133 and Xenon-135.

The Health Canada website reports the external absorbed dose from all gamma sources (natural and artificial) as well as the external gamma dose from the 3 monitored noble gases as nanoGray per month. The monthly data is provided on the Health Canada website and the results are below the public dose limit of 1mSv per year.

7.0 Engagement with Indigenous Nations and Communities

CNSC staff are committed to working directly with Indigenous Nations and communities and knowledge holders on integrating their knowledge, values, land use information, and perspectives in the CNSC's EPR reports, where appropriate and when shared with the CNSC.

In response to feedback and comments raised previously by Hiawatha First Nation, Curve Lake First Nation and the Mississaugas of Scugog Island First Nation - the most actively engaged rights bearing Williams Treaties First Nations in relation to the Darlington site — regarding the CNSC's EPR reports, CNSC staff made efforts to engage these three First Nations with regards to this EPR Report prior to it being published. In December 2023, CNSC met individually with Hiawatha First Nation, Curve Lake First Nation and the Mississaugas of Scugog Island First Nation to discuss the EPR report. These meetings included a presentation by CNSC staff on the purpose of EPRs, the anticipated timeline as well as an open discussion on the First Nation's key interests and opportunities to review the report and provide input. CNSC staff noted that this was in an effort to beginning addressing concerns raised with the EPR reports, including the need to consider and reflect their Aboriginal and treaty Rights, views, knowledge, and perspectives in the reports.

On September 4, 2024, CNSC staff shared the Darlington Nuclear Site EPR with Hiawatha First Nation, Curve Lake First Nation and the Mississaugas of Scugog Island First Nation to review and provide feedback on the report, acknowledging that the incorporation of the feedback received from the First Nations will be an ongoing process. CNSC staff noted that they will work to address and incorporate feedback in this version of the report and that if CNSC staff are unable to address all the feedback in this version of the report, CNSC staff are committed to working with the First Nations to address their feedback in future iterations of the report.

CNSC received feedback from Mississaugas of Scugog Island First Nation and Curve Lake First Nation. CNSC staff have incorporated some of the comments into the report and will continue to work to incorporate comments into future iterations of the report. CNSC staff are also working to provide responses directly to Curve Lake First Nation and Mississaugas of Scugog Island First Nation to some of the questions and comments received. CNSC staff also worked with Curve Lake First Nation and Mississaugas of Scugog Island First Nation to include the views expressed sections in the Darlington NGS Licence Renewal Commission Member Document (CMD 25-H2) to provide additional context and information regarding some of their broader concerns, views and perspectives.

CNSC staff are committed to working directly with Indigenous Nations and communities and knowledge holders on integrating their knowledge, Aboriginal and treaty Rights, values, land use information, and perspectives in the CNSC's EPR reports, where appropriate and when shared with the CNSC.

7.1 Views expressed by Curve Lake First Nation on the EPR

The following views, perspectives and information about CLFN's key issues were provided by CLFN as part of their October 11, 2024 submission of comments on the Darlington Site EPR Report.

On behalf of Curve Lake First Nation (CLFN), we would like to commend the Canadian Nuclear Safety Commission (CNSC) for ensuring that First Nations who hold Aboriginal *and treaty Rights, are offered an opportunity to review the Environmental Protection Review Report (EPRR). CLFN was not able to exhaustively review and provide input to the EPRR in this instance but are supportive of the current attempt of inclusion in the review cycle. CLFN appreciates that CNSC staff will do their best to incorporate feedback in this iteration of the draft EPR report and if unable to address them in this iteration, that CNSC staff will collaborate with CLFN to address them in future iterations of this report. Reciprocally, CLFN will continue to make best efforts to review, understand, and share in future iterations of this report. Many small steps taken together will eventually lead to habits and systemic changes together.*

CLFN has had the opportunity to contribute inputs on various hearings, public meetings and regulatory documents, thanks to the CNSC Participant Funding Program (PFP). We acknowledge the CNSC's staff commitment to reviewing these comments with CLFN and compiling key issues to work on at a programmatic level with the CNSC. We recognize that our relationship with the CNSC staff is good and implementing systemic changes is a long and patient journey. We preface this in our subsequent comments, as we aim to highlight key issues, some of which may be beyond this single document. We look forward to working on these topics with the CNSC staff into 2025 and beyond.

Within the EPRR, CNSC states that:

"The purpose of this EPR is to report the outcome of CNSC staff's assessment of the Ontario Power Generation Inc. (OPG)'s EP measures and CNSC staff's health science and environmental compliance activities for the Darlington Nuclear Site (DN site) – operations at both the Darlington Nuclear Generating Station (DNGS) and the Darlington Waste Management Facility (DWMF). This review serves to assess whether OPG's EP measures at the DN site meet regulatory requirements and adequately protects the environment and health and safety of persons."

We wish to identify an opportunity to expand the scope and purpose of this review and utilize such processes to underscore the value and importance of Indigenous Rights, values and culture, and the role of the Crown, and by extension CNSC to understand and limit potential impacts on the Nation's Aboriginal and Treaty Rights. An understanding of the ongoing impact to Aboriginal and Treaty Rights through such a review could help to inform ongoing discussions between the Nation and CNSC, about appropriate measures, mitigations and accommodations.

It is critical that the CNSC mandate, as a Crown Responsibility, be updated to respect the adaption of the United Nations Declaration on the Rights of Indigenous Peoples Act 2021, the subsequent the 2023-2028 Action Plan, and respect Free, Prior, and Informed Consent (FPIC) principles. This would include, but not limited to, the Duty to Consult and Accommodate and the Honour of the Crown inform the policies, processes and culture of the CNSC. This ensures that relevant First Nations are characterized as having Rights, rather than interests in policies and reports such as the EPRR.

Some consideration for implementations of the Act 2021:

- ***Free, Prior, and Informed Consent (FPIC):*** *Before granting licence to any projects, ensure the FPIC of the WTFNs' is obtained, not just as a consultation but* *as a process to gain meaningful consent or at minimum, ensure proper accommodations will be met.*

- ***Indigenous Governance and Self-Determination:*** *Respect the governance systems and decision- making processes of Anishinaabe peoples when planning and conducting environmental assessments.*
- ***Cultural and Environmental Preservation:*** *Ensure that environmental and cultural heritage protection frameworks and policies respect the WTFNs' connections and Rights to the land.*

We note that the EPRR has been constructed through the lens of Western science and epistemology, which values certain characteristics and types of evidence. The language throughout this report implies a knowledge hegemony. We wish to note that there are other knowledge systems, values and lenses, including our own, which could be reflected. We appreciate that there is much work to be done in the area of working with Indigenous Knowledge Systems, and so as a first step, we would encourage the CNSC to acknowledge that its reports are developed using western-science approaches and values, and that there are other ways of knowing. We acknowledge the CNSC's staff commitment in the area of Indigenous Knowledge Studies with the Wiliams Treaties First Nations (WTFN) communities and the related funding available for these studies. We hope upon completion of these studies that future documents, like this one, can be more holistic in its knowledge systems and representation.

The EPRR focused largely on releases of radiological material into the environment, however, we wish to highlight the importance of documenting, analyzing and understanding the overall impact of ongoing operations which results in impacts to Indigenous health and well-being. It is important to note that activities that impact the natural environment and human health, such as nuclear activities, have a disproportionate impact on Indigenous Peoples, their health and well-being. Well-being is not limited to physical radiological doses to a human receptor, but also those impacts to the emotional, spiritual and cultural aspects of well-being which are impacted by ongoing nuclear activities. We would encourage the CNSC to incorporate this reality into its analysis, especially when considering the impacts to vulnerable sectors, or understanding human-health impacts. As a first step in this direction, we are proud to say that the CNSC has taken samples of our traditional food manoomin (wild rice), as part of their Independent Environmental Monitoring Program, and we hope that this is a catalyst into a more inclusive look at the environmental impacts of nuclear operations in our Territory.

Throughout the EPRR, CNSC cites data as part of its analysis and understanding. We wish to note that this data ranges in terms of age, anywhere from a decade to a few years before the publication of this report. CLFN wishes to raise concern over the use of old data to make conclusions about the circumstances of the activities at Darlington. Additionally, while we appreciate that it was noted within the report that activities related to the Darlington New Nuclear Plant are not considered, it is our view that this represents a large gap in properly ground truthing the findings of this study. The activities at DNNP, Pickering Nuclear Generating Station, and the many other nuclear facilities within our Territory have a cumulative impact on the environment, which is not captured within this report.

We are encouraged by the understanding demonstrated by the CNSC of the relevance of the difference between Nations and communities and commend the CNSC for their efforts to continue to learn about these important nuances.

It is the submission of Curve Lake First Nation that there remain opportunities to clarify, center and prioritize Indigenous Peoples, their Rights, values and culture, Crown-Indigenous Relations and the Duty to Consult within the document.

7.2 Views expressed by the Mississaugas of Scugog Island First Nation on the EPR

The Mississaugas of Scugog Island First Nation (MSIFN) has expressed concerns that free, prior, and informed consent of MSIFN was not sought for the construction of the Darlington Used Fuel Dry Storage Facility, Darlington New Nuclear Project, and Refurbishment and Continued Operation. MSIFN requests the report indicate that OPG and the CNSC did not seek MSIFN's informed consent on these activities.

MSIFN emphasized that the report does not provide evidence of collaboration with treaty rights holding First Nations, specifically regarding the selection of VECs. MSIFN requests that the CNSC provide evidence that the VECs used by the CNSC have been selected in collaboration with treaty rights holding First Nations.

MSIFN is concerned that processes used by CNSC and licensees, such as to characterize risk or establish control, have not been developed to protect MSIFN's Treaty Rights. One example pointed to are the requirements set out in CSA N288.6-12, and REGDOC 2.9.1 which MSIFN views does not serve as the basis for the development of site-specific measures that would protect MSIFN's Treaty Rights. MSIFN commented that there is a lack of consideration for methods that go beyond assessing single averages for radionuclides and hazardous chemicals or long-term analysis on aquatic organisms, particularly those harvested by WTFN members. MSIFN is of the view that the results presented in the EPR do not add to the body of evidence that MSIFN's Aboriginal and Treaty Rights are protected in the vicinity of the DN site.

MSIFN has also raised questions on whether referenced studies were Indigenous-led or produced and requested that the EPR indicate as such.

7.3 CNSC response to views expressed by MSIFN and CLFN

CNSC staff greatly appreciate receiving feedback from MSIFN and CLFN on this EPR Report and take the concerns, views and perspective shared seriously. CNSC staff are currently working with CLFN, MSIFN and other Williams Treaties First Nations through:

- Issues and concerns tracking and responses
- Terms of Reference and long-term engagement work plans
- Collaboration on monitoring activities including the IEMP
- Support for the gathering of Indigenous Knowledge
- Support for conducting cumulative effects studies

- Support for community led monitoring initiatives
- Collaborative oversight of OPG commitments and engagement activities with the Nations

CNSC staff look forward to continuing to work with MSIFN, CLFN and other WTFNs on enhancing the way our environmental monitoring, reporting and oversight reflects their knowledge, rights and interests as that information is shared with the CNSC by the First Nations.

8.0 Findings

This EPR report focused on items of current Indigenous, public and regulatory interest, including physical stressors, and airborne and waterborne releases from ongoing operations at the DN site. CNSC staff have found that the potential risks from physical stressors, as well as from nuclear and hazardous releases to the atmospheric, terrestrial, aquatic and human environments from the DN site, are low to negligible, and that people and the environment remain protected.

8.1 Canadian Nuclear Safety Commission staff's follow-up

The following list summarizes CNSC staff's recommendations regarding the EP measures implemented by OPG for the DN Site. CNSC staff will follow-up on these recommendations during the review of future submissions of EP documents. The following do not change CNSC staff's findings and are included for transparency with Indigenous Nations and communities and the public. CNSC staff expect that OPG will:

- complete air monitoring to reduce uncertainties with respect to NO_x concentrations in air;
- complete an evaluation of soil concentrations to inform soil management for localized areas with soil contamination

8.2 Canadian Nuclear Safety Commission staff's findings

CNSC staff's findings from this EPR report may inform and support staff recommendations to the Commission in future licensing and regulatory decision making that pertains to the DN site. These findings are based on CNSC staff's technical assessments associated with OPG's DN site, such as the submitted ERA documentation and the conduct of compliance verification activities, including the review of annual and quarterly reports and onsite inspections. CNSC staff also reviewed the results from various relevant or comparable health studies, and other EMPs conducted by other levels of government, to substantiate CNSC staff's findings. CNSC staff conducted IEMP sampling around the DN site in 2014, 2015, 2017, 2021 and 2023.

CNSC staff have found that the potential risks from climate change parameters, physical stressors, as well as from radiological and hazardous releases to the atmospheric, aquatic, terrestrial and human environments from the DN site, are low to negligible. The potential risks to the environment from these releases or stressors are similar to natural background, and the potential risks to humans health are indistinguishable from health outcomes in the general public. Therefore, CNSC staff have found that OPG has and will continue to implement and maintain effective EP measures to adequately protect the environment and the health and safety of persons. CNSC staff will continue to verify and ensure that, through ongoing licensing and compliance activities and reviews, the environment and the health and safety of persons around the DN site are protected.

9.0 Abbreviations

Units

Bq	becquerel
Bq/L	becquerels per litre
ha	hectares
hr	hours
kg	kilograms
km	kilometres
m	metres
MeV	Mega electron-volt
mGy	milligray
mGy/d	milligray per day
µGy/h	microgray per hour
mm	millimetre
m/s	metres per second
mSv	millisievert
µg	microgram
µSv	microsievert
ΔT	change in temperature

Acronyms

AAQC	ambient air quality criteria
AL	action level
ALARA	as low as reasonably achievable
ALW	active liquid waste
BAF	bioaccumulation factors
BTEX	benzene, toluene, ethylbenzene and xylenes
C-14	carbon-14
CANDU	CANada Deuterium Uranium
CCME	Canadian Council of Ministers of the Environment
CCW	condenser cooling water

CEAA 1992	*Canadian Environmental Assessment Act, 1992*
CEAA 2012	*Canadian Environmental Assessment Act, 2012*
CEPA 1999	*Canadian Environmental Protection Act, 1999*
CLFN	Curve Lake First Nation
CNSC	Canadian Nuclear Safety Commission
COG	CANDU Owners Group
COPC	contaminant of potential concern
Co-60	cobalt-60
COPD	chronic obstructive pulmonary disease
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CRMN	Canadian Radiological Monitoring Network
CSQG	Canadian Sediment Quality Guidelines
DFO	Fisheries and Oceans Canada
DN	Darlington
DN site	Darlington Site
DNGS	Darlington Nuclear Generating Station
DNNP	Darlington New Nuclear Project
DRHD	Durham Region Health Department
DRL	derived releases limit
DSC	dry storage container
DWMF	Darlington Waste Management Facility
DWSP	Drinking Water Surveillance Program
EA	environmental assessment
ECA	environmental compliance approval
ECCC	Environment and Climate Change Canada
EcoRA	ecological risk assessment
EMP	Environmental monitoring program
EMS	Environmental management system
EP	environmental protection
EPC	exposure point concentrations
EPG	emergency power generator
EPP	environmental protection program
EPR	environmental protection review

EPS	emergency power service
ERA	environmental risk assessment
ESA	*Endangered Species Act*
ESDM	Emission Summary and Dispersion Modelling
FAA	*Fisheries Act* authorization
FEQG	Federal Environmental Quality Guideline
FPS	fixed point surveillance
FUMP	follow-up monitoring program
GHG	greenhouse gas
GWMP	groundwater monitoring program
GWPP	groundwater protection program
HEPA	High Efficiency Particulate Air
HFN	Hiawatha First Nation
HHRA	human health risk assessment
HQ	hazard quotient
HT	elemental tritium
HTO	tritiated water
HWMB	heavy water management building
I-131	iodine-131
IAA	*Impact Assessment Act of Canada*
ICRP	International Commission on Radiological Protection
IEMP	Independent Environmental Monitoring Program
IIP	Integrated Implementation Plan
ILCR	incremental lifetime cancer risk
INWORKS	International Nuclear Worker Study
IWST	injection water storage tank
KERMA	Kinetic Energy Release in Matter
LCH	licence conditions handbook
LHIN	Local Health Integration Network
MECP	Ontario Ministry of the Environment, Conservation and Parks
MISA	Municipal Industrial Strategy for Abatement
MNRF	Ministry of Natural Resources and Forestry
MOU	memorandum of understanding

MSIFN	Mississaugas of Scugog Island First Nation
MWAT	maximum weekly average temperature
NO_x	nitrogen oxides
NPRI	National Pollutant Release Inventory
NSCA	*Nuclear Safety and Control Act*
OPG	Ontario Power Generation Inc
ORSP	Ontario Reactor Surveillance Program
PAH	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyl
PDP	preliminary decommissioning plan
PHC	petroleum hydrocarbon
PHU	public health unit
PMF	probably maximum flood
PMP	probable maximum precipitation
PN	Pickering
POI	point of impingement
POR	points of reception
PSA	Probabilistic Safety Assessment
PSR	periodic safety review
PWQO	Provincial Water Quality Objective
RADICON	Radiation Exposure and Cancer Incidence Around Nuclear Power Plants
RLW	radioactive liquid waste
RWSB	Retube Waste Storage Building
SAP	sampling and analysis plan
SARA	*Species at Risk Act*
SARO	species at risk in Ontario
SENES	Specialist in Energy Nuclear Environmental Services
SO_2	sulphur dioxide
TKN	total Kjeldahl nitrogen
TOC	total organic carbon
TRC	total residual carbon
TRF	Tritium Removal Facility
TSS	total suspended solids

UCLM	upper confidence limit of the mean
UFDSF	used fuel dry storage facility
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation
VC	valued component
VEC	valued ecosystem component
VOC	volatile organic compound
WTP	water treatment plant
WWMF	Western Waste Management Facility

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11.0 Appendix A – Summary Pamphlet

Canadian Nuclear Safety Commission Commission canadienne de sûreté nucléaire

Canada

Environmental Protection Review

The following is a summary of the Environmental Protection Review (EPR) for the Darlington Nuclear Site (DN Site) located in the Municipality of Clarington, Ontario. Ontario Power Generation (OPG) operates the DN Site, which includes the Darlington Nuclear Generating Station (DNGS), the Darlington Waste Management Facility (DWMF), the proposed Darlington New Nuclear Project (DNNP) and the Tritium Removal Facility. This EPR focuses on DNGS and DWMF. EPRs are an evidence-based technical assessment conducted by the Canadian Nuclear Safety Commission (CNSC) staff, as required by the *Nuclear Safety and Control Act*.

Darlington Nuclear Site

The DN Site is located within the lands and waters of the Michi Saagiig Anishinaabeg, the Gunshot Treaty (1787-88), the Williams Treaties (1923), and the Williams Treaties First Nations Settlement Agreement (2018).

Key Findings

Airborne Emissions | Waterborne Effluent | IEMP | Health Studies

CNSC staff found that OPG has effective environmental protection measures which adequately protect the environment and the health and safety of persons.

Scan to access the full report or find it at **nuclearsafety.gc.ca**

Indigenous Knowledge

The CNSC recognizes the importance of considering and including Indigenous Knowledge in all aspects of the CNSC's regulatory processes.

To find out more, visit the CNSC's Indigenous Knowledge Policy Framework

Effects to the Environment

CNSC staff reviewed OPG's assessment of current and predicted effects of licensed activities on the environment and health of persons in the 2020 environmental risk assessment for the facility.

Atmospheric Environment

OPG routinely conducts ambient air quality monitoring to assess radiological emissions to air from DN Site operations including noble gases, iodine-131, tritium and carbon-14. CNSC staff found that ambient air quality around the facility remains at levels protective of human health and the environment.

Terrestrial Environment

OPG has a routine terrestrial monitoring program including soil, sand and vegetation monitoring at the DNGS. CNSC staff found that the concentrations of contaminants in soil, sand and vegetation surrounding the DNGS are acceptable. Localized soil contamination was identified, but risk to people and the environment is considered low. OPG has commissioned a soil characterization study which will inform the next steps in managing the soil from these areas.

Human Environment

OPG assessed the risk to a hypothetical person that could represent someone living near the DN Site to determine if there is an impact to human health through breathing the air, drinking and swimming in the water, and eating plants, fish, and wildlife from the area.

The estimated annual radiological doses for the 2016 to 2020 period have remained below the regulatory annual dose limit for the public. CNSC staff have found that impacts to humans from radiological and hazardous substances released from the DNGS are negligible, and that people in and around the facility remain protected.

For questions, contact: ea-ee@cnsc-ccsn.gc.ca

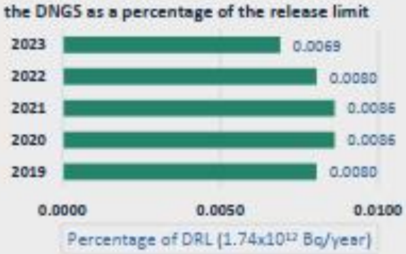
Releases to the Environment

Hazardous and radiological substances have the potential to cause negative impacts to both humans and the environment. Derived release limits (DRLs) are established to ensure releases remain at levels protective of the environment and human health.

Airborne Emissions

From 2019 to 2023, all airborne releases from the DNGS remained well below the DRLs. As an example, Iodine-131 is displayed below. CNSC staff have found that OPG continues to provide adequate protection of people and the environment from airborne emissions.

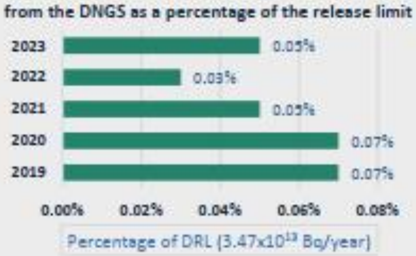
Annual airborne emissions of tritium oxide from the DNGS as a percentage of the release limit



Waterborne Effluent

From 2019 to 2023, all waterborne releases of from the DNGS remained below the DRLs. As an example, gross beta/gamma can be seen below. CNSC staff have found that OPG's treatment of effluent is providing appropriate protection to people and the environment.

Annual waterborne effluent of gross beta/gamma from the DNGS as a percentage of the release limit



The exposure pathway

This figure illustrates a conceptual model of the environment around a generic nuclear processing facility site to show the relationship between releases (airborne emissions or waterborne effluent) and human and ecological receptors or exposure pathways.

Health Studies

The CNSC conducts and reviews health studies as an important component of ensuring that the health of people living near or working at DNGS is protected.

CNSC staff review:

- ✓ Regional community health studies and reports
- ✓ Canadian and international scientific publications
- ✓ Population and worker epidemiological studies

CNSC staff have not observed and do not expect to observe any adverse health outcomes connected to the DNGS.

CNSC Independent Environmental Monitoring Program (IEMP)

The IEMP is carried out by CNSC staff in publicly accessible areas and consists of taking samples from the environment and analyzing them for harmful substances released from facilities in all areas of the nuclear fuel cycle.

The IEMP results for 2014, 2015, 2017, 2021 and 2023 confirm that the public and the environment surrounding the DNGS **remain protected.**

Results are consistent with the results submitted by OPG.

Scan to view IEMP results or find them at nuclearsafety.gc.ca

Current Licence

The current licence is provided on the following pages of this document.

Word Ref.: e-Doc 7460942
PDF Ref.: e-Doc 7460944
File / Dossier: 2.01

NUCLEAR POWER REACTOR OPERATING LICENCE

DARLINGTON NUCLEAR GENERATING STATION

I) LICENCE NUMBER: **PROL 13.05/2025**

II) LICENSEE: Pursuant to section 24 of the *Nuclear Safety and Control Act* this licence is issued to:

Ontario Power Generation Inc
700 University Avenue
Toronto, Ontario
M5G 1X6

III) LICENCE PERIOD: This licence is valid from January 1, 2016 to November 30, 2025, unless suspended, amended, revoked or replaced.

IV) LICENSED ACTIVITIES:

This licence authorizes the licensee to:

(i) operate the Darlington Nuclear Generating Station, including equipment for the production of radionuclides identified in (vi) and the Darlington Tritium Removal Facility housed within the Heavy Water Management Building (hereinafter "the nuclear facility"), at a site located in the Municipality of Clarington, in the Regional Municipality of Durham, in the Province of Ontario; [Amended 2024.06]

(ii) possess, transfer, use, package, manage and store the nuclear substances that are required for, associated with, or arise from the activities described in (i);

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

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

(v) possess, transfer, process, package, manage and store the nuclear substances associated with the operation of the Darlington Tritium Removal Facility;

(vi) produce, possess, transfer, use, package, manage and store nuclear substances that are required for, associated with, or arise from the activities associated with operations of the Darlington Nuclear Generating station and activities described in (i) associated with production of: (1) Co-60; and (2) Mo-99 (including its decay radionuclides); [Amended 2024.06]

V) EXPLANATORY NOTES:

(i) Nothing in this licence shall be construed to authorize non-compliance with any other applicable legal obligation or restriction.

(ii) Unless otherwise provided for in this licence, words and expressions used in this licence have the same meaning as in the *Nuclear Safety and Control Act* and associated Regulations.

(iii) The Darlington NGS Licence Conditions Handbook (LCH) provides compliance verification criteria including the Canadian standards and regulatory documents used to verify compliance with the conditions in the licence. The LCH also provides information regarding delegation of authority, applicable versions of documents and non-mandatory recommendations and guidance on how to achieve compliance.

VI) CONDITIONS:

G. **General**

G.1 The licensee shall conduct the activities described in Part IV of this licence in accordance with the licensing basis, defined as:

(i) the regulatory requirements set out in the applicable laws and regulations
(ii) the conditions and safety and control measures described in the facility's or activity's licence and the documents directly referenced in that licence
(iii) the safety and control measures described in the licence application and the documents needed to support that licence application;

unless otherwise approved in writing by the Canadian Nuclear Safety Commission (CNSC, hereinafter "the Commission").

G.2 The licensee shall give written notification of changes to the facility or its operation, including deviation from design, operating conditions, policies, programs and methods referred to in the licensing basis.

G.3 The licensee shall control the use and occupation of any land within the exclusion zone.

G.4 The licensee shall provide, at the nuclear facility and at no expense to the Commission, suitable office space for employees of the Commission who customarily carry out their functions on the premises of that nuclear facility (onsite Commission staff).

G.5 The licensee shall maintain a financial guarantee for decommissioning that is acceptable to the Commission.

G.6 The licensee shall implement and maintain a public information and disclosure program.

1. Management System

1.1 The licensee shall implement and maintain a management system.

2. Human Performance Management

2.1 The licensee shall implement and maintain a human performance program.

2.2 The licensee shall implement and maintain the minimum shift complement and control room staffing for the nuclear facility.

2.3 The licensee shall implement and maintain training programs for workers. The certification process and supporting examinations and tests shall be conducted in accordance with CNSC regulatory document REGDOC-2.2.3, PERSONNEL CERTIFICATION, VOLUME III: CERTIFICATION OF REACTOR FACILITY WORKERS, VERSION 2. Workers who began an applicable initial training program in accordance with the requirements outlined in REGDOC-2.2.3, *Personnel Certification, Volume III: Certification of Persons Working at Nuclear Power Plants*, before [Amended 2025.02]

January 31, 2025, may continue to be certified under requirements of this version until January 31, 2030.

Persons appointed to the following positions require certification:

(i) Responsible Health Physicist;
(ii) Shift Manager;
(iii) Control Room Shift Supervisor;
(iv) Authorized Nuclear Operator; and
(v) Unit 0 Control Room Operator.

3. Operating Performance

3.1 The licensee shall implement and maintain an operations program, which includes a set of operating limits.

3.2 The licensee shall not restart a reactor after a serious process failure without the prior written approval of the Commission, or prior written consent of a person authorized by the Commission.

3.3 The licensee shall notify and report in accordance with CNSC regulatory document REGDOC-3.1.1 Reporting Requirements: Nuclear Power Plants.

3.4 The licensee shall implement a periodic safety review in support of its subsequent power reactor operating licence application.

4. Safety Analysis

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

5. Physical Design

5.1 The licensee shall implement and maintain a design program.

5.2 The licensee shall implement and maintain a pressure boundary program and have in place a formal agreement with an Authorized Inspection Agency.

5.3 The licensee shall implement and maintain an equipment and structure qualification program.

6. Fitness for Service

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

7. Radiation Protection

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

8. Conventional Health and Safety

8.1 The licensee shall implement and maintain a conventional health and safety program.

9. Environmental Protection

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

10. Emergency Management and Fire Protection

10.1 The licensee shall implement and maintain an emergency preparedness program.

10.2 The licensee shall implement and maintain a fire protection program.

11. Waste Management

11.1 The licensee shall implement and maintain a waste management program.

11.2 The licensee shall implement and maintain a decommissioning strategy.

12. Security

12.1 The licensee shall implement and maintain a security program.

13. Safeguards and Non-Proliferation

13.1 The licensee shall implement and maintain a safeguards program.

14. Packaging and Transport

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

15. Nuclear Facility-Specific

15.1 The licensee shall implement and maintain an operations program for the Tritium Removal Facility, which includes a set of operating limits.

15.2 The licensee shall implement a return to service plan for refurbishment.

15.3 The licensee shall implement the Integrated Implementation Plan.

15.4 The licensee shall obtain the approval of the Commission, or consent of a person authorized by the Commission, prior to the removal of established regulatory hold points.

15.5 The licensee shall limit the activities of import and export of nuclear substances to those occurring as contaminants in laundry, packaging, shielding or equipment. [Added 2017.10]

15.6 The licensee shall implement and maintain an operations program for the production of Molybdenum-99 and its associated decay isotopes. The licensee shall obtain the approval of the Commission, or consent of a person authorized by the Commission, prior to the removal of established regulatory hold points. [Added 2021.10]

15.7 The licensee shall implement and maintain a Co-60 operations program for the activities described in part IV of the licence. [Added 2024.06]

February 7, 2025
Date

Pierre Tremblay, President

On behalf of the Canadian Nuclear Safety Commission

Proposed Licence Changes

Overview

As detailed in the table below, the changes proposed for the licence are mainly administrative in nature, providing standardized text that can be used for future operating licenses of nuclear power plants. The addition of a licence condition regarding ongoing indigenous engagement, would ensure Indigenous concerns are heard regarding the means to ensure OPG’s engagement throughout the licence period. This would ensure the programs implementation throughout the duration of the licence period, which will include the normal suite of regulatory oversight (including reporting on performance) against this licence condition.

Licence Conditions

PROPOSED LICENCE CHANGES		
Current Text	**Proposed Text**	**Rationale for Change**
G.2 The licensee shall give written notification of changes to the facility or its operation, including deviation from design, operating conditions, policies, programs and methods referred to in the licensing basis.	G.2 The licensee shall give notification of changes to the facility's safety and control measures that impact the licensing basis.	The proposed change better aligns with the definition of the licensing basis.
No text currently	G.7 The licensee shall implement and maintain an Indigenous engagement program.	Added to address Indigenous concerns regarding the means to ensure OPG’s engagement throughout the licence period.
2.2 The licensee shall implement and maintain the minimum shift complement and control room staffing for the nuclear facility.	2.2 The licensee shall implement and maintain a minimum shift complement and control room staffing.	No value added to “for the nuclear facility”.
2.3 The licensee shall implement and maintain training programs for workers. The certification process and supporting examinations and tests shall be conducted in accordance with CNSC regulatory	2.3 The licensee shall implement and maintain training programs for workers.	Broken up into two sections.

document REGDOC-2.2.3, PERSONNEL CERTIFICATION, VOLUME III: CERTIFICATION OF PERSONS WORKING AT NUCLEAR POWER PLANTS. Persons appointed to the following positions require certification: (i) Responsible Health Physicist; (ii) Shift Manager; (iii) Control Room Shift Supervisor; (iv) Authorized Nuclear Operator; and (v) Unit 0 Control Room Operator.		
No text currently	2.4 The licensee shall implement and maintain certification programs in accordance with CNSC regulatory document REGDOC-2.2.3, PERSONNEL CERTIFICATION, VOLUME III: CERTIFICATION OF REACTOR FACILITY WORKERS, VERSION 2. Workers who began an applicable initial training program in accordance with the requirements outlined in REGDOC-2.2.3, Personnel Certification, Volume III: Certification of Persons Working at Nuclear Power Plants, before January 31, 2025, may continue to be certified under requirements	Changed due to change in title of REGDOC. New second sentence added for the next 5 years for workers currently in the certification stream under the older version of the REGDOC.

	of this version until January 31, 2030. Persons appointed to the following positions require certification: (i) responsible health physicist; (ii) authorized nuclear operator; (iii) control room shift supervisor; (iv) Unit 0 control room operator; and (v) shift manager	
3.5 The licensee shall implement a periodic safety review in support of its subsequent power reactor operating licence application.	3.5 The licensee shall conduct, and submit results of, a periodic safety review at least every 10 years.	Such a LC is required by Class I Nuclear Facilities Regulations, according to clause 8.01 (1): "Every licensee who is licensed to operate a nuclear power plant must conduct a periodic safety review of the nuclear power plant at an interval specified in the licence." This term therefore needs to be defined.
11.2 The licensee shall implement and maintain a decommissioning strategy.	11.2 The licensee shall implement and maintain a decommissioning plan.	Wording updated to align with that in the standard.
14.1 The licensee shall implement and maintain a packaging and transport program.	14.1 The licensee shall implement and maintain a packaging and transport of nuclear substances program	Reflects the title of the regulation.

Licence Format

No change

Licence Period

Section 2.8 of this CMD contains a detailed rationale for CNSC staff's support of a 30-year licence period.

Proposed Licence

The proposed licence is provided on the following pages of the document.

Word Ref.: e-Doc 7434481
PDF Ref.: e-Doc XXXXXXX
File / Dossier: 2.01

NUCLEAR POWER REACTOR OPERATING LICENCE

DARLINGTON NUCLEAR GENERATING STATION

I) LICENCE NUMBER: **PROL 13.00/2055**

II) LICENSEE: Pursuant to section 24 of the *Nuclear Safety and Control Act* this licence is issued to:

Ontario Power Generation Inc
700 University Avenue
Toronto, Ontario
M5G 1X6

III) LICENCE PERIOD: This licence is valid from December 1, 2025 to November 30, 2055, unless suspended, amended, revoked or replaced.

IV) LICENSED ACTIVITIES:

This licence authorizes the licensee to:

(i) operate the Darlington Nuclear Generating Station, including equipment for the production of radionuclides identified in (vi) and the Darlington Tritium Removal Facility housed within the Heavy Water Management Building (hereinafter “the nuclear facility”), at a site located in the Municipality of Clarington, in the Regional Municipality of Durham, in the Province of Ontario;

(ii) possess, transfer, use, package, manage and store the nuclear substances that are required for, associated with, or arise from the activities described in (i);

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

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

(v) possess, transfer, process, package, manage and store the nuclear substances associated with the operation of the Darlington Tritium Removal Facility;

(vi) produce, possess, transfer, use, package, manage and store nuclear substances that are required for, associated with, or arise from the activities associated with operations of the Darlington Nuclear Generating station and activities described in (i) associated with production of:
(1) Co-60; and
(2) Mo-99
Including the associated decay radionuclides.

V) EXPLANATORY NOTES:

(i) Nothing in this licence shall be construed to authorize non-compliance with any other applicable legal obligation or restriction.

(ii) Unless otherwise provided for in this licence, words and expressions used in this licence have the same meaning as in the *Nuclear Safety and Control Act* and associated Regulations.

(iii) The Darlington NGS Licence Conditions Handbook (LCH) provides compliance verification criteria including the Canadian standards and regulatory documents used to verify compliance with the conditions in the licence. The LCH also provides information regarding delegation of authority, applicable versions of documents and non-mandatory recommendations and guidance on how to achieve compliance.

VI) CONDITIONS:

G. General

G.1 The licensee shall conduct the activities described in Part IV of this licence in accordance with the licensing basis, defined as:

(i) the regulatory requirements set out in the applicable laws and regulations
(ii) the conditions and safety and control measures described in the facility's or activity's licence and the documents directly referenced in that licence
(iii) the safety and control measures described in the licence application and the documents needed to support that licence application;

unless otherwise approved in writing by the Canadian Nuclear Safety Commission (CNSC, hereinafter "the Commission").

G.2 The licensee shall give notification of changes to the facility's safety and control measures that impact the licensing basis.

G.3 The licensee shall control the use and occupation of any land within the exclusion zone.

G.4 The licensee shall provide, at the nuclear facility and at no expense to the Commission, suitable office space for employees of the Commission who customarily carry out their functions on the premises of that nuclear facility (onsite Commission staff).

G.5 The licensee shall maintain a financial guarantee for decommissioning that is acceptable to the Commission.

G.6 The licensee shall implement and maintain a public information and disclosure program.

G.7 The licensee shall implement and maintain an Indigenous engagement program.

1. Management System

1.1 The licensee shall implement and maintain a management system.

2. Human Performance Management

2.1 The licensee shall implement and maintain a human performance program.

2.2 The licensee shall implement and maintain the minimum shift complement and control room staffing.

2.3 The licensee shall implement and maintain training programs for workers.

2.4 The licensee shall implement and maintain certification programs in accordance with CNSC regulatory document REGDOC-2.2.3, Personnel Certification, Volume III: Certification of Reactor Facility Workers, Version 2.

Workers who began an applicable initial training program in accordance with the requirements outlined in REGDOC-2.2.3, Personnel Certification, Volume III: Certification of Persons Working at Nuclear Power Plants, before January 31, 2025, may continue to be certified under requirements of this version until January 31, 2030.

Persons appointed to the following positions require certification:

(i) Responsible Health Physicist;
(ii) Shift Manager;
(iii) Control Room Shift Supervisor;
(iv) Authorized Nuclear Operator; and
(v) Unit 0 Control Room Operator.

3. Operating Performance

3.1 The licensee shall implement and maintain an operations program, which includes a set of operating limits.

3.2 The licensee shall not restart a reactor after a serious process failure without the prior written approval of the Commission, or prior written consent of a person authorized by the Commission.

3.3 The licensee shall notify and report in accordance with CNSC regulatory document REGDOC-3.1.1 REPORTING REQUIREMENTS: NUCLEAR POWER PLANTS.

3.4 The licensee shall conduct and submit, results of a periodic safety review at least every 10 years.

4. Safety Analysis

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

5. Physical Design

5.1 The licensee shall implement and maintain a design program.

5.2 The licensee shall implement and maintain a pressure boundary program and have in place a formal agreement with an Authorized Inspection Agency.

5.3 The licensee shall implement and maintain an equipment and structure qualification program.

6. Fitness for Service

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

7. Radiation Protection

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

8. Conventional Health and Safety

8.1 The licensee shall implement and maintain a conventional health and safety program.

9. Environmental Protection

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

10. Emergency Management and Fire Protection

10.1 The licensee shall implement and maintain an emergency preparedness program.

10.2 The licensee shall implement and maintain a fire protection program.

11. Waste Management

11.1 The licensee shall implement and maintain a waste management program.

11.2 The licensee shall implement and maintain a decommissioning plan.

12. Security

12.1 The licensee shall implement and maintain a security program.

13. Safeguards and Non-Proliferation

13.1 The licensee shall implement and maintain a safeguards program.

14. Packaging and Transport

14.1 The licensee shall implement and maintain a packaging and transport of nuclear substances program.

15. Nuclear Facility-Specific

15.1 The licensee shall implement and maintain an operations program for the Tritium Removal Facility, which includes a set of operating limits.

15.2 The licensee shall implement a return to service plan for refurbishment.

15.3 The licensee shall implement the Integrated Implementation Plan.

15.4 The licensee shall obtain the approval of the Commission, or consent of a person authorized by the Commission, prior to the removal of established regulatory hold points.

15.5 The licensee shall limit the activities of import and export of nuclear substances to those occurring as contaminants in laundry, packaging, shielding or equipment.

15.6 The licensee shall implement and maintain an operations program for the use of the Target Delivery System to produce the radionuclides described in section IV (vi) (2).

15.7 The licensee shall implement and maintain a Co-60 operations program for the activities described in part IV of the licence.

Draft Licence Conditions Handbook

The draft LCH is provided on the following pages of the document.

Canada's Nuclear Regulator

e-Doc 7445268 (Word)

e-Doc 7445267 (PDF)

LICENCE CONDITIONS HANDBOOK

LCH-PR-13.00/2055-R000

DARLINGTON NUCLEAR GENERATING STATION NUCLEAR POWER REACTOR OPERATING LICENCE

LICENCE # PROL 13.00/2055

Canadian Nuclear Safety Commission | Commission canadienne de sûreté nucléaire

Canada

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Licence Conditions Handbook **Effective:** **Pending**

LCH-PR-13.00/2055-R000

Darlington Nuclear Generating Station
Nuclear Power Reactor Operating Licence

PROL 13.00/2055

SIGNED at OTTAWA: Pending.

Dr. Alex Viktorov
Director General, Directorate of Power Reactor Regulation
CANADIAN NUCLEAR SAFETY COMMISSION

Revision History

Effective Date	Revision #	LCH e-Doc #	Description of the Changes	DCR List e-Doc #
Pending	R000	Word e-Doc 7445268 Signed PDF embedded 7445267	First Issue	Word e-Doc 7445270 Signed PDF embedded 7445269

TABLE OF CONTENTS

PART I – INTRODUCTION

The purpose of the Licence Conditions Handbook (LCH) is to identify and clarify the relevant parts of the licensing basis for each licence condition (LC) (see CNSC *REGDOC-3.5.3 Regulatory Fundamentals* for description of licensing basis). The LCH should be read in conjunction with the *Nuclear Safety and Control Act* (NSCA), its regulations, the licence, and licence application and supporting documents.

Paragraph 24 (1) of the NSCA states "The Commission may establish classes of licences authorizing the licensee to carry on any activity described in any of paragraphs 26 (a) to (f) that is specified in the licence for the period that is specified in the licence."

Paragraph 26 (a) of the *NSCA* states "Subject to the regulations, no person shall, except in accordance with a licence,

- (a) possess, transfer, import, export, use or abandon a nuclear substance, prescribed equipment or prescribed information;
- (b) mine, produce, refine, convert, enrich, process, reprocess, package, transport, manage, store or dispose of a nuclear substance;
- (c) produce or service prescribed equipment;
- (d) operate a dosimetry service for the purposes of this Act;
- (e) prepare a site for, construct, operate, modify, decommission or abandon a nuclear facility; or
- (f) construct, operate, decommission or abandon a nuclear-powered vehicle or bring a nuclear-powered vehicle into Canada."

The licence pertaining to this licence conditions handbook (LCH) authorizes the licensee to:

(i) operate the Darlington Nuclear Generating Station, including equipment for the production of radionuclides identified in (vi) and the Darlington Tritium Removal Facility housed within the Heavy Water Management Building (hereinafter "the nuclear facility"), at a site located in the Municipality of Clarington, in the Regional Municipality of Durham, in the Province of Ontario;

(ii) possess, transfer, use, package, manage and store the nuclear substances that are required for, associated with, or arise from the activities described in (i);

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

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

(v) possess, transfer, process, package, manage and store the nuclear substances associated with the operation of the Darlington Tritium Removal Facility;

(vi) produce, possess, transfer, use, package, manage and store nuclear substances that are required for, associated with, or arise from the activities associated with operations of the Darlington Nuclear Generating station and activities described in (i) associated with production of:

(1) Co-60; and
(2) Mo-99

Including the associated decay radionuclides.

The LCH is organized in accordance with the licence conditions (LCs). The LCs themselves are organized, to a large degree, per the CNSC's safety and control area (SCA) framework [e-Doc 3410839, Safety and control areas].

The LCH content for each LC is typically applicable to all activities authorized by the licence. However, some LCs are specific to certain licensed activities; in such cases the LCH clarifies the licensing basis only in the context of the specific activity referenced in the LC.

The LCH typically has three parts under each LC: the Preamble, Compliance Verification Criteria (CVC), and Guidance. The Preamble explains, as needed, the regulatory context, background, and/or history related to the LC. CVC are criteria used by CNSC staff to verify compliance with the LC and hence are the basis of the compliance plan for this facility. Guidance may provide additional information relevant to compliance with the LC.

Some documents, including licensee documents and publications, that are cited in this LCH are not publicly available (e.g., documents containing proprietary information or prescribed information as defined by the *General Nuclear Safety and Control Regulations)*. Publicly-unavailable CNSC documents cited in the LCH are provided to the licensee upon request.

Interaction between the licensee and CNSC staff that is described in this LCH is governed by any communication protocols that may be established between the two, unless specified otherwise in the LCH.

Current versions of the licensee documents listed in this LCH (except COG documents) are recorded in CNSC document "OPG Darlington NGS PROL Written Notification Documents in LCH" (e-Doc 3959167), which is controlled by the Darlington Regulatory Program Division.

PART II – FACILITY SPECIFIC

G. GENERAL

G.1 Licensing Basis for the Licensed Activities

Licence Condition G.1:

The licensee shall conduct the activities described in Part IV of this licence in accordance with the licensing basis, defined as:

(i) the regulatory requirements set out in the applicable laws and regulations
(ii) the conditions and safety and control measures described in the facility's or activity's licence and the documents directly referenced in that licence
(iii) the safety and control measures described in the licence application and the documents needed to support that licence application;

unless otherwise approved in writing by the Canadian Nuclear Safety Commission (CNSC, hereinafter "the Commission").

Preamble

CNSC regulatory document REGDOC-3.5.3, *Regulatory Fundamentals*, *version 3* *(published March 2023)* describes what constitutes the licensing basis of a nuclear facility or activity.

This LC is not intended to unduly inhibit the licensee's ability to implement changes.

For some specific changes, the licensing basis has provisions for CNSC staff to confirm whether the change would be in accordance with the licensing basis. These are referred to as 'CNSC staff authorizations.' Examples include terms or conditions in the licensing basis that permit or constrain a particular activity by means of a phrase such as:

- "approved in writing by the Commission or a person authorized by the Commission"
- "without the written approval of the Commission or a person authorized by the Commission"
- "requested by the Commission or a person authorized by the Commission"
- "prior written approval of the Commission, or prior written consent of a person authorized by the Commission"

As another example, licensing basis publications or other licensing basis requirements may include a requirement to obtain the acceptance or approval from the regulatory authority or authority having jurisdiction (AHJ).

For the four listed items, the Commission authorized CNSC staff (through CMD 00-M25 and its reference, CMD 00-M18) to grant approval if, among other things, staff were satisfied that the proposed change or action would not result in:

- an unreasonable risk to the environment or the health and safety of persons,
- an unreasonable risk to national security, or

- a failure to achieve conformity with measures of control and international obligations to which Canada has agreed

The criteria have been effectively incorporated in the licensing basis concept.

This licence condition and CMD 00-M25 do not grant CNSC staff the authority to approve changes that are not in accordance with the licensing basis.

<Optional where there is a general delegation in a Record of Decision> Unless otherwise indicated in the CVC of specific LCs in this LCH, delegation of authority by the Commission to act as a "person authorized by the Commission" is only applied to the incumbents of the following positions [Record of Decision for licence renewal issued month 20XX]:

- Director, <Licensing > Division
- Director General, Directorate of <Facility or Activity Type> Regulation
- Executive Vice-President and Chief Regulatory Operations Officer, Regulatory Operations Branch

Changes that are within the licensing basis and do not require CNSC staff authorization may still require notification. See LC G.2 for further information on notification to CNSC staff of changes to safety and control measures.

In the event of any real or perceived inconsistency or conflict between elements of the licensing basis, the licensee is expected to consult CNSC staff for resolution. In the event of a conflict between CSA standards, the licensee is expected to consult with CSA Group to aid in its resolution. In the event that the Commission grants approval to operate in a manner that is not in accordance with the previously established licensing basis, this would effectively revise the licensing basis for the facility. The appropriate changes would be reflected in the CVC of the relevant LC.

Compliance Verification Criteria

Part (i) of the licensing basis, includes, but is not limited to, the following:

- *Nuclear Safety and Control Act;*
- *Regulations made by the CNSC*
- *Canada/IAEA Safeguards Agreement.*

Parts (ii) and (iii) of the licensing basis refer to safety and control measures described in the licence, the documents directly referenced in that licence, the licence application and the documents needed to support that licence application. Such measures, when adequately implemented and maintained, allow the licensee to meet the applicable laws and regulations and thereby provide adequate protection for the health, safety, security and the environment, while enabling the fulfillment of Canada's international obligations.

Safety and control measures may be identified in high-level programmatic licensee documents or in lower-level supporting licensee documentation. Safety and control measures are also identified in licensing basis publications (e.g., CNSC regulatory documents or CSA Group standards) that are cited in the licence and the licence application.

The applicable versions of licensing basis publications are listed in tables in this LCH under the most relevant LC. All "shall" or normative statements in licensing basis publications are considered CVC unless stated otherwise.

The licensee documents and relevant licensing basis publications may cite other documents that also contain safety and control measures (i.e., there may be safety and control measures in "nested" references). There is no predetermined limit to the degree of nesting at which relevant safety and control measures may be found.

LC G.1 requires the licensee to implement the safety and control measures identified in the licensing basis. Note, however, that not all details in referenced documents are necessarily considered to be safety and control measures. Details (even if in normative format) that are irrelevant to safety and control measures for facilities or activities authorized by the licence are excluded from the CVC of LC G.1.

The licensee may propose alternate approaches to implement safety and control measures already identified in the licensing basis. The licensee shall assess changes to confirm that licensed activities remain in accordance with the licensing basis. In addition, for staff authorizations, the licensee shall carry out any other assessments or determinations identified in the requirements associated with the staff authorization. When it cannot be confirmed that the change is in accordance with the licensing basis, the licensee shall seek prior approval of the Commission for the change.

For unapproved operation that is not in accordance with the licensing basis, the licensee shall take action as soon as practicable to return to a state consistent with the licensing basis, taking into account the risk significance of the situation. The licensee shall report these situations to CNSC; see LC 3.3.

The licensee's safety and control measures are described in the following documentation provided at the time of the licence application, or in support of thereafter:

Date	Document Title	Document #	E-Doc #
December 13, 2013	Darlington NGS - Application for Renewal of Darlington Nuclear Generating Station Power Reactor Operating Licence 13.00/2014	NK38-CORR-00531-16490	4261350
May 1, 2014	Darlington NGS- Updated Application Requirements for Renewal of the Darlington Nuclear Generating Station Power Reactor Operating Licence- Transition Plans for New and Revised Standards and Regulatory Documents	NK38-CORR-00531-16780	4429709

Date	Document Title	Document #	E-Doc #
January 30, 2015	Darlington NGS- Additional information in Support of Application for Renewal of Darlington's Power Reactor Operating Licence (PROL) 13.01/2015	NK38-CORR-00531-17206	4635419

Recommendations and Guidance

CNSC REGDOC-1.1.3, Licence Application Guide: Licence to Operate a Nuclear Power Plant, describes a wide, but not necessarily exhaustive, range of safety and control measures that may be relevant to an operating nuclear power plant. In Version 1.2 of REGDOC-1.1.3, Section 4 discusses these measures for each of the 14 SCAs, while Section 5 discusses some safety and control measures that may be associated with other matters of regulatory interest that do not fall within the 14 SCAs.

A list of criteria that could help determine if a change would be in accordance with the licensing basis is provided in Appendix A of *Assessment of licensee changes to documents or operations* [e-Doc # 4055483]. Such criteria would also be used if the change requires CNSC staff authorization.

When the licensee is unsure if a proposed change or activity is in accordance with the licensing basis, it can consult CNSC staff. The licensee should take into account that certain types of proposed changes might require significant lead times before CNSC staff can make recommendations and/or the Commission can properly consider them. Examples of these types of changes are discussed under various LCs in this LCH. Guidance for notifications to the CNSC related to licensee changes is discussed under LC G.2.

G.2 Notification of Changes

Licence Condition G.2:

The licensee shall give notification of changes to the facility's safety and control measures that impact the licensing basis.

Preamble

The safety and control measures subject to this notification are part of the licensing basis as described in LC G.1. Facility specific safety and control measures are identified in the documents listed in the CVC of this LCH. Current versions of the licensee documents listed in this LCH that require notification of change are recorded in CNSC document "OPG - Darlington NGS PROL Written Notification Documents in LCH" (e-Doc 3959167).

A notification is defined as a formal, recorded communication from the licensee to CNSC staff.

Licensee documents tabulated in the CVC of the LCH have different requirements for notification of change, depending on their significance. Some documents will require notification prior to a change being implemented (denoted as "PI" in the CVC tables) and others will require notification at the time of implementation (denoted as "TI" in the CVC tables).

Compliance Verification Criteria

Compliance with this LC includes notification of changes to the licensee documents listed under CVC of the LCs in this LCH. However, noting the general description of safety and control measures in the CVC for LC G.1, the licensee shall also provide notification of any change that could reasonably be assumed to impact the licensee's ability to meet applicable laws and regulations, as well as the conditions of its licence, and thereby provide adequate protection for the health, safety, security and the environment, while enabling the fulfillment of Canada's international obligations.

Notifications shall include a summary description of the change, the rationale for the change, expected duration (if not a permanent change), and a summary explanation of how the licensee has concluded that the change remains in accordance with the licensing basis. Changes for which that conclusion is not obvious require further assessment of impact to determine if Commission approval is required in accordance with LC G.1.

For licensee documents designated as PI, the licensee shall submit the document to the CNSC prior to implementing changes. The licensee shall allow sufficient time for the CNSC to review the change proportionate to its complexity and the importance of the safety and control measures being affected. Typically, significant changes require submission a minimum of 30 days prior to planned implementation. For documents designated as TI, the licensee need only submit the revised document at the time of implementing the change.

A copy of any revised document that is material to the change shall accompany the notification. These documents may include documents that are nested references in licensee documents and/or documents produced by third parties (e.g., reports prepared by third party contractors). The notification requirements

(PI or TI) that apply to the licensee document listed under CVC also apply to the nested or associated document. Changes to referenced third-party documents require notification to the CNSC only if the new version continues to form part of the licensing basis. That is, if the licensee implements a new version of a document prepared by a third party, in addition to confirming that the new version is in accordance with the licensing basis, it shall inform the CNSC of the change(s). On the other hand, if a third party has updated a supporting document, but the licensee has not adopted the new version as part of its safety and control measures, the licensee is not required to inform the CNSC that the third party has changed the document.

OPG shall follow its process OPG-PROG-0001, *Information Management*, for any changes related to a document listed in Appendix D.

The following documents require written notification of change:

Document Title	Document #	Notification Status
Information Management	OPG-PROG-0001	TI

Recommendations and Guidance

Appendix A of *Assessment of licensee changes to documents or operations* [e-Doc # 4055483] identifies some factors that could be addressed to confirm how a change remains in accordance with the licensing basis.

For proposed changes that would not be in accordance with the licensing basis, the Guidance for LC G.1 applies.
The following scenarios, not necessarily mutually exclusive, are examples of changes that require notification even if they do not involve changes to licensee documents listed under CVC:

a) The licensee plans to make changes to the facility or its operation, such as deviations from design, operating conditions, policies, programs or methods, and such changes are not explicitly permitted in the licensee's governance or other parts of the licensing basis.
b) The licensee requires staff authorization (see description under CVC of LC G.1) for a planned change. The specific requirements for such notifications may be identified in the part of the licensing basis that establishes the basis for the staff authorization.
c) The licensee plans to implement a new or revised regulatory document or industry standard. The notification would typically indicate the date by which implementation of the publication will be complete and describe any corresponding changes needed for implementation.

For the above scenarios, in the event that a change to a licensee document listed under CVC is also involved, there would another notification required later when the change to the document is executed.

The following are two examples that are illustrative of changes in scenario a), but in no way do they form a representative or exhaustive list.

- The licensee is changing certain responsibilities of a worker that could have a significant impact on emergency response, and those responsibilities are not documented in a document identified in the LCH requiring notification of change
- The licensee is planning a significant plant modification that would not necessitate a change in a document identified in the LCH requiring notification of change

G.3 Land Use and Occupation

Licence Condition G.3:

The licensee shall control the use and occupation of any land within the exclusion zone.

Preamble

The *General Nuclear Safety and Control Regulations* require that a licence application contain a description of the nuclear facility.

The siting guide used at the time of design of all Canadian NPPs (AECB-1059, e-Doc 3000249) stipulated an exclusion zone that extended at least 914 metres (3000 feet) from the exterior of any reactor building.

Compliance Verification Criteria

The licensee shall ensure that the use and occupancy of land within the exclusion zone does not compromise the safety and control measures in the licensing basis. Specifically, the licensee shall consider emergency preparedness and ALARA with respect to land use within the exclusion zone. This applies to land the licensee occupies as well as to land occupied by others.

The licensee shall not permit a permanent dwelling to be built within the exclusion zone. “Permanent dwelling” refers to housing that is meant to be fixed. The licensee may erect, for a short time without prior notification, a temporary dwelling (e.g., a trailer).

The licensee shall notify the CNSC of changes to the use and occupation of any land within the exclusion zone. The notice shall be submitted prior to the change, with lead time in proportion to the expected impact of the change on the licensee’s safety and control measures.

The licensee shall notify the CNSC of changes to the licence agreement with the Municipality of Clarington, which ensures safe public access to the waterfront trail that traverses the Darlington site.

The following documents require written notification of change:

Document Title	Document #	Notification Status
Darlington NGS-A Plant Survey	LO4254-DZS-10162-0531	PI
Darlington Safety Report Part 1 and 2	NK38-SR-03500-10001	TI
Site and Improvements Site Plan General Arrangement	NK38-D0H-10220-1001	TI
Site Improvements Base Line Plan and Construction Grid	NK38-D0H-10220-1002	TI

LO4254-DZS-10162-0531, *Darlington NGS-A Plant Survey*, NK38-D0H-10220-1001, *Site and Improvements Site Plan General Arrangement*, and NK38-D0H-10220-1002, *Site Improvements Base Line Plan and Construction Grid*, describe the exclusion zone, identifying the parcels of land that are not owned by OPG and provide information on land use. These documents shall be revised to reflect any transfer of land within the exclusion zone to non-licensee ownership. The Plant Survey also appears in NK38-SR-03500-10001, *Darlington Safety Report Part 1 and 2*, which provides added details on the plant and site description.

Recommendations and Guidance

This section has no contents applicable to this LC.

G.4 Office for CNSC On-Site Inspectors

<u>Licence Condition G.4:</u>

The licensee shall provide, at the nuclear facility and at no expense to the Commission, suitable office space for employees of the Commission who customarily carry out their functions on the premises of that nuclear facility (onsite Commission staff).

<u>Preamble</u>

CNSC staff require suitable office space and equipment at the nuclear facility in order to satisfactorily carry out its regulatory activities.

<u>Compliance Verification Criteria</u>

Any changes of accommodation or equipment shall be made based on discussion, and subsequent agreement, between the CNSC and the licensee.

Suitable office space is office space that is separated from the remainder of the building in which it is located by walls or other suitable structures.

<u>Recommendations and Guidance</u>

This section has no contents applicable to this LC.

G.5 Financial Guarantee

<u>Licence Condition G.5:</u>

The licensee shall maintain a financial guarantee for decommissioning that is acceptable to the Commission.

<u>Preamble</u>

The *General Nuclear Safety and Control Regulations* requires that a licence application contain a description of any proposed financial guarantee relating to the activity to be licensed.

The licensee is responsible for all costs of decommissioning and all such costs are included in the decommissioning cost estimates and are covered by licensee's consolidated financial guarantee for decommissioning.

OPG conducted a complete decommissioning cost estimate review as part of the 5-year Ontario Nuclear Funds Agreement reference plan update cycle. Gaps identified between the preliminary decommissioning plan and CSA standard N294-19, *Decommissioning of facilities containing nuclear substances*, that could impact on the decommissioning costs, were addressed by OPG in the cost estimate review.

The financial guarantee is composed of the following components:

- segregated funds established pursuant to the Ontario Nuclear Funds Agreement (ONFA) between the licensee and the Province of Ontario as amended and effective March 1, 2010;
- trust fund for the management of used fuel established pursuant to the *Nuclear Fuel Waste Act*; and
- Provincial Guarantee pursuant to the Provincial Guarantee Agreement between the CNSC and the Province of Ontario, which was amended March 1, 2010.

<u>Compliance Verification Criteria</u>

The financial guarantee for decommissioning the nuclear facility shall be reviewed and revised by the licensee every five years or when the Commission requires or following a revision of the preliminary decommissioning plan that significantly impacts the financial guarantee.

CNSC REGDOC-3.3.1, *Financial Guarantees for Decommissioning of Nuclear Facilities and Termination of Licensed Activities*, was published in January 2021. As detailed in OPG letter N-CORR-00531-23536 (e-doc 6955238), submissions of financial guarantees for OPG owned facilities will be compliant with REGDOC-3.3.1. The next full update to the 5-year reference plan for financial guarantee purposes is expected in 2027.

The licensee shall submit annually to the Commission a written report confirming that the financial guarantees for decommissioning costs remain valid and in effect and sufficient to meet the decommissioning needs. The licensee shall submit this report by the end of February of each year, or at any time as the Commission may request.

Relevant documents that require version control:

Source	Document Title	Document #	Revision #	Effective Date
NA	CNSC Financial Security and ONFA Access Agreement and Provincial Guarantee Agreement, effective January 1, 2013	N/A	Amended 2013-01-01	2016-01-01
CNSC	Financial Guarantees for Decommissioning of Nuclear Facilities and Termination of Licensed Activities	REGDOC-3.3.1	2021	2027-12-30

Recommendations and Guidance

This section has no contents applicable to this LC.

G.6 Public Information and Disclosure

<u>Licence Condition G.6:</u>

The licensee shall implement and maintain a public information and disclosure program.

<u>Preamble</u>

A public information and disclosure program (PIDP) is a regulatory requirement for licence applicants and licensees under the *Class I Nuclear Facilities Regulations*, which requires that a licence application contain a program to inform persons living in the vicinity of the site of the general nature and characteristics of the anticipated effects of the licensed activity on the environment, health and safety of persons.

<u>Compliance Verification Criteria</u>

The licensee shall implement and maintain a program for public information and disclosure. This program shall comply with the requirements set out in CNSC regulatory document REGDOC-3.2.1, *Public Information and Disclosure*.

Relevant documents that require version control:

Source	Document Title	Document #	Revision #	Effective Date
CNSC	Public Information and Disclosure	REGDOC-3.2.1	2018	2020-12-11

Where the public has indicated an interest to know, the PIDP shall include a commitment to and disclosure protocol for ongoing, timely communication of information related to the licensed facility during the course of the licensing period.

The following documents require written notification of change:

Document Title	Document #	Notification Status
Nuclear Public Information and Disclosure	N-STD-AS-0013	TI

<u>Recommendations and Guidance</u>

It is recommended that OPG submit annually to CNSC staff a report summarizing the events and developments involving OPGs nuclear facilities.

G.7 Indigenous Engagement

<u>Licence Condition G.7:</u>

The licensee shall implement and maintain an Indigenous engagement program.

<u>Preamble</u>

The Darlington site resides on lands in which many Indigenous Nations and communities have a vested interest and rights, lying within the lands and waters of the Michi Saagiig Anishinaabeg, the Gunshot Treaty (1877-88), the Williams Treaties (1923), and the Williams Treaties Settlement Agreement (2018).

The *Class I Nuclear Facilities Regulations* requires that licensees describe and maintain a program to inform persons living in the area of the site of the nature and characteristics of the anticipated effects of the activity on the environment, as well as on the health and safety of persons. Indigenous Nations and communities are required to be included as a target audience for the licensee's public information and disclosure program, in accordance with REGDOC-3.2.1, *Public Information and Disclosure*.

For reference, CNSC staff identified Indigenous Nations and communities who have interests and Indigenous and/or Treaty rights in the area where the Darlington site is located within Section 4.1.1 of CMD 25-H2.

<u>Compliance Verification Criteria</u>

The licensee shall conduct ongoing engagement specific to the DNGS in accordance with OPG-POL-0027, *Indigenous Relations Policy*, the identified Indigenous Nations and communities with Indigenous and/or Treaty rights in the area of the DNGS and those who have expressed an interest in the DNGS, throughout the licence period. If an Indigenous Nation and/or community is not actively pursuing engagement opportunities, the licensee shall continue to share information and provide opportunities for engagement, unless the Indigenous Nation and/or community specifically requests that the licensee stop sharing information regarding the DNGS.

To ensure ongoing engagement, OPG shall collaborate and engage with the identified Nations on the specific commitments made in the Darlington NGS PROL Licence Renewal Application, and any subsequent similar commitments made to Indigenous Nations and communities, including to:

1. Seek their input and work in collaboration with Indigenous Nations to update the Darlington NGS PROL Indigenous Engagement Plan as required.
2. Work in collaboration with Indigenous Nations and communities to identify approaches to engagement and communication that takes into consideration the knowledge, needs, preferences and interests of each Indigenous Nation and community.
3. Provide opportunities for site visits, workshops and information sessions or as interest is expressed by Indigenous Nations and communities.
4. Respond to questions, concerns or comments from Indigenous Nations and communities regarding the DNGS and consider feedback with regards to how to continuously improve engagement and communications activities.

In addition to the commitments noted above, specific to the Michi Saagiig Nations of the Williams Treaties First Nations (Alderville First Nation (AFN), Curve Lake First Nation (CLFN), Hiawatha First Nation (HFN) and the Mississaugas of Scugog Island First Nation (MSIFN)) OPG shall:

5. Collaborate with MSIFN, CLFN, HFN and AFN to incorporate the outcomes of the Indigenous Knowledge Study (IKS), led by MSIFN, CLFN, HFN and AFN related to the Darlington site into ongoing oversight and monitoring of the DNGS throughout the licensing period, as appropriate.

The licensee shall submit to the CNSC, an annual report, submitted by July 1st, on the engagement activities it has undertaken with the Indigenous Nations and communities. The licensee should also provide a copy of the summary to each Indigenous Nation or community engaged in advance or at the same time it is filed with the CNSC. It is acknowledged that an Indigenous Nation or community may share information with the licensee in confidence. The licensee should work with the Indigenous Nation or community to ensure this information is not disclosed and the Indigenous Nation or community is comfortable with the level of detail communicated within the report.

Each report shall describe:

- The name of the Indigenous Nation or community.
- The method(s), date(s), location(s), and topics of engagement activities with the Indigenous Nation or community.
- An update on the commitments (items 1 through 5 above) along with any relevant information and context regarding the status of, timelines, and progress made on the initiatives and commitments.
- A summary of any issues, interests, or concerns raised, including those in relation to any potential impacts on identified or established Indigenous and/or Treaty rights.
- The measures taken, or that will be taken, to address or respond to the issues or concerns. Alternatively, an explanation as to why no further action is required to address or respond to issues or concerns shall be provided.
- A description of any changes to project activities and/or programs to address and incorporate the measures taken to respond to issues or concerns, or to incorporate knowledge and feedback from Indigenous Nations and communities.
- The status of OPG’s Indigenous Relations Policy initiatives.
- The status of OPG’s Reconciliation Action Plan and its specific actions, commitments, deliverables and timelines.
- The status of existing and anticipated Framework Agreements with Indigenous Nations and communities.

Relevant documents that require version control:

Source	Document Title	Document #	Revision #	Effective Date
CNSC	Public Information and Disclosure	REGDOC-3.2.1	2018	2020-12-11

The following documents require written notification of change:

Document Title	Document #	Notification Status
Indigenous Relations Policy	OPG-POL-0027	TI

Recommendations and Guidance

In conducting its engagement activities, the licensee should consider the guidance provided throughout REGDOC-3.2.2, *Indigenous Engagement, version 1.1 (2019)*.

1 SCA – MANAGEMENT SYSTEM

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

Performance Objective(s)

There is an effective management system that integrates provisions to address all regulatory and other requirements to enable the licensee to achieve its safety objectives, continuously monitor its performance against those objectives and maintain a healthy safety culture.

1.1 Management System Requirements

Licence Condition 1.1:

The licensee shall implement and maintain a management system.

Preamble

The *General Nuclear Safety and Control Regulations* require that a licence application contain information related to the organizational management structure and responsibilities.

The *Class I Nuclear Facilities Regulations* require that a licence application contain the proposed quality assurance program.

Safe and reliable operation requires a commitment and adherence to a set of management system principles and, consistent with those principles, the establishment and implementation of processes that achieve the expected results. CSA standard N286, *Management system requirements for nuclear facilities*, contains the requirements for a management system throughout the life cycle of a nuclear power plant and extends to all safety and control areas.

The management system must satisfy the requirements set out in the, regulations made pursuant to the *Nuclear Safety and Control Act*, the licence and the measures necessary to ensure that safety is of paramount consideration in implementation of the management system. An adequately established and implemented management system provides CNSC staff confidence and evidence that the licensing basis remains valid.

Compliance Verification Criteria

The licensee shall implement and maintain a management system. This management system shall comply with the requirements set out in CSA standard N286, *Management system requirements for nuclear facilities*.

The licensee shall ensure that the management system meets the requirements of CSA N286 at all times throughout operation, refurbishment and return to service for all units.

Relevant documents that require version control:

Source	Document Title	Document #	Revision #	Effective Date
CSA	Management system requirements for nuclear facilities	N286	2012 (Reaffirmed 2022)	2016-01-01
CNCS	Management Systems	REGDOC-2.1.1	2019	2024-09-27
CNSC	Safety Culture	REGDOC-2.1.2	2018	2023-11-24

Management System

The management and operation of OPG nuclear facilities is defined by the programs and associated nuclear governing documents as described in N-CHAR-AS-0002, *Nuclear Management System*. The management system documentation shall contain sufficient detail to demonstrate that the described processes stated directly or by reference, provides the needed direction to comply with the conditions stated in the PROL and the criteria herein.

Organization

The licensee shall document the organizational structure for safe and reliable conduct of licensed activities and shall include all positions with responsibilities for the management and control of the licensed activity. OPG's organization is defined by N-STD-AS-0020, *Nuclear Management Systems Organizations*, OPG's role documents for certified positions and OPG correspondence "*Persons Authorized to Act on Behalf of OPG in Dealings with the CNSC*".

Safety Culture

Licensees shall ensure that the management of the organization supports the safe conduct of nuclear activities. The licensee shall ensure that sound nuclear safety is the overriding priority in all activities performed in support of the nuclear facilities and has clear priority over schedule, cost and production. The licensee's approach to worker safety is governed by OPG-PROG-0005, *Environment Health and Safety Managed Systems*, which defines the overall process for managing safety and the responsibilities of the parties, specifically at the corporate level.

A safety culture self-assessment methodology is developed following a continuous improvement process, which is governed by N-PROC-AS-0077, *Nuclear Safety & Security Culture Assessment*.

Business Continuity

Business continuity is addressed in N-GUID-09100-10000, *Contingency Guideline for Maintaining Staff in Key Positions When Normal Station Access is Impeded*, which provides a strategic plan for safe shutdown and follow-up activities in the event of labour disruptions, and OPG-PROG-0033, *Business Continuity Program*. These are also key documents in support of the minimum shift complement (see LC 2.2).

The following documents require written notification of change:

Document Title	Document #	Notification Status
Management System		
Nuclear Management System	N-CHAR-AS-0002	PI
Nuclear Management System Administration	N-PROG-AS-0001	TI
Information Management	OPG-PROG-0001	TI
Project Management	OPG-PROG-0039	TI
Construction Management	OPG-PROG-0046	TI
Managing Change	OPG-STD-0140	TI
Organization		
Nuclear Management Systems Organizations	N-STD-AS-0020	TI
Organization Design Change	OPG-PROC-0166	TI
Plant Management (including Safety Culture)		
Nuclear Safety & Security Policy	N-POL-0001	TI
Nuclear Safety Oversight	N-STD-AS-0023	TI
Environment Health and Safety Managed Systems	OPG-PROG-0005	TI
Nuclear Safety & Security Culture Assessment	N-PROC-AS-0077	TI
Independent Assessment	N-PROG-RA-0010	TI
Contingency Guideline for Maintaining Staff in Key Positions When Normal Station Access is Impeded	N-GUID-09100-10000	TI
Business Continuity Program	OPG-PROG-0033	TI
Items and Services Management	OPG-PROG-0009	TI

Recommendations and Guidance

The management system should be used to promote and support a healthy safety culture. The CNSC recognizes the following characteristics that form the framework for a healthy safety culture:

- Safety is a clearly recognized value;
- Accountability for safety is clear;
- Safety is integrated into all activities;
- A safety leadership process exists, and

- Safety culture is learning-driven.

2 SCA – HUMAN PERFORMANCE MANAGEMENT

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

Performance Objective(s)

The licensee has an integrated approach to managing human performance so that all workers have the necessary knowledge, skills and attributes, are fit for duty, are sufficient in number, and are supported to carry out their work tasks safely.

2.1 Human Performance Program

Licence Condition 2.1:

The licensee shall implement and maintain a human performance program.

Preamble

Human performance relates to reducing the likelihood of human error in work activities. It refers to the outcome of human behaviour, functions and actions in a specified environment, reflecting the ability of workers and management to meet the system's defined performance under the conditions in which the system will be employed.

Human Factors are factors that influence human performance as it relates to the safety of a nuclear facility or activity over all design and operations phases. These factors may include the characteristics of the person, task, equipment, organization, environment, and training. The consideration of human factors in issues such as interface design, training, procedures, and organization and job design may affect the reliability of humans performing tasks under various conditions.

The *General Nuclear Safety and Control Regulations* require different elements related to the human performance program.

CNSC regulatory document REGDOC-2.2.1, *Human Factors*, describes how the CNSC will take human factors into account during its licensing, compliance and standards-development activities.

For clarification, CNSC regulatory oversight related to hours of work is for the purpose of "nuclear safety" not for the purpose of "worker protection". Worker protection is covered under the SCA "Conventional Health and Safety" (LC 8.1).

Compliance Verification Criteria

In order to establish, maintain and improve human performance, the licensee shall monitor and control the work hours and shift schedules of nuclear workers, in accordance with governance N-PROC-OP-0047, *Hours of Work Limits and Managing Worker Fatigue*. All workers performing safety related tasks or working on safety-related systems are subject to these hours of work and scheduling limits.

The licensee shall also monitor and control the fitness for duty of its workers at all times by implementing and maintaining their "Continuous Behaviour Observation Program", N-CMT-62808-00001, which covers aspect related to fitness for duty. Specific fitness for duty requirements for certified personnel can be found in CNSC regulatory document REGDOC-2.2.3, *Personnel Certification, Volume III: Certification of Reactor Facility Workers, version 2*, and those for nuclear security officers can be found in CNSC regulatory document REGDOC-2.2.4, Fitness for Duty, Volume III: *Nuclear Security Officer Medical, Physical and Psychological Fitness*.

REGDOC-2.2.4 *Fitness for Duty, Volume II: Managing Alcohol and Drug Use Version 3*, published in January 2021, sets out requirements and guidance for managing the fitness for duty of workers in relation to alcohol and drug use and abuse. As detailed in CNSC letter e-Doc 5969253, CNSC staff accepted OPG's implementation timeline set out in OPG correspondence N-CORR-00531-19643 (e-Doc 5865465). In its letter of 28 January 2022 (N-CORR-00531-22958, e-Doc 6728014), OPG has indicated it is in compliance with all REGDOC-2.2.4 Vol II requirements, with the exception of pre-placement and random alcohol and drug testing. OPG has committed to providing further details of its implementation of the remaining portions of REGDOC-2.2.4 Vol II once a decision has been rendered.

Relevant documents that require version control:

Source	Document Title	Document #	Revision #	Effective Date
CNSC	Personnel Certification, Volume III: *Certification of Reactor Facility Workers*	REGDOC-2.2.3	2023 (Version 2)	2025-02-07
CNSC	Fitness for Duty: Managing Worker Fatigue	REGDOC-2.2.4	2017	2019-01-01
CNSC	Fitness for Duty, Volume II: Managing Alcohol and Drug Use	REGDOC-2.2.4	2021 (Version 3)	2021-07-22*
CNSC	Fitness for Duty, Volume III Nuclear Security Officer Medical, Physical, Psychological Fitness	REGDOC-2.2.4	2018	2020-12-31

* For all requirements other than pre-placement and random alcohol and drug testing

The following documents require written notification of change:

Document Title	Document #	Notification Status
Hours of Work Limits and Managing Worker Fatigue	N-PROC-OP-0047	PI
Listing of Broad Population and Safety Sensitive Job Codes	N-LIST-09110-10005	PI
Human Performance	N-PROG-AS-0002	TI
Procedure Use and Adherence	N-STD-AS-0002	TI
Communications	N-STD-OP-0002	TI
Self-Check	N-STD-OP-0004	TI
Conservative Decision Making	N-STD-OP-0012	TI
Second Party Verification	N-STD-RA-0014	TI
Pre-Job Brief / Safe Work Plan and Post-Job Debriefing	N-PROC-OP-0005	TI
Continuous Behaviour Observation Program (CBOP) – Participants Materials – Workbook Components	N-CMT-62808-00001	TI
Fitness For Duty: Policy On Managing Alcohol and Drug Use	OPG-PROC-0208	TI

Recommendations and Guidance

Licensees should implement a program that continuously monitors human performance, takes steps to identify human performance weaknesses, improves human performance, and reduces the likelihood of human performance related causes and root causes of nuclear safety events.

The Human Performance Program should address and integrate the range of human factors that influence human performance, which include, but may not be limited to the following:

- The provision of qualified staff
  - Certification and Training
  - Staffing
  - Minimum Shift Complement
  - Fitness for duty
    - Hours of Work
    - Fatigue Management
- The reduction of human error
  - HF in Design
  - Procedures Development
  - Procedural Compliance
  - Work protection and Work Permit Systems
  - Shift Turnover
  - Pre and Post Job Briefings
  - Safe work strategies/practices
- Organizational support for safe work activities
  - Human Actions in Safety Analysis
  - Organizational Performance and Safety culture
- The continuous improvement of human performance

Additional guidance is provided in CNSC regulatory document REGDOC-2.5.1, *General Design Considerations: Human Factors*.

2.2 Minimum Shift Complement

Licence Condition 2.2:

The licensee shall implement and maintain the minimum shift complement and control room staffing.

Preamble

The *General Nuclear Safety and Control Regulations*, require that the licensee ensure the presence of a sufficient number of qualified workers at the nuclear facility.

The minimum shift complement specifies the numbers of qualified staff that are required to operate and maintain unit(s) safely under all operating states including normal operations, anticipated operational occurrences, design basis accidents and emergencies.

This licence condition ensures the presence of a sufficient number of qualified workers who must be present at all times to ensure safe operation of the nuclear facility, and to ensure adequate emergency response capability.

Compliance Verification Criteria

Minimum Shift Complement

The licensee's minimum shift complement (MSC) documentation, D-PROC-OP-0009, *Station Shift Complement*, describes the minimum number of workers with specific qualifications required for the safe operation of the nuclear facilities-under all operating states and the measures in place to mitigate the impact of any MSC violations until minimum complement requirements are restored.

The licensee shall operate the nuclear facility in accordance with these documents and shall monitor and keep records of each shift's complement. The licensee shall provide a rolling five year profile of certified operators on an annual basis.

The MSC is considered part of the licensing basis. Changes to the MSC are subject to LC G.1. The following tables summarize the facility's MSC. These tables are taken from D-PROC-OP-0009. In the event of a discrepancy between these tables below and the licensee documentation upon which they are based, the licensee documentation shall be considered the authoritative source (assuming that the licensee has followed its own change control process).

<u>Shift Complement by Work Group (Normal Operation)</u>

<u>Operations Work Group Minimum Complement</u>

Position	**Minimum Complement # (3 Units Fueled)**	**Minimum Complement # (4 Units Fueled)**	**Scheduled Complement #**
Authorized Nuclear Operators (ANO)	5 (7)	6 (7)	7
Unit 0 Control Room Operators (CRO)	2	2	2
Field Shift Operating Supervisor (FSOS)	1	1	1
Unit 0 Nuclear Operators	3	3	3
Nuclear Operators (NO) (Units 1 – 4)	11 (7)	10 (7)	12
Shift Manager (SM)	1	1	1
Control Room Shift Supervisor (CRSS)	1	1	1
Supervising Nuclear Operators (SNO)	4	4	4
Unit 0 Field Supervising Nuclear Operator	1	1	1
Operations Sub-Total	**29**	**29**	**32**

Other Work Groups Minimum Complement

Work Group	Position	Minimum Complement #				Scheduled Complement #			
TRF	Control Room SNO	1				1			
TRF	Major Panel Operator (MPO)	1				1			
TRF	Nuclear Operators	2 (1)				2 (1)			
Lab	Chemical Technician	2				2			
FP	Emergency Response Maintainer (ERM)	6				6			
FP	Shift Emergency Response Manager (SERM)	1				1			
Maint	FLM – Control	1				1			
Maint	Shift Control Technician (SCT) (3) (4)	2 [1]				3 [2]			
Maint	Mechanical Maintainer (3)	1 [0]				2 [0]			
Maint	FH Mech. Maintainer/Control Technician (4)	1 [0]				2 [0]			
Maint	FLM – FH (4)	1 [0]				1 [0]			
Security	Nuclear Security Officer (NSO)	NS (5)				NS (5)			
Number of FH Trolleys Operated (6)		0	1	2	3	0	1	2	3
FH	Field Shift Operating Supervisor	0	0	0	0	0	1	1	1
FH	Supervising Nuclear Operator (2)	1	1	1	1	1	1	1	1
FH	Major Panel Operator (2)	0	1	2	3	0	1	2	3
FH	Nuclear Operator (2)	1	2	2	2	2	2	2	3
Other Work Groups Sub-Total (4)		22 [18]	24 [20]	25 [21]	26 [22]	26 [21]	28 [23]	29 [24]	31 [26]
All Work Groups (including Operations) Total (4)		52 [48]	54 [50]	55 [51]	56 [52]	59 [54]	61 [56]	62 [57]	64 [59]

(1) TRF Nuclear Operators minimum and scheduled complements are reduced to 1 during TRF outage (i.e. hydrogen, deuterium and tritium inventories have been removed from the TRF process). Default complement is 2 (TRF in service).

(2) The workgroup minimum complement for Fuel Handling is one (1) SNO and one (1) Nuclear Operator, when no trolleys are being operated. However, the station strives to staff to allow for one trolley to be operated (1 SNO, 1 MPO and 2 NO's).

(3) One SCT has Design Basis Accident response duties while FH Operations staff (or other qualified staff as per N-PROC-MA-0012) assist with PPT verification (refer to N-INS-03490-10003 for details on credited response to Loss of Instrument Air event and PHT LRV Fail Open event).

(4) Night shift complement, where different from days, shown in square brackets [ ].

(5) NS = not specified in this document – security protected. Refer to Site Security Report.

(6) For the purposes of MCCP alarm limits, complement numbers for 1 trolley operation are used.

(7) When a reactor unit is in a defueled state the minimum complement of certified ANOs required to be present in the facility is reduced to five (5) and the minimum complement of Nuclear Operators for units 1-4 is increased to 11. The number of NOs is increased in order to provide a second emergency MCRA (CSP) qualified operator as per the following table: ERO Requirements (for emergency conditions) Notation 8. Any certified ANO surplus to minimum complement can also fill this role.

Shift Complement for Emergency Response Organization (ERO)

ERO Requirements (for emergency conditions)

Position	Work Group (1)	Minimum Complement #	Scheduled Complement #
Authorized Nuclear Operators (ANO)	Operations	6 (8)	7
Unit 0 Control Room Operator (CRO)	Operations	2	2
Chemical Technician	Chemistry	2	2
Crew Accounting Supervisor	Fuel Handling	1	1
Emergency MCRA (CSP Monitor)	Operations	1 (8)	1
Emergency Response Maintainer (ERM)	Fire Protection	6	6
Emergency TRF Operator	TRF	1	1
Emergency Unit Operator (Units 1–4)	Operations	5	5
EPGQO - Unit 0 Nuclear Operators/FSNO (2)	Operations	3	3
In-Plant Survey Team	Operations	2	3
In-Plant Coordinator	Operations	1	1
Off-Site Survey Team Captain (3)	Maintenance	1 [0]	1 [0]
Off-Site Survey Team (3)	Maintenance	2 [0]	2 [0]
Out-of-Plant Coordinator (3)	Maintenance	1 [0]	1 [0]
Emergency Shift Assistant (ESA)	Operations	1	1
Shift Emergency Response Coordinator	Fire Protection	1	1
Shift Manager (4)	Operations	1	1
Control Room Shift Supervisor (CRSS)	Operations	1	1
Shift Resource Coordinator	Maintenance	1	1
TRF SNO	TRF	1	1
TRF Major Panel Operator	TRF	1	1
Supervising Nuclear Operator (Units 1–4)	Operations	4	4
Mechanical Maintainer (7) – DBA action	Maintenance	1	1
Shift Control Technician (7) – DBA action	Maintenance	1	1
Security (5)	Security	NS (6)	NS (6)
Total		**47 [44]**	**49 [45]**

(1) To ensure the assignment of ERO roles is managed, the assignment of staff by each Work Group is identified in the above table. Nevertheless, these positions may be filled by staff from any work group provided they are qualified and incremental to the roles that are Work Group specific.

(2) The Unit 0 complement requirements for a Main Steam Line Break or a Common Mode Event are one (1) EPGQO and two (2) Unit 0 NO's. In order to facilitate tracking of the EPG Qualified Operators and the Unit 0 NO's together in the Minimum Complement Coordination Program, the station shall continue to ensure that all Unit 0 NO's are EPG qualified. They are to be available to restore EPS/ESW to all affected units within 30 minutes.

(3) Day shift only position (12 hours/day, 7 days/week). Night shift complement, where different from days, shown in square brackets [ ].

(4) The Shift Manager executes both the emergency Shift Manager role and the ERM role until such time as the Site Management Center is declared operational.

(5) Security shall provide two drivers for the Off-Site Survey Team.

(6) NS = not specified in this document – security protected. Refer to Site Security Report.

(7) One MM and one SCT have Design Basis Accident response duties (refer to N-INS-03490-10003 for details on credited MM/CM response to Loss of Instrument Air event and PHT LRV Fail Open event).

(8) When a reactor unit is in a defueled state, the minimum complement of certified ANOs required to be present in the facility is reduced to five (5) and the minimum complement of Emergency MCRAs (CSP Monitors) is increased to two (2) to maintain overall Operations minimum complement unchanged. Any certified ANO surplus to minimum complement can also fill the role of emergency MCRA.

Control Room Staffing

The licensee shall comply with the minimum certified personnel requirements for the nuclear facility and for the main control room. The certified positions are listed in LC 2.3.

In conjunction with the minimum shift complement for the facility, the licensee shall maintain adequate control room staffing. For the following certified positions, the licensee shall have the following certified personnel at all times:

(i) in the nuclear facility, at least one certified shift manager, one certified control room shift supervisor, two certified unit 0 control room operators, and the following number of authorized nuclear operators for the specified number of reactor units with fuel in the core.

- (a) Five authorized nuclear operators for three fueled units; and
- (b) Six authorized nuclear operators for four fueled units.

(ii) in the main control room, at least the following number of certified authorized nuclear operators for the specified number of reactor units with fuel in the core:

- (a) Three authorized nuclear operators for three fueled units; and
- (b) Four authorized nuclear operators for four fueled units.

(iii) in the main control room, at least one certified unit 0 control room operator, except for brief absences to determine the origin of fire alarms.

(iv) in the main control room, a certified authorized nuclear operator in direct attendance at the control panels of each reactor unit with fuel in the core.

The minimum certified personnel requirements for the main control room that this condition imposes do not apply where this minimum cannot be met due to emergency conditions that could cause an unwarranted hazard to personnel in the main control room, in which case the licensee shall place the reactor(s) in a safe shutdown state and the nuclear facility in a safe condition.

"In direct attendance" means the certified person must physically be in the direct line of sight and in close proximity to the control room panels to continuously monitor, recognize and differentiate panel displays, alarms and indications.

A certified person shall be in a position to rapidly respond, in accordance with his/her role, to changing unit conditions, at all times, as described in D-PROC-OP-0009, *Station Shift Complement*.

The following documents require written notification of change:

Document Title	Document #	Notification Status
Station Shift Complement	D-PROC-OP-0009	PI
Duty Crew Minimum Complement Assurance	D-INS-09260-10001	PI

Recommendations and Guidance

The adequacy of the minimum shift complement should be determined through a systematic analysis of the most resource-intensive conditions under all operating states, design basis accidents, and emergencies. The results of the analysis should then be validated to determine the degree to which the minimum shift complement facilitates the achievement of the overall safety goals.

Recommendations and guidance for the development and validation of the minimum shift complement are provided in the following CNSC guidance documents:

- REGDOC-2.2.5, Minimum Shift Complement describes the CNSC recommended approach for defining the minimum shift complement and sets out the key factors that CNSC staff will take into account when assessing whether the licensee has made, or the applicant will make, adequate provision for ensuring the presence of a sufficient number of qualified staff.
- REGDOC-2.5.1, General Design Considerations: Human Factors describes the elements of effective human factors verification and validation planning, including a suggested format for documenting these elements.

2.3 Personnel Training

Licence Condition 2.3:

The licensee shall implement and maintain training programs for workers.

Preamble

The *General Nuclear Safety and Control Regulations* require the licensee to train the workers to carry on the licensed activity in accordance with the *Nuclear Safety and Control Act*, the associated regulations and the licence.

The *Class I Nuclear Facilities Regulations* requires that:

- A licence application to operate a Class I nuclear facility contain the proposed responsibilities of and qualification requirements and training program for workers, including the procedures for the requalification of workers; and
- The licensee submits the necessary information for certification or renewal of certification of the applicable positions.

Compliance Verification Criteria

The licensee shall implement and maintain programs for training of personnel. The licensee shall implement and maintain initial and continuing training programs for all workers in accordance with CNSC regulatory document REGDOC-2.2.2, *Personnel Training, Version 2*.

Relevant documents that require version control:

Source	Document Title	Document #	Revision #	Effective Date
CNSC	Personnel Training, Version 2	REGDOC-2.2.2	2016	2024-03-19

The licensee shall implement and maintain an overall training policy, including initial and continuing training sub-programs for all workers. The program shall be based on long-term qualifications and competencies required for job performance, as well as training goals that acknowledge the critical role of safety.

Training Programs for All Workers

As defined by the *General Nuclear Safety and Control Regulations*, a worker is a person who performs work that is referred to in a licence. Workers include contractors and temporary employees; therefore, training requirements apply equally to these types of workers as to the licensee's own employees.

This licence condition provides the regulatory requirements for the development and implementation of training programs for workers. It also provides the requirements for training programs and processes necessary to support responsibilities, qualifications and requalification training of persons at the nuclear facility.

The licensee shall ensure that all workers are qualified to perform the duties and tasks required of their position.

All training programs related to workers in positions where the consequence of human error poses a risk to the environment, the health and safety of persons, or to the security of the nuclear facilities and licensed activities, are evaluated against the criteria for a systematic approach to training (SAT).

The following documents require written notification of change:

Document Title	Document #	Notification Status
Training	N-PROG-TR-0005	TI
Systematic Approach to Training	N-PROC-TR-0008	TI

Recommendations and Guidance

This section has no contents applicable to this LC.

2.4 Personnel Certification

<u>Licence Condition 2.4:</u>

> **The licensee shall implement and maintain certification programs in accordance with CNSC regulatory document REGDOC-2.2.3, PERSONNEL CERTIFICATION, VOLUME III: CERTIFICATION OF REACTOR FACILITY WORKERS, VERSION 2. Workers who began an applicable initial training program in accordance with the requirements outlined in REGDOC-2.2.3, Personnel Certification, Volume III: Certification of Persons Working at Nuclear Power Plants, before January 31, 2025, may continue to be certified under requirements of this version until January 31, 2030.**
>
> **Persons appointed to the following positions require certification:**
>
> **(i) Responsible Health Physicist;**
> **(ii) Shift Manager;**
> **(iii) Control Room Shift Supervisor;**
> **(iv) Authorized Nuclear Operator; and**
> **(v) Unit 0 Control Room Operator.**

<u>Preamble</u>

This LC provides the regulatory requirements for the programs and processes to be implemented in support of the certification and the renewal of the certification of workers employed in designated positions, including those related to initial and continuing training, certification examinations, and requalification testing.

The licensee's governance describes the roles and responsibilities of workers employed in designated positions.

<u>Compliance Verification Criteria</u>

The licensee shall ensure that workers employed in designated positions at the nuclear facility hold a valid certification duly issued by the CNSC for the position to which they have been appointed.

The licensee shall implement and maintain effective qualification and requalification programs in support of the certification, and the renewal of the certification, of workers employed in the positions designated in the licence in accordance with the requirements and guidance set out in CNSC regulatory document REGDOC-2.2.3, *Personnel Certification, Volume III: Certification of Reactor Facility Workers.*

The initial and continuing training programs implemented in support of personnel certification shall also comply with the requirements and guidance set out in CNSC regulatory document REGDOC-2.2.2, *Personnel Training.*

The roles and responsibilities of the designated positions are considered safety and control measures. Any changes to the associated documentation will be reviewed by CNSC staff to confirm said roles and responsibilities remain within the licensing basis, in consultation with a the appropriate designated officer authorized to certify and decertify persons referred to in sections 9 and 12 of the *Class I Nuclear Facilities Regulations*. The general criteria for reviewing changes include those described in Appendix

A.4. Any changes outside the licensing basis would require prior written approval of the Commission, per LC G.1.

Relevant documents that require version control:

Source	Document Title	Document #	Revision #	Effective Date
CNSC	Personnel Training	REGDOC-2.2.2	2016 (Version 2)	2024-03-19
CNSC	*Personnel Certification, Volume III:* Certification of Reactor Facility Workers	REGDOC-2.2.3	2023 (Version 2)	2025-02-07

Conduct of Examinations and Tests for Certified Personnel

Currently, the following three CNSC documents contain the requirements and guidance for administering the certification examinations and requalification tests required by REGDOC-2.2.3, Volume III:

- CNSC-*EG1, Rev.0: Requirements and Guidelines for Written and Oral Certification Examinations for Shift Personnel at Nuclear Power Plants*,
- CNSC-*EG2, Rev.0: Requirements and Guidelines for Simulator-based Certification Examinations for Shift Personnel at Nuclear Power Plants*, and
- CNSC document: *Requirements for the Requalification Testing of Certified Shift Personnel at Nuclear Power Plants, Revision 2.*

Under a pilot program approved by CNSC staff (e-Doc 6352433), OPG may choose to administer the General Written Initial Certification Examinations (specified in CNSC-EG1) using Multiple Choice Question (MCQ) format. During this pilot program, the development, conduct, and marking of MCQ General initial certification examinations shall be in accordance with the following OPG document(s):

- N-INS-08920-10004, Written and Oral Initial Certification Examination for Shift Personnel

The following documents require written notification of change:

Document Title	Document #	Notification Status
Training	N-PROG-TR-0005	TI
Systematic Approach to Training	N-PROC-TR-0008	TI
Written and Oral Initial Certification Examination for Shift Personnel	N-INS-08920-10004	PI
Simulator-Based Initial Certification Examinations for Shift Personnel	N-INS-08920-10002	TI
Requalification Testing of Certified Shift Personnel	N-INS-08920-10001	TI
Responsible Health Physicist	N-MAN-08131-10000-CNSC-031	PI

Document Title	Document #	Notification Status
Shift Manager, Darlington Nuclear	N-MAN-08131-10000-CNSC-006	PI
Authorized Nuclear Operator	N-MAN-08131-10000-CNSC-010	PI
Control Room Shift Supervisor – Darlington Nuclear	N-MAN-08131-10000-CNSC-008	PI
Unit 0 Control Room Operator	N-MAN-08131-10000-CNSC-025	PI

Recommendations and Guidance

This section has no contents applicable to this LC.

3 SCA – OPERATING PERFORMANCE

The safety and control area "Operating Performance" includes an overall review of the conduct of the licensed activities and the activities that enable effective performance.

Performance Objective(s)

Plant operation is safe and secure, with adequate regard for health, safety, security, radiation and environmental protection, and international obligations.

3.1 Operations Program

Licence Condition 3.1:

The licensee shall implement and maintain an operations program, which includes a set of operating limits.

Preamble

The *Class I Nuclear Facilities Regulations* require that a licence application contain the proposed measures, policies, methods and procedures for operating and maintaining the nuclear facility.

The operations program establishes safe operating practices within the nuclear facility, under all operating conditions (routine and non-routine), and provides the ability to ensure the facility is operated in such a manner that:

- Applicable regulations, licence conditions, and standards are followed;
- The requirements of the Operating Policies and Principles (OP&Ps) are implemented; and
- Limits are established in accordance with a Safe Operating Envelope (SOE) are not exceeded.

The OP&Ps:

- Define the operating rules consistent with the safety analyses and other licensing support documentation within which the facility will be operated, maintained and modified, all of which should ensure nuclear safety;
- Specify the authorities of the facility staff positions to make decisions within the defined boundaries; and
- Identify and differentiate between actions where discretion may be applied and where jurisdictional authorization is required.

The SOE is defined in CSA standard N290.15, *Requirements for the safe operating envelope of nuclear power plants*, as "the set of limits and conditions within which the nuclear generating station must be operated to ensure compliance with the safety analysis upon which reactor operation is licensed and which can be monitored by or on behalf of the operator and can be controlled by the operator."

The SOE consists of a number of parameters:

- Safe operating limits;

- Conditions of operability;
- Actions and action times; and
- Surveillances.

The safe operating limits are derived from the safety analysis limits. The SOE parameters are currently identified in various station documents, including Operational Safety Requirements (OSR), Instrument Uncertainty Calculations (IUC), the Abnormal Incidents Manual and surveillance documentation. Power limit specifications set limits on parameters that affect reactor core, channel, and fuel bundle powers, to ensure compliance with limits imposed by the Design and Safety Analysis assumptions. The magnitude of the initial reactor power, channel powers and bundle powers in the reactor prior to an accident are the fundamental parameters governing whether fuel or fuel channel failure will occur during anticipated transients and the postulated Design Basis Accidents (DBA).

Heat sinks are combination of systems or portions of systems that contribute to conveying heat to the atmosphere or body of water, known as the ultimate heat sink (UHS). The goal of the heat sink systems is to provide heat removal from the heat source (reactor core, pump heat) to the UHS, where the residual heat can always be transferred.

The outage heat sink management defines the strategy to ensure the plant is safe throughout the outage duration when the normal (at high power) heat sinks may not be available. The outage is considered to be terminated when the normal heat sinks are re-established as part of the plan to proceed to sustained high power operation.

Accident management provisions are to ensure effective defences against radiological hazards resulting from DBAs and Beyond Design Basis Accidents (BDBAs). The fundamental premise underlying accident management is that the licensee has established and maintained overlapping measures for accident prevention and, should an accident occur, is able to:

- Prevent the escalation of the accident;
- Mitigate the consequences of the accident; and
- Achieve a long-term safe stable state after the accident.

Compliance Verification Criteria

The licensee shall implement and maintain operations programs. These programs shall consist of, at a minimum, a safe operating envelope, a set of operating policies and principles, and accident management procedures and/or guides for design basis and beyond design basis accidents, including overall strategies for recovery. These programs shall comply with the requirements set out in:

- CNSC regulatory document REGDOC-2.3.2, *Accident Management*, Version 2; and
- CSA standard N290.15, *Requirements for the safe operating envelope of nuclear power plants*.

Relevant documents that require version control:

Source	Document Title	Document #	Revision #	Effective Date
CSA	Requirements for the safe operating envelope of nuclear power plants	N290.15	2019	2024-03-19
CNSC	Accident Management	REGDOC-2.3.2	2015 (Version 2)	2023-04-19

Operation in states not considered in, or not bounded by, the safety analyses is not permitted.

Aspects of operations or procedures that impact the limits documented in the operating policies and principles or safe operating envelope are considered safety and control measures and therefore subject to LC G.1.

Power Limits

In accordance with the Safety Analysis (refer to LC 4.1) and the Licensing Basis (refer to LC G.1), during operation:

- The total power generated in any one fuel bundle shall not exceed the applicable channel-specific bundle power limit as defined in the current licensing submissions under steady-state operating conditions. The maximum value in the channel-specific bundle power limit map is 908.5 kilowatts.
- The total power generated in any fuel channel shall not exceed the applicable channel-specific channel power limit as defined in the current licensing submissions under steady-state operating conditions. The maximum value in the channel-specific power limit map is 7200 kilowatts.
- The total thermal power from the reactor fuel shall not exceed 2776 megawatts under steady-state operating conditions.
- The reactor, channel and bundle power limits are considered safety and control measures. Any changes to them, or planned operations outside of these limits are subject to LC G.1.

Operating Policies and Principles

The operating policies and principles shall provide direction for the safe operation and as a minimum, reflect the safety analyses that have been previously submitted to the Commission.

The licensee shall, at all times, maintain and operate the nuclear facility within the limits of the OP&Ps and SOE. If operation outside the operating boundaries as defined in the OP&Ps and SOE is discovered, the licensee shall take immediate action to return the facility within the boundaries of safety analyses, in a safe manner.

Safe Operating Envelope

The licensee's safe operating limits, conditions and surveillance requirements, as well as their bases are documented in station and system specific OSR documents along with any associated IUCs. The limits and conditions defined in the OSRs, including any requirements for corrective or mitigating actions and action times, are specified in the applicable operations and maintenance tests, procedures and processes to ensure compliance with the SOE.

The licensee shall maintain a set of OSRs and IUCs that define the limits and conditions of the safe operating envelope.

The SOE is considered part of the licensing basis. Any changes to the safety and control measures listed in the SOE documentation (including OSRs and IUCs) require Prior Written Notification, subject to LC G.1 and G.2.

Changes affecting SOE documentation, that are credited through approved Document Change Requests and have resulted in revisions to downstream SOE documentation, require Prior Written Notification, subject to G.2

Accident Management

The licensee shall implement and maintain operational procedures for operation in all states analyzed in the design basis, including abnormal and emergency states.

The licensee's operational procedures ensure that the operation of the facility can be returned to a safe and controlled state should operation deviate from normal operation. The licensee shall ensure all abnormal operational scenarios analyzed in the design basis are accounted for in the operational procedures with the purpose of mitigating situations that may arise which cause a deviation from the expected state. These documents are conceived to return the plant to a safe and controlled state and to prevent the further escalation of the abnormal incident into a more serious deviation.

In addition to the operational guidance for abnormal and emergency states, the licensee shall implement and maintain a severe accident management program to address residual risks posed by severe accidents. The licensee shall also ensure clear instruction is provided directing operations to use an appropriate set of severe accident management guidelines (SAMGs), if a severe accident is detected.

Incorporating lessons learned from world events, OPG has issued a series of emergency operating procedures, the Emergency Mitigating Equipment Guidelines (EMEGs). EMEGS were developed to enable the use of portable diesel pumps and generator to provide coolant inventory make up (to steam generators, moderator and heat transport systems), and electrical power to essential instrumentation. The EMEGs are initiated following a total loss of Class IV and Class III electrical power or a Seismic Event where both Emergency Power Generators fail and cannot be restored, with the intention of preventing a Fukushima type core damage event.

The licensee shall ensure clear instruction is provided directing operations in abnormal scenarios to the appropriate set of procedures or guides.

OPG is compliant with the 2015 version of REGDOC-2.3.2, *Accident Management,* Version 2 as of 19 April 2023.

Other Requirements

All work-related tasks shall be supported by procedures that are fit for purpose and are used appropriately to minimize the potential for human error.
Additionally, the licensee shall maintain a set of technical basis documents describing the design basis for chemistry control.

In addition to the documents listed in the table below, the licensee shall provide WN to CNSC staff prior to implementation, of any changes to any procedures that could potentially impact on the reactor, the channel or the bundle power limits. Changes that would impact these limits are subject to LC G.1.

In 2013, CNSC staff agreed to the implementation of Rod-based Guaranteed Shutdown State as a Guaranteed Shutdown State at Darlington NGS (e-Doc 4192803). In 2019, CNSC staff provided concurrence to OPG's request to extend the applicability of RBGSS for outages up to 375 days in length, without the need to notify CNSC staff (e-Doc 5979625). RBGSS is established through the application of physical barriers and procedural controls guaranteeing that the shut-off absorbers, control absorbers, and adjuster absorber rods remain in-core to ensure a sub-critical reactor status. In addition, to the inserted rods, a concentration of at least 3.3 ppm of Gadolinium Nitrate (Gd) is maintained in the moderator as a "poison" providing additional defence-in-depth. The licensee shall provide prior written notification for changes to operations or procedures for the Rod-based Guaranteed Shutdown State. CNSC staff will use the criteria in Appendix A.4 and any other applicable criteria to confirm the changes remain within the licensing basis. Changes outside of the licensing basis will require prior written approval by the Commission, per LC G.1.

OPG has committed to implementing CSA N290.11-13 (R2019), *Requirements for reactor heat removal capability during outage of nuclear power plants* by 30 September 2025 [CD# NK38-CORR-00531-25642, e-Doc 7372903].

The following documents require written notification of change:

Document Title	Document #	Notification Status
Operating Policies and Principles	NK38-OPP-03600	PI
Safe Operating Envelope	N-STD-MP-0016	PI
Heat Sink Management	N-STD-OP-0025	TI
Nuclear Safety Configuration Management	N-STD-OP-0024	TI
Nuclear Operations	N-PROG-OP-0001	TI
Chemistry	N-PROG-OP-0004	TI
Conservative Decision-Making	N-STD-OP-0012	TI
Operational Decision Making	N-STD-OP-0036	TI
Beyond Design Basis Accident Management	N-STD-MP-0019	PI

Document Title	Document #	Notification Status
Operations Performance Monitoring	N-STD-OP-0011	TI
Operating Experience Process	N-PROC-RA-0035	TI
Processing Station Conditions Records	N-PROC-RA-0022	TI
Performance Improvement	N-PROG-RA-0003	TI
Response to Transients	N-STD-OP-0017	TI
Reactor Safety Program	N-PROG-MP-0014	TI
Reactivity Management	N-STD-OP-0009	TI
Control of Fuelling Operations	N-STD-OP-0021	TI
Darlington Operational Safety Requirements: Emergency Coolant Injection System	NK38-OSR-08131.02-10001	PI
Darlington Operational Safety Requirements: Emergency Service Water System	NK38-OSR-08131.02-10002	PI
Operational Safety Requirements: Fuel and Reactor Physics	NK38-OSR-08131.02-10003	PI
Shutdown Systems	NK38-OSR-08131.02-10004	PI
Darlington Operational Safety Requirements: Main Steam Supply System	NK38-OSR-08131.02-10005	PI
Darlington NGS: Negative Pressure Containment	NK38-OSR-08131.02-10006	PI
Darlington Operational Safety Requirements: Steam Generator Emergency Cooling System	NK38-OSR-08131.02-10007	PI
Darlington NGS Operational Safety Requirements: Moderator System	NK38-OSR-08131.02-10008	PI
Operational Safety Requirements: Powerhouse Steam Venting System	NK38-OSR-08131.02-10009	PI
Operational Safety Requirements: Reactor Regulating System	NK38-OSR-08131.02-10010	PI

Document Title	Document #	Notification Status
Darlington Operational Safety Requirements: Group 1 Service Water Systems	NK38-OSR-08131.02-10011	PI
Darlington NGS Emergency Power Supply System	NK38-OSR-08131.02-10012	PI
Darlington Operational Safety Requirements: Feedwater System	NK38-OSR-08131.02-10013	PI
Darlington Operational Safety Requirements: Shutdown Cooling System	NK38-OSR-08131.02-10014	PI
Darlington Operational Safety Requirements: Heat Transport System	NK38-OSR-08131.02-10015	PI
Darlington NGS: Group 1 Electrical Power Systems	NK38-OSR-08131.02-10016	PI
Darlington Operational Safety Requirements: Toxic Gas Monitoring and MCR Breathing Air	NK38-OSR-08131.02-10017	PI
Darlington NGS Operational Safety Requirements: Fuel Handling System and Irradiated Fuel Bays	NK38-OSR-08131.02-10018	PI
Darlington NGS Operational Safety Requirements: Powerhouse Steam and Flooding Protective Provisions	NK38-OSR-08131.02-10019	PI
Darlington NGS Operational Safety Requirements: Annulus Gas System	NK38-OSR-08131.02-10020	PI
Darlington NGS Critical Safety Parameter Monitoring Instrumentation	NK38-OSR-08131.02-10021	PI
Darlington NGS Operational Safety Requirements: Shield Cooling System	NK38-OSR-08131.02-10022	PI
Darlington NGS ECIS Instrument Uncertainties and Allowable values	NK38-CALC-63432-10001	PI
Darlington NGS SDS1 Instrument Uncertainties and Allowable values	NK38-CALC-68200-10001	PI
Darlington NGS SDS2 Instrument Uncertainties and Allowable values	NK38-CALC-68300-10001	PI

Document Title	Document #	Notification Status
Darlington NPCS Instrument Uncertainties and Allowable values	NK38-CALC-63420-10001	PI
Darlington NGS Steam Generator Emergency Cooling System Instrument Uncertainties and Allowable Values	NK38-CALC-63671-10001	PI
Darlington NGS Moderator System Instrument Uncertainties and Allowable Values	NK38-CALC-63210-10001	PI
Darlington PSVS Instrument Uncertainties and Allowable Values	NK38-CALC-67322-10001	PI
Darlington NGS Reactor Regulating System Instrument Uncertainties and Allowable Values	NK38-CALC-63700-10001	PI
Darlington NGS Feedwater System Instrument Uncertainties and Allowable Values	NK38-CALC-64320-10001	PI
Darlington NGS Shutdown Cooling System Instrument Uncertainties and Allowable Values	NK38-CALC-63341-10001	PI
Darlington HTS Instrument Uncertainties and Allowable Values	NK38-CALC-63330-10001	PI
Darlington NGS Powerhouse Steam and Flooding Protective Provisions Instrument Uncertainties And Allowable Values	NK38-CALC-67320-10001	PI
Darlington NGS Annulus Gas System Instrument Uncertainties and Allowable Values	NK38-CALC-63488-10001	PI
Darlington NGS Critical Safety Parameter Monitoring Instrumentation Uncertainties and Allowable Values	NK38-CALC-60350-10001	PI
Darlington NGS Shield Cooling System Instrument Uncertainties and Allowable Values	NK38-CALC-63411-10001	PI

Recommendations and Guidance

The licensee should manage all outage heat sink work activities in accordance with CSA standard N290.11, *Requirements for heat removal capability during outage of nuclear power plants*.

Additional recommendations and guidance regarding Beyond Design Basis Accidents (BDSAs) are found in CSA standard N290.16, *Requirements for beyond design basis accidents.*

3.2 Approval to Restart After a Serious Process Failure

Licence Condition 3.2:

The licensee shall not restart a reactor after a serious process failure without the prior written approval of the Commission, or the prior written consent of a person authorized by the Commission.

Preamble

A serious process failure and its related definitions are defined, as follows:

- Serious process failure – With respect to CANDU reactor facilities, a failure that leads or that could lead, in the absence of action by any special safety system, to significant fuel damage or a significant release from the CANDU reactor facility.
- Significant fuel damage - An event or situation that brought the fuel (>1%) outside of its fitness for service limits.
- Significant release – A release of radioactive material that results in an effective dose, received by or committed to a typical member of the critical group, in excess of 0.5 millisievert.

The definition of serious process failure can also be found in CNSC regulatory document REGDOC-3.6, *Glossary of CNSC Terminology*. The reporting requirements are also provided in CNSC regulatory document REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants*.

As described in Appendix A.1, on Delegation of Authority, Delegation of approval by the Commission, to give consent, applies to the incumbents of the following positions:

- Darlington Regulatory Program Director,
- Director General, Directorate of Power Reactor Regulation, and
- Executive Vice President and Chief Regulatory Operations Officer, Regulatory Operations Branch.

Person(s) authorized have the authority to give the consent to OPG to proceed with the restart of the Darlington NGS reactor if there is sufficient assurance that the following criteria have been met, otherwise, approval to restart must be granted by the Commission:

- Cause of the serious process failure has been resolved;
- Darlington NGS is within the licensing basis;
- Fuel is fit for service; and
- the serious process failure did not exceed a frequency of greater than one per three year rolling period

Compliance Verification Criteria

Serious process failures are reportable in accordance with REGDOC-3.1.1, [LC 3.3]. When an event is found to be a serious process failure or where the determination as to the cause and/or extent of condition has proved inconclusive (i.e. a serious process failure cannot be ruled out), a formal request for restart of the reactor shall be submitted in writing to the CNSC. In accordance with the licence condition, to restart the reactor, OPG shall obtain approval of the Commission, or the prior written consent of a person authorized by the Commission, depending on the criteria.

The written request for restart of the reactor shall include the following information:

- Description of the event;
- Causes of the event;
- Consequences and safety significance of the event;
- Recovery plan including corrective actions, and fitness for service assessment on the systems/components impacted from the failure if applicable, which shall be completed prior to reactor restart;
- A statement regarding plant readiness to resume safe operation, which shall include any conditions that the licensee proposes to impose upon reactor restart and/or subsequent reactor operation to ensure safe operation of the nuclear facility; and
- Extent of completion of the conditions mentioned in the statement regarding plant readiness to resume safe operation.

As specified for LC G.1, for unapproved operation that is not in accordance with the licensing basis, the licensee shall take action as soon as practicable to return to a state consistent with the licensing basis, taking into account the risk significance of the situation.

For minor deviations outside the licensing basis, the licensee may use their internal procedures to return to a state consistent with the licensing basis and report the incident to the CNSC through REGDOC-3.1.1 [LC 3.3].

For more significant situations, serious process failures, approval or consent is required before returning to service in accordance with LC 3.2. In such cases systematic and systemic damage to a barrier to the release of radioactivity has or could have occurred.

The following documents require written notification of change:

Document Title	Document #	Notification Status
Operating Policies and Principles	NK38-OPP-03600	PI
Reactor Safety Program	N-PROG-MP-0014	TI
Response to Transients	N-STD-OP-0017	TI

Recommendations and Guidance

In addition to the requirements listed above, the written request to restart a reactor after a serious process failure should also include the following information:

- Documentation and communication to licensee staff addressing the root cause analysis, corrective actions, and plant readiness to resume operation (including additional training, if necessary); and
- Applicable historical Operating Experience (OPEX) review for comparable events (OPEX is further described in LC 1.1).

As the fuel sheath is the barrier that contains the vast majority of the fission products during normal operations, this barrier was selected, with its fitness for service limits as the criteria. Specifically: Sheath Temperatures less than or equal to 450 C; and Sheath Strains less than or equal to 0.5%.

In order to screen out insignificant events, such as individual fuel failure due to debris fretting, a threshold criteria was established of at least 1% of the core or about 50 bundles in the definition for significant fuel damage. If a single component of a bundle is not fit for service (e.g. one pin) then the entire bundle is not fit for service.

A review of the applicable criteria should be performed to ensure the continued operations will remain within the licensing basis, in accordance with Appendix A of CNSC internal document “Overview of assessing licensee changes to documents or operations”, e-Doc 4055483 including results of Serious Process Failure Tool screening, e-Doc 7046698.

Relevant guidance publications:

Source	Document Title	Document #	Revision #
CNSC	Nuclear Fuel Safety	REGDOC-2.4.5	April 2024
COG	Principles & Guidelines For Deterministic Safety Analysis, CANDU Owners Group, Safety Analysis Improvement Task Team	COG-09-9030	R03
COG	Fuel and Pressure Tube Fitness-For-Service Criteria for LOF, SBLOCA and Slow LORC	COG-12-2049	July 2015

3.3 Reporting Requirements

Licence Condition 3.3:

The licensee shall notify and report in accordance with CNSC regulatory document REGDOC 3.1.1 REPORTING REQUIREMENTS: NUCLEAR POWER PLANTS.

Preamble

CNSC regulatory document REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants*, has comprehensive reporting requirements (scheduled and unscheduled) for operation of NPPs. It describes information that the CNSC needs to evaluate the performance of the facilities it regulates. This document is complementary to the reporting requirements in the *Nuclear Safety and Control Act* and the associated regulations.

Compliance Verification Criteria

Relevant documents that require version control:

Source	Document Title	Document #	Revision #	Effective Date
CNSC	Reporting Requirements for Nuclear Power Plants	REGDOC-3.1.1	2016 (Version 2)	2024-03-19

In April 2024, the Commission published REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants*, Version 3 (2024). OPG was requested to provide an implementation plan for event reports by 03 February 2025. For the quarterly reports, OPG has committed to begin submitting reports in accordance with REGDOC-3.1.1 version 3 for the reporting period starting in January 2025. For the annual reports, OPG has committed to adapting the 2024 reporting period data that would be reported in 2025 to version 3.

The following documents require written notification of change:

Document Title	Document #	Notification Status
Written Reporting to Regulatory Agencies	N-PROC-RA-0005	TI
Preliminary Event Notifications	N-PROC-RA-0020	TI

Recommendations and Guidance

This section has no contents applicable to this LC.

3.4 Periodic Safety Review

Licence Condition 3.4:

The licensee shall conduct and submit, results of a periodic safety review at least every 10 years.

Preamble

In support of refurbishment activities and continued long term operation, OPG has conducted an Integrated Safety Review in accordance with CNSC regulatory document RD-360, *Life Extension of Nuclear Power Plants*.

An Integrated Safety Review (ISR) is a process which includes an assessment of the current state of the plant and plant performance to determine the extent to which the plant conforms to modern standards and practices, and to identify any factors that would limit safe long-term operation. The process starts with a comprehensive review of the facility and its operations and results in the production of an integrated implementation plan (IIP) which describes practical and reasonable modifications to be carried out by the licensee.

The periodic safety review (PSR) process mirrors this approach. The PSR process requires OPG submittal of a PSR basis document, safety factor reports, a global assessment report and an Integrated Implementation Plan. Per international practice, the appropriate interval between PSRs is considered to be 10 years.

Compliance Verification Criteria

The licensee shall conduct a PSR in accordance with CNSC regulatory document REGDOC-2.3.3, *Periodic Safety Reviews*.

Relevant documents that require version control:

Source	Document Title	Document #	Revision #	Effective Date
CNSC	Periodic Safety Reviews	REGDOC-2.3.3	2015	2016-01-01

Recommendations and Guidance

When conducting a PSR, the licensee should refer to CSA standard N290.18, *Periodic safety review for nuclear power plants (2017), and IAEA, Specific Safety Guide No. SSG-25 - Periodic Safety Review for Nuclear Power Plants (2013)* for further guidance.

When preparing the subsequent OPG Darlington licence application, OPG should refer to REGDOC-1.1.3, *Licence Application Guide: Licence to Operate a Nuclear Power Plant*, and ensure that the application addresses it to the extent practicable. This document provides information that supplements and clarifies the basic requirements of the regulations to assist an applicant in providing a sufficient level of detail in the application. It contains clearly separated references to CNSC REGDOCs and industry codes and standards that an applicant must comply with and those which an applicant is recommended to address. Additionally, descriptions of the contents of the programs to be submitted are contained in this REGDOC.

4 SCA – SAFETY ANALYSIS

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

Performance Objective(s)

There is demonstration of the acceptability of the frequency and consequences of design-basis and beyond design basis events, and the ability of protective systems and emergency mitigating equipment to adequately control power, cool the fuel and contain or limit any radioactivity that could be released from the plant.

4.1 Safety Analysis Program

Licence Condition 4.1:

The licensee shall implement and maintain a safety analysis program.

Preamble

The *General Nuclear Safety and Control Regulations* require that a licence application contain a description and the results of any analyses performed.

The *Class I Nuclear Facilities Regulations* require, amongst other requirements, that a licence application contain a final safety analysis report, and additional supporting information.

A deterministic safety analysis evaluates the NPP's responses to such events by using predetermined rules and assumptions (conservative or best-estimate methods). The objectives of the deterministic safety analysis (DSA) are stated in CNSC regulatory document REGDOC-2.4.1, *Deterministic Safety Analysis*. DSA allows predicting the extent of potential loads, such as temperatures and pressures, on reactor system and structures in assumed accident scenarios.

Probabilistic safety assessment (PSA) is a comprehensive and integrated assessment of the safety of the nuclear power plant that, by considering the initial plant state and the probability, progression, and consequences of equipment failures and operator response, derives numerical estimates of a consistent measure of the safety of the design. Such assessments are most useful in assessing the relative level of safety. The objectives of the probabilistic safety analysis are stated in CNSC regulatory document REGDOC-2.4.2, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants*.

CSA standard N286.7, *Quality assurance of analytical, scientific and design computer programs,* provides the specific requirements related to the development, modification, maintenance and use of computer programs used in analytical, scientific and design applications. These requirements apply to the design, development, modification and use of computer programs that are used in analytical, scientific and design applications at nuclear power plants.

Compliance Verification Criteria

The licensee shall implement and maintain programs for the development and updates of safety analyses. These programs shall comply with the requirements set out in:

- CNSC regulatory document REGDOC-2.4.1, *Deterministic Safety Analysis*;
- CNSC regulatory document REGDOC-2.4.2, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants*; and
- CSA standard N286.7, *Quality assurance of analytical, scientific and design computer programs*.

Relevant documents that require version control:

Source	Document Title	Document #	Revision #	Effective Date
CNSC	Deterministic Safety Analysis	REGDOC-2.4.1	2014	2016-01-01
CNSC	Probabilistic Safety Assessment (PSA) for Nuclear Power Plants	REGDOC-2.4.2	2014	2020-01-01
CSA	Quality assurance of analytical, scientific and design computer programs	N286.7	2016 (Reaffirmed 2021)	2024-09-27

The licensee shall demonstrate compliance of computer programs used in analytical, scientific and design applications used to support the safe plant operation in accordance with CSA N286.7.

Deterministic Safety Analysis

The licensee shall conduct and maintain a deterministic safety analysis as documented in the plant Final Safety Analysis Report. The deterministic safety analysis shall demonstrate that the radiological consequences of the postulated initiating events do not exceed the accident-dependent reference public dose limits in the following table:

	Reference Dose Limit (most exposed member of the public)	
Class of Postulated Event	Thyroid Dose (mSv)	Whole Body Dose (mSv)
Class 1	5	0.5
Class 2	50	5
Class 3	300	30
Class 4	1000	100
Class 5	2500	250

All new analysis will be performed in accordance with REGDOC-2.4.1.

REGDOC-2.4.1 includes modern requirements associated to the lessons learned from the Fukushima nuclear events. OPG has developed an implementation plan while undertaking gap identification and prioritization in compliance with REGDOC-2.4.1 to the extent practicable. During this licence period, OPG shall begin to upgrade the individual sections and appendices that form Part 3, Accident Analysis, of the Darlington Safety Report, in a staged manner in accordance with the implementation plan. To support continued safe operation and the refurbishment project, OPG has a well-structured approach to identifying, prioritizing and updating analyses as required. The implementation plan was revised and submitted to CNSC in 2021 (N-CORR-00531-22934, e-Doc 6703592, enclosure 1) to describe the phase of implementation from 2022 to 2024, N-PLAN-03500-0500515 R005. CNSC staff reviewed the plan and found it to be acceptable, CNSC staff are currently reviewing the enclosures 2 to 5, to the revised implementation plan (e-Doc 6760262).

Recognizing that full implementation of REGDOC-2.4.1 may not be practicable or provide substantial safety benefit beyond the current safety case; a method of evaluating the significance of gaps (applying a graded approach) against REGDOC-2.4.1 and their importance to safety shall be established and applied on an as-needed basis to determine if corrective actions are required.

The Darlington reactors are designed to standards and regulatory requirements that pre-date the issuing of REGDOC-2.4.1. Where compliance with the requirements (e.g., the single failure criterion (SFC)) cannot be demonstrated by the existing design, the REGDOC-2.4.1 requirements should be applied commensurate with risk, such as permitted in Canadian Standards Association CSA N286-12, recognizing the existing design basis.

These include:

- When demonstrating Level 3 DiD for Design Basis Accidents (DBAs)
    - Apply the SFC by selecting the SFC from the active components that are required to change state for each acceptable criterion.
    - For system availability, sensitivity cases instead of the SFC applying the minimum allowable performance, which accounts for the withdrawal from service of components for limited periods for maintenance, testing, inspection, or repair (MTIR) by selecting components unavailable as assessed in the operational limits and conditions.
- For Anticipated Operating Occurrences (AOOs).
    - Assess operating experience to establish whether the facility had a consequential radioactive release and remains operable.
    - Assess Level 2 system actions, if necessary, using realistic operating conditions.
- For each hazard Postulated Initiating Events, classify credible external events into the AOO, DBA and Design Extension Conditions classes using event-specific standards and guidelines that are consistent with the existing design basis of the plant.

Criteria for implementation of REGDOC-2.4.1 include the following elements:

- Assessment of the current safety analysis practices against REGDOC-2.4.1 to identify gaps;
- Prioritization of the identified gaps using formal methods;
- Justification of non-conformances (e.g., full compliance with REGDOC-2.4.1 is not practicable or does not provide a demonstrable safety benefit); and
- Development and execution of corrective action plans to address the important gaps.

OPG, along with industry partners, has developed a set of derived acceptance criteria (DAC) for slow events, as documented in COG-13-9035-R00, *Derived Acceptance Criteria for Deterministic Safety Analysis*. These DAC were reviewed and accepted by CNSC staff (e-Doc 4981431) and shall be used by OPG when conducting deterministic safety analysis.

Additional Requirements

CSA standard N293, *Fire protection for nuclear power plants*, contains specific requirements for deterministic analysis related to fire protection. CNSC staff review the fire safety assessment primarily to verify that the licensee employs appropriate assumptions, uses validated models, applies adequate scope, and demonstrates results that are within the design acceptance criteria. See LC 10.2 for version control of CSA N293.

Probabilistic Safety Assessment

CNSC regulatory document REGDOC-2.4.2 outlines the requirements related to PSA and requires licensees to establish a program for the development and use of PSA as a means to manage radiological risks and to contribute to safe design and operation of reactor facilities.

In accordance with regulatory requirements, OPG shall provide the updated Darlington PSA report and models every 5 years, or sooner if there are significant changes in the plant design or operation. In 2024, OPG submitted the revised PSA methodologies for compliance with REGDOC 2.4.2, Version 2 (2022). The revision included alignment with current REGDOCs, and CSA Guides. CNSC staff concluded that the new and revised Darlington PSA methodologies met the applicable regulatory requirements.

OPG is currently in the process of updating the PSA to the requirements of REGDOC-2.4.2, Version 2. The next Darlington PSA update is expected to be compliant with REGDOC-2.4.2, Version 2, and is due to CNSC staff by 17 December 2025,

The following documents require written notification of change:

Document Title	Document #	Notification Status
Darlington Safety Report Part 1 and 2	NK38-SR-03500-10001	TI
Darlington Nuclear 1-4 Safety Report: Part 3-Accident Analysis	NK38-SR-03500-10002	TI
Darlington Analysis of Record	NK38-REP-00531.7-10001	TI
Beyond Design Basis Accident Management	N-STD-MP-0019	PI
Reactor Safety Program	N-PROG-MP-0014	TI
Safety Analysis Basis and Safety Report	N-PROC-MP-0086	TI
Risk and Reliability Program	N-PROG-RA-0016	TI

Document Title	Document #	Notification Status
Preparation, Maintenance and Application of Probabilistic Safety Assessment	N-STD-RA-0034	TI
Software	N-PROG-MP-0006	TI
Retube Waste Processing Building Safety Analysis Summary Report	NK38-REP-09701-10344	PI
Darlington Retube Waste Processing Building - Safety Assessment	NK38-REP-09701-10326	PI
RWPB Worker Dose During Normal Operations and Under Accident Conditions	NK38-CORR-09701-0597849	PI
Derived Acceptance Criteria for Deterministic Safety Analysis	COG-13-9035-R00	PI

<u>Recommendations and Guidance</u>

Detailed methodologies and derived acceptance criteria for the conduct of deterministic safety analysis are described in the following COG documents:

- COG-09-9030-R03, Principles & Guidelines For Deterministic Safety Analysis;
- COG-11-9023-R00, Guidelines for Application of the Limit of Operating Envelope Methodology to Deterministic Safety Analysis;
- COG-06-9012-R01, Guidelines for Application of the Best Estimate Analysis and Uncertainty (BEAU) Methodology to Licensing Analysis;
- COG-08-2078-R00, Principles and Guidelines for NOP/ROP Trip Setpoint Analysis for CANDU Reactors.

Updates to deterministic safety analysis should contain a revision summary sheet highlighting the key differences between the existing analyses and updated analysis. The revision summary should include:

- Summary of changes (key differences) such as:
  - In acceptance criteria;
  - In event characterization;
  - In safety analysis assumptions;
  - In methodology, or in elements of a methodology;
  - In plant models;
  - In use of computer codes and embedded models;
  - In trip coverage.
- Reasons for updating the analysis and for updating models, assumptions, initial conditions or boundary conditions;
- Significance of changes, and their justification;

- Significant changes in results that may affect the conclusions of the analysis for the design; operational or emergency safety requirements for a particular situation or event; and
- Impact on operating and safety margins.

The licensee should maintain a Safety Report Basis consisting of a listing of Analysis of Record Items and auxiliary documents. The licensee should continue to provide CNSC staff with regular updates of the list indicating the submissions to be included in the next Safety Report update (Part 3).

When the deterministic safety analysis methodology is modified as a result of improved knowledge, or to address emerging issues, the licensee should assess the impact of such a modification on the operating limits, as well as procedural and administrative rules.

The licensee should not credit results obtained with a modified safety analysis methodology to relax operating conditions and/or change safety margins until the modification of the methodology has been reviewed by CNSC staff. If CNSC staff indicate that the modified methodology is appropriate, the licensee must still fulfill any other requirements or criteria associated with the changes to the operating conditions or safety margins, as documented under other LCs such as those in Section 3. General criteria that CNSC will consider when reviewing such methodologies are provided in Appendix A.4.

In addition to industry standards, CNSC staff will refer to the applicable industry verification and validation process practices related to computer codes and software used to support the safe plant operation.

CSA N290.17, *Probabilistic safety assessment for nuclear power plants* (2023), provides current industry practice regarding preparation and maintenance of a probabilistic safety assessment (PSA) for a water-cooled nuclear power plant. It is considered one of the CNSC staff acceptable approaches to meet regulatory requirements for the development and maintenance of PSA specified in REGDOC 2.4.2.

5 SCA – PHYSICAL DESIGN

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

Performance Objective(s)

There is confirmation that systems, structures and components that are important to nuclear safety and security continue to meet their design basis in all operational states and design basis accidents until the end of their design life.

5.1 Design Program

Licence Condition 5.1:

The licensee shall implement and maintain a design program.

Preamble

The *Class I Nuclear Facilities Regulations* require that a licence application contain a description of the structures, systems and components (SSC), and relevant documentation of the plant design.

A design program ensures that the plant design is managed using a well-defined systematic approach. Implementing and maintaining a design program confirms that safety-related SSCs and any modifications to them continue to meet their design bases given new information arising over time and taking changes in the external environment into account. It also confirms that SSCs continue to be able to perform their safety functions under all plant states. An important cross-cutting element of a design program is design basis management.

A design program should be composed of elements that consider topics including but not limited to: pressure boundary design, civil structure design, seismic design, mechanical design, fuel design, core nuclear design, core thermal-hydraulic design, safety system design, fire protection design, electrical power system design, as well as instrumentation and control system design.

Compliance Verification Criteria

The licensee shall ensure that all safety-related SSCs are designed to perform their required functions under all plant states for which the system must remain available. OPG shall ensure that any modifications made to the facility are in accordance with OPG engineering change control process, and CSA standards:

- CSA standard N291, *Requirements for safety related structures for CANDU nuclear power plants* (update no. 2, 2011);
- CSA standard N290.0, *General requirements for safety systems of nuclear power plants*;
- CSA standard N290.12, *Human Factors in Design for Nuclear Power Plants*; and

- CSA standard N290.14, *Qualification of Digital Hardware and Software for Use in Instrumentation and Control Applications for Nuclear Power Plants*

Relevant documents that require version control:

Source	Document Title	Document #	Revision #	Effective Date
CSA	Requirements for safety related structures for CANDU nuclear power plants	N291*	2008 and update no. 2, 2011 (Reaffirmed 2013)	2016-01-01
CSA	General requirements for safety systems of nuclear power plants	N290.0	2017 (Reaffirmed 2022)	2024-03-19
CSA	Human Factors in Design for Nuclear Power Plants	N290.12	2014	2018-03-31
CSA	Qualification of Digital Hardware and Software for Use in Instrumentation and Control Applications for Nuclear Power Plants	N290.14	2015 (Reaffirmed 2020)	2022-11-01

** OPG intends to transition to the 2019 edition of CSA N291, Requirements for nuclear safety-related structures, and has committed to be compliant with the standard by January 1, 2027. [e-Doc 7227986, CD# N-CORR-00531-23959]*

OPG has committed to implementing the following CSA standards by 01 January 2027 [e-Doc 7372903, CD# NK38-CORR-00531-25642]:

- CSA N287.1-14 (R2019), *General requirements for concrete containment structures for nuclear power plants*;
- CSA N287.2-17 (R2022), *Material requirements for concrete containment structures for nuclear power plants*; and
- CSA N287.8-15 (R2020), *Aging management for concrete containment structures for nuclear power plants*.

Design Basis Management

The licensee shall ensure that plant status changes (design modifications) are controlled such that the plant is maintained and modified within the limits prescribed by the design and licensing basis. Aspects of design are considered safety and control measures if changes to them could:

- Invalidate the limits documented in the operating policies and principles or safe operating envelope referred to in LC 3.1;
- Introduce hazards different in nature or greater in probability or consequence than those considered by the safety analyses and probabilistic safety assessment; and/or
- Adversely impact other important safety and control measures, such as those related to operations, radiation protection, emergency preparedness, etc.

The licensee shall ensure that changes to those aspects of design remain within the licensing basis and shall notify the CNSC when such changes are planned. When reviewing such changes, CNSC staff will use the criteria in Appendix A.4 and any other applicable criteria. Changes outside the licensing basis would require prior written approval by the Commission.

The licensee shall ensure that plant design and changes to plant design are accurately reflected in the safety analysis (see section 4.1 for licensee documents that contain the facilities descriptions and the final safety analysis reports). Where specific reports (e.g., external third party reviews as required by CSA standard N293, *Fire protection for nuclear power plants*, which is cited in LC 10.2) are required by the standards in the licensing basis, these shall be submitted to the CNSC.

Design Sub-programs

See LC 5.2 for compliance verification criteria on pressure boundary design and LC 5.3 for compliance verification criteria on equipment and structure qualification.
Modification of the special safety systems (Shutdown System 1, Shutdown System 2, Emergency Core Cooling System and Containment System) or significant changes to systems connected to the special safety systems (e.g. change that would impact safety margins) would require prior notification and engagement of CNSC. When reviewing such changes, CNSC staff will use the criteria in Appendix A.4 and any other applicable criteria. Changes outside the licensing basis would require prior written approval by the Commission. Prior notification is not required for changes to items that serve the same functional characteristics of the originally designed item and does not result in a change to operating procedures or safety system testing.

All changes or modifications, temporary or permanent, to the special safety systems (SSS) and systems related to safety (SRS) shall be identified in the annual reliability report.

The licensee shall have sub-program elements that address the design and modification of concrete containment structures and safety-related structures.

The licensee shall design, build, modify and otherwise carry out work related to the nuclear facility with potential to impact protection from fire in accordance with CSA N293. Any changes that have the potential to impact fire protection are assessed for compliance with CSA N293 and, if required, an external third party review shall be performed and the results submitted to the CNSC. See LC 10.2 for version control of CSA N293.

The plant electrical power system design shall include the safety classifications of the systems. Its design shall be adequate for all modes of operation under steady-state, voltage and frequency excursion, and transient conditions, as confirmed by electrical analysis. The electrical power systems shall be monitored and tested to demonstrate they comply with the design requirements and to verify the operability for AC systems and DC systems.

The licensee shall ensure that the plant overall instrumentation and control (I&C) system and electrical power systems is designed to satisfy the following:

- The safety classification of the I&C system is in compliance with plant level system classification and is justified by analysis;
- System meets separation requirements between the groups and channels;

- Safety features for enhancing system reliability and integrity are identified and implemented in the design, for example, fail safe design, redundancy, independence and testing capability
- System is not vulnerable to common cause failures; and
- I&C and electrical power systems of safety systems meet the requirements of single failure criteria.

The licensee shall demonstrate survivability of the I&C systems and component that are critical to the management of BDBAs, and the availability of power supply to necessary equipment and associated I&C for BDBAs.

Prior to making use of a new fuel bundle/fuel bundle string or fuel assembly design in the reactor, the licensee shall perform design verification activities, analyses and testing to demonstrate that design requirements are met. The length and complexities of those activities depend on the novelty of the design. When considering possible design changes to fuel bundles and fuel assemblies, the licensee shall provide prior notification and engage CNSC staff early enough to confirm that the changes are within the licensing basis. When reviewing such changes, CNSC staff will use the criteria in Appendix A.4 and any other applicable criteria. Changes outside the fuel design basis would require prior written approval by the Commission.

The licensee shall update and maintain the reactor core nuclear design information found in the safety report and supporting design manuals. Core surveillance activities shall be implemented to ensure compliance with reactor core nuclear design and operation within the design envelope. Significant changes to core nuclear design would require prior notification and engagement of CNSC. When reviewing such changes, CNSC staff will use the criteria in Appendix A.4 and any other applicable criteria. Changes outside the reactor core nuclear design basis would require prior written approval by the Commission.

The design of the existing safety-related structures and components and any modification shall include consideration for human factors. For proposed modifications, modern requirements that are consistent with the current licensing basis of the plant shall be applied to the extent practicable.

The licensee shall ensure configuration management is aligned with the design and safety analysis and incorporated into purchasing, construction, commissioning, operating and maintenance documentation. Conformance is to be maintained between design requirements, physical configuration and facility configuration information. The licensee shall establish a design authority function with the authority to review, verify, approve (or reject), document the design changes and maintain design configuration control.

The following documents require written notification of change:

Document Title	Document #	Notification Status
Conduct of Engineering	N-STD-MP-0028	TI
Engineering Change Control	N-PROG-MP-0001	TI
Configuration Management	N-STD-MP-0027	TI
Design Management	N-PROG-MP-0009	TI

Document Title	Document #	Notification Status
Fuel	N-PROG-MA-0016	TI
Procurement from Licensed Canadian Nuclear Utilities	N-INS-08173-10050	TI
Engineering Change Control Process	N-PROC-MP-0090	PI

As per the agreement reached in CNSC letter dated June 22, 2012 (e-Doc 3947068) a number of design-related codes and standards, associated effective dates and conditions were established. The purpose of the agreement is to ensure consistent and stable design requirements are applied throughout the Darlington Refurbishment Project. For refurbishment design, the agreement took effect upon issuance of the letter; for other design activities the agreement took effect on October 30, 2013. The agreement will remain valid until the end of the Darlington Refurbishment Project, including completion of all close-out documentation.

OPG shall provide to the CNSC the code-over-code reviews conducted for any subsequent editions, addendums and/or updates of the codes and standards that were agreed upon, with OPG's assessment of the changes and their significance upon completion of the review and assessment of significance (e-Doc 3947068 and 4058619). OPG shall submit such assessments on an annual basis.

Recommendations and Guidance

With regard to modifications, the design basis for the plant should be documented and maintained to reflect design changes to ensure adequate configuration management. The design basis should be maintained to reflect new information, operating experience, safety analyses, and resolution of safety issues or correction of deficiencies. The impacts of the design changes should be fully assessed, addressed and accurately reflected in the safety analyses prior to implementation.

The design program should minimize the potential for human error and promote safe and reliable system performance through the consideration of human factors in the design of facilities, systems, and equipment. Recommendations and guidance for considering human factors in design programs are provided in CNSC regulatory document REGDOC-2.5.1, *General Design Considerations: Human Factors*.

Recommendations and guidance are found in the following documents:

- CSA standards N287 Series (287.1 to 287.6), which covers concrete containment structures;
- CSA standards N289 Series (289.1 to 289.5), which covers seismic qualification;
- CSA standards N290 series (290.1 to 290.6), which covers shutdown systems, emergency core cooling, containment systems, reactor control, electrical power and instrument air systems, and monitoring and display functions;
- CSA standard N286.10, *Configuration Management for High Energy Reactor Facilities;*
- REGDOC-2.5.2, *Design of Reactor Facilities: Nuclear Power Plants*; and
- UFC 3-340-02, which covers structures to resist accidental explosions.

The licensee's design program should provide a table or roadmap that identifies relevant design basis documents, design sub-programs and processes that are maintained by the licensee.

5.2 Pressure Boundary Program

<u>Licence Condition 5.2:</u>

The licensee shall implement and maintain a pressure boundary program and have in place a formal agreement with an Authorized Inspection Agency.

<u>Preamble</u>

This licence condition provides regulatory oversight with regards to the licensee's implementation of a pressure boundary program and holds the licensee responsible for all aspects of pressure boundary registration and inspections.

A pressure boundary program is comprised of the many programs, processes and procedures and associated controls that are required to ensure compliance with CSA standard N285.0, *General requirements for pressure-retaining systems and components in CANDU nuclear power plants*, which defines the technical requirements for the design, procurement, fabrication, installation, modification, repair, replacement, testing, examination and inspection of pressure-retaining and containment systems, including their components and supports.

This LC also ensures that an Authorized Inspection Agency (AIA) will be subcontracted directly by the licensee. An AIA is an organization recognized by the CNSC as authorized to register designs and procedures, perform inspections, and other functions and activities as defined by CSA N285.0 and its applicable referenced publications (e.g. CSA standard B51, *Boiler, pressure vessel and piping*, National Board Inspection Code). The AIA is accredited by the American Society of Mechanical Engineers (ASME) as stipulated by NCA-5121 of the ASME *Boiler and Pressure Vessel Code* (BPVC).

A pressure boundary is a boundary of any pressure retaining vessel, system or component of a nuclear or non-nuclear system, where the vessel, system or component is registered or eligible for registration.

<u>Compliance Verification Criteria</u>

The licensee shall implement and maintain a pressure boundary program. This program shall be in accordance with CSA standard N285.0, *General requirements for pressure retaining systems and components in CANDU nuclear power plants*.

Relevant documents that require version control:

Source	Document Title	Document #	Revision #	Effective Date
CSA	General requirements for pressure-retaining systems and components in CANDU nuclear power plants	N285.0	2008 and update no. 2*	2016-01-01

**Note: (a) Including update no. 1, (b) Annex M and Annex K are accepted to be used as "Normative" Annexes. OPG has committed to transition to CSA N285.0-23 (including Annex G, J and K as "Normative") by 01 January 2027 [CD# N-CORR-00531-23959, e-Doc 7227986].*

OPG has committed to implement the entire CSA N285.6 SERIES-23 by 01 January 2027, after Darlington refurbishment is completed *[CD# N-CORR-00531-23959, e-Doc 7227986]*.

Transitional Provisions to CSA N285.0-08 and update no. 2 with Annex M and Annex K:

Pressure boundary activities shall be compliant with CSA N285.0-08 and update no.2, CSA B51-09 and update no. 1, ASME BPVC 2010 ED with 2011 ADD, ASME B31.1-2010, *Power Piping*, ASME B31.3-2010, *Process Piping Code*, and ASME B31.5-2010, *Refrigeration Piping and Heat Transfer Component Code*, except as provided below:

a) Work packages compliant with CSA N285.0-08 and update no.1, being produced or underway prior to October 30, 2013 will remain valid for implementation until June 30, 2019.
b) Design modifications classified (approved by CNSC or using the OPG Classification procedure) after January 1, 2011 and before October 30, 2013 will be designed and installed to the CSA N285.0 and ASME edition or version specified in the System Classification List, when installed no later than June 30, 2019.
c) Purchase orders compliant with CSA N285.0-08 and update no. 1 issued prior to October 30, 2013 will remain valid for installation.
d) The Code Effective Dates do not apply to “non-design-related” requirements under the codes and standards listed above. CNSC may require OPG’s programs or processes to be updated for “non-design-related” requirements to meet the new version of the standards once it is published.
e) OPG shall provide to the CNSC the code-over-code reviews conducted for any subsequent editions, addendums and/or updates of the codes and standards listed above, with OPG’s assessment of the changes and their significance upon completion of the review and assessment of significance. OPG shall submit such assessments on an annual basis.

Engineering planning activities for the Darlington Refurbishment Project follow CSA N285.0-08 with update no.2, CSA B51-09 and update no. 1, ASME BPVC 2010 ED with 2011 ADD, ASME B31.1-2010, ASME B31.3-2010, and ASME B31.5-2010.

The licensee shall maintain a Pressure Boundary Program Document roadmap in compliance with Annex N of CSA N285.0-12 and update no. 1.

The licensee shall operate vessels, boilers, systems, piping, fittings, parts, components, and supports safely and keep them in a safe condition. OPG shall:

a) Follow work plans and procedures, accepted by the AIA, to test, maintain, or alter over-pressure protection devices;
b) Comply with operating limits specified in certificates, orders, designs, overpressure protection reports, and applicable codes and standards; and
c) Have any certified boiler or vessel that is in operation or use inspected and certified by an authorized inspector according to an accepted schedule.

Personnel conducting non-destructive examinations shall be certified in accordance with the edition of CAN/CGSB 48.9712/ISO 9712 currently adopted for use by the National Certification Body (NCB) of

Natural Resources Canada for the appropriate examination method. If the NCB does not offer certification for a specific inspection method, the relevant alternate requirements of Clause 11.3 of CSA N285.0 shall apply to ensure that personnel are appropriately trained and qualified.

The licensee shall use the accepted variance to CSA N285.0-08 and Update No. 2, clause 3 and clause 14.2.7, to perform external weld overlay repairs based on the OPG document N-INS-01913.11-10024 “External Weld Buildup to Repair Pressure Retaining Item” (Enclosure 1 of N-CORR-00531-19208, e-Doc 5575333), under the conditions described in CNSC acceptance letter e-Doc 5635890.

Classification, Registration and Reconciliation Procedures

Licensee procedures describing the classification, registration and reconciliation processes and the associated controls shall form part of the pressure boundary program. The licensee shall provide prior notification of any changes to the procedures describing the classification, registration and reconciliation processes.

Overpressure Protection Reports

The licensee shall provide written notification to CNSC staff, of new or revised overpressure protection reports, after the final registration of the system. General criteria for CNSC’s review of such notices are provided in Appendix A.4.

Quality Assurance Program

The licensee’s pressure boundary quality assurance program shall comply with clause 10 of CSA N285.0 with the exception of sub-clause 10.2.6. Repair and replacement activities shall comply with subclause 10.3 of CSA N285.0.

Classification and Registration of Fire Protection Systems

Fire protection systems and associated fittings and components are to be classified at least as Code Class 6, designed to ASME B31.1 and registered, unless the exemption criteria noted below are met.

The following fittings and components may be exempt from requiring a Canadian Registration Number (CRN) provided they meet the following exemption criteria:

a) Fittings and components that are cUL or ULC and suitable for the expected environmental conditions and maximum pressure; or
b) pressurized cylinders and tubes, such as extinguishers, inert gas and foam tanks, that bear Transport Canada approvals and suitable for the expected environmental conditions and maximum pressures; or
c) buried fire protection piping that is in compliance with NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*.

Buried fire protection piping designed to the ASME piping code may be exempt from the ASME pressure testing requirements if the pressure testing is performed to NFPA 24.

The requirements of CSA N285.0 apply for components higher than Code Class 6.

Formal Agreement with an Authorized Inspection Agency

The licensee shall always have in place a formal agreement with an AIA to provide services for the pressure boundaries of the nuclear facility as defined by CSA N285.0 and its applicable referenced publications. The AIA must be accredited by the ASME as stipulated by NCA-5121 of the ASME *Boiler and Pressure Vessel Code*.

Design registration services for pressure boundaries shall be provided by an AIA legally entitled under the Provincial Boilers and Pressure Vessels acts and regulations to register designs. Registration of piping systems shall be done by the Technical Standards and Safety Authority (TSSA), who is legally entitled to register designs in Ontario.

A copy of the signed Agreement shall be provided to the CNSC. During the licence period, the licensee shall notify the CNSC in writing of any change to the terms and conditions of the Agreement, including termination of the Agreement.

The licensee shall arrange for the AIA inspectors to have access to all areas of the facility and records, and to the facilities and records of the licensee's pressure boundary contractors and material organizations, as necessary for the purposes of performing inspections and other activities required by the standards. Inspectors of the AIA shall be provided with information, reasonably in advance with notice and time necessary to plan and perform inspections and other activities required by the standards.

For a variance or deviation from the requirements of CSA N285.0, the licensee must first submit the proposed resolution to the AIA for evaluation, and then to the CNSC for consent. Per the agreement with the AIA, the evaluated resolution shall not be implemented without the prior written consent of CNSC staff. General criteria for obtaining prior written consent/approval for a proposed resolution from the CNSC can be found in Appendix A.4.

The following documents require written notification of change:

Document Title	Document #	Notification Status
Pressure Boundary	N-PROG-MP-0004	PI
System and Item Classification	N-PROC-MP-0040	PI
Design Registration	N-PROC-MP-0082	PI
Pressure Boundary Program Manual	N-MAN-01913.11-10000	TI
Index to OPG Pressure Boundary Program Elements	N-LIST-00531-10003	TI
Authorized Inspection Agency for Pressure Boundary Inspection and Registration Service	N-CORR-00531-22359	PI*
OPG - Amendment to the Formal Agreement with the Authorized Inspection Agency for Pressure Boundary Inspection and Registration Services	N-CORR-00531-24236	PI

** Termination of the agreement is considered a change that requires written notification to the CNSC.*

Recommendation and Guidance

Recommendations and guidance are found in the following CSA standards and ASME codes:

- CSA standards N285.6 Series, which covers material standards for CANDU reactor components;
- CSA standards N289 Series, which covers seismic qualification;
- ASME *Boiler and Pressure Vessel Code*;
- ASME B31.1, *Power Piping*;
- ASME B31.3, *Process Piping Code*;
- ASME B31.5, *Refrigeration Piping and Heat Transfer Component Code*; and
- CSA standard B51, *Boiler, pressure vessel and piping*.

Note: Where these standards/codes or portions thereof are required for compliance with a governing standard referenced in the LCH under LC 5.2, compliance to the referenced standards/codes or portions thereof is required for compliance with the governing standard and the LC referencing the overlying standard.

The AIA, and its authorized inspectors, should be familiar with and capable of applying the CSA N285.0 provisions to perform their activities as defined by the standard.

Leak mitigation must be undertaken using a managed process, including engineering review, and additional controls to ensure it is not applied inappropriately. Furthermore, leak mitigation should be managed in accordance with the approved white paper, N-REF-01913.11-00001, 2018, *Temporary Leak Maintenance by Leak Mitigation Process* (Enclosure to N-CORR-00531-19502, e-Doc 5823652).

5.3 Equipment and Structure Qualification Program

Licence Condition 5.3:

The licensee shall implement and maintain an equipment and structure qualification program.

Preamble

Environmental qualification (EQ) ensures that all required equipment in a nuclear facility are qualified to perform their safety functions if exposed to harsh environmental conditions resulting from credited Design Basis Accidents (DBA) and that this capability is preserved for the life of the plant.

Condition monitoring assesses variables that indicate the physical state of the equipment, and assesses its ability to perform its intended function following the period of observation. Environmental monitoring measures environmental stressors, such as temperature, radiation and operational cycling during normal operating conditions.

Seismic qualification (SQ) ensures that all seismically credited safety-related SSCs in a Nuclear Power Plant are designed, installed and maintained to perform their safety function during and/or after (as needed and pre-defined) a design basis earthquake or site design earthquake and also ensures an adequate margin against review level earthquakes.

Compliance Verification Criteria

The licensee shall implement and maintain environmental and seismic qualification programs. The programs shall be in accordance with CSA standards:

- CSA standard N290.13, *Environmental qualification of equipment for CANDU nuclear power plants*; and
- CSA standard N289.1, *General requirements for seismic, design and qualification of CANDU nuclear power plants*.

Relevant documents that require version control:

Source	Document Title	Document #	Revision #	Effective Date
CSA	Environmental qualification of equipment for CANDU nuclear power plants	N290.13*	2005 and update no. 1 (2009) (Reaffirmed 2015)	2016-01-01
CSA	General requirements for seismic, design and qualification of CANDU nuclear power plants	N289.1**	2008 (Reaffirmed 2013)	2016-01-01

**N290.13-18 (R2023), Environmental qualification of equipment for nuclear power plants was published in December 2018. OPG has committed to fully implementing this version by 2026-09-30. [e-Doc 6925032, CD# N-CORR-00531-23325]*

***As communicated in N-CORR-00531-23959 (e-Doc 7227986), OPG proposes to transition to the 2018 edition of CSA N289.1 by January 1, 2027.*

OPG has committed to implementing the following standard by 01 January 2027 [CD# NK38-CORR-00531-25642, e-Doc 7372903]:

- CSA N289.3-20, *Design procedures for seismic qualification of nuclear power plants*;
- CSA N289.4-22, *Testing procedures for seismic qualification of nuclear power plant structures, systems, and components*; and
- CSA N289.5-12 (R2022), *Seismic instrumentation requirements for nuclear power plants and nuclear facilities* (Update No. 1, June 2021).

Environmental Qualification

In addition to the criteria set out in CSA N290.13, the EQ program shall include a monitoring program consisting of condition monitoring and environmental monitoring, to measure degradation and failures of qualified equipment, including cables.

Seismic Qualification

Seismically credited safety-related SSCs in a nuclear facility shall be designed, installed and maintained to perform their safety function against earthquakes.

Seismic qualification or modification of a seismically qualified SSC would require prior notification and engagement of CNSC. When reviewing such changes, CNSC staff will use the criteria in Appendix A.4 and any other applicable criteria. Changes outside the licensing basis would require prior written approval by the Commission.

OPG is conducting a gap analysis and will provide CNSC staff with an implementation plan documenting the key dates for OPG to implement CSA N289.2, *Ground motion determination for seismic qualification of CANDU nuclear power plants* (2021) by 3 September 2025 [CD# NK38-CORR-00531-25642; e-Doc 7372903].

The following documents require written notification of change:

Document Title	Document #	Notification Status
Environmental Qualification	N-PROG-RA-0006	TI

Per the agreement reached in CNSC letter dated 22 June 2012 (e-Doc 3947068) a number of design-related codes and standards, associated effective dates and conditions were established, including application of CSA N290.13. The purpose of the agreement is to ensure consistent and stable design requirements are applied throughout the Darlington Refurbishment Project. For refurbishment design, the agreement took effect upon issuance of the letter; for other design activities the agreement took effect on 30 October2013. The agreement will remain valid until the end of the Darlington Refurbishment Project, including completion of all close-out documentation.

OPG shall provide to the CNSC the code-over-code reviews conducted for any subsequent editions, addendums and/or updates of CSA N290.13-05 and update no.1, with OPG's assessment of the changes and their significance upon completion of the review and assessment of significance (e-Doc 3947068). OPG shall submit such assessments on an annual basis.

Recommendations and Guidance

The processes and procedures related to the EQ program should meet the requirements of recognized industrial standards.

In addition to addressing the detailed requirements of CSA N289.1, the licensee SQ sub-program should:

- Identify the methods for establishing SQ, including code effective dates;
- Identify the SSCs for which evaluation of their capacity beyond the Design Basis Earthquake has been done;
- Identify the methods used for Beyond Design Basis Earthquake evaluation;
- Include procedural controls for periodic inspection and maintenance of conditions to ensure SQ of existing SSCs for the life of the plant;
- Identify the seismic monitoring system and its design and maintenance requirements; and
- Include procedural controls for establishing SQ for new and replacement items.

The processes and procedures related to the SQ program should address the following CSA standards:

- CSA standard N289.2, *Ground motion determination for seismic qualification of nuclear power plants*;
- CSA standard N289.3, *Design procedures for seismic qualification of nuclear power plants*;
- CSA standard N289.4, *Testing procedures for seismic qualification of nuclear power plant structures, systems and components*; and
- CSA standard N289.5, *Seismic instrumentation requirements for nuclear power plants and nuclear facilities*.

6 SCA – FITNESS FOR SERVICE

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

Performance Objective(s)

Systems, structures and components whose performance may affect safe operations or security remain available, reliable and effective, and are consistent with the design, quality control measures and analysis documents.

6.1 Fitness for Service Programs

Licence Condition 6.1:

The licensee shall implement and maintain a fitness for service program.

Preamble

The *Class I Nuclear Facilities Regulations* requires that a licence application contain the proposed measures, policies, methods and procedures to maintain the nuclear facility.

The following program elements ensure fitness for service of SSCs:

- Maintenance program defining the policies, processes and procedures that provide direction for maintaining SSCs of the plant;
- Effective control of plant chemistry to ensure critical plant equipment performs safely and reliably;
- Aging management activities to ensure the reliability and available of required safety functions of SSCs;
- Periodic and in-service inspection programs to ensure that pressure-boundary components; containment structures and components, continue to meet their design requirements;
- In-service inspection of balance of plant to ensure safety significant pressure retaining systems, components and safety-related structures are monitored for degradation; and
- Proper reliability program and implementation to ensure that Systems Important to Safety continue to meet their performance requirements.

Compliance Verification Criteria

The licensee shall implement and maintain programs to ensure fitness for service of systems, structures and components. These programs shall be in accordance with:

- CNSC regulatory document REGDOC-2.6.2, *Maintenance Programs for Nuclear Power Plants*;
- CNSC regulatory document REGDOC-2.6.1, *Reliability Programs for Nuclear Power Plants*;
- CNSC regulatory document REGDOC-2.6.3, *Aging Management*;
- CSA standard N285.4, *Periodic inspection of CANDU nuclear power plant components*;
- CSA standard N285.5, *Periodic inspection of CANDU nuclear power plant containment components*;
- CSA standard N285.8, *Technical requirements for in-service inspection evaluation of zirconium alloy in pressure tubes in CANDU reactors*;
- CSA standard N287.7, *In-service examination and testing requirements for concrete containment structures for CANDU nuclear power plants*; and
- CSA standard N291, *Requirements for safety related structures for CANDU nuclear power plants* (update no. 2, 2011).

Relevant documents that require version control:

Source	Document Title	Document #	Revision #	Effective Date
CNSC	Maintenance Programs for Nuclear Power Plants	REGDOC-2.6.2	2017	2020-09-15
CNSC	Reliability Programs for Nuclear Power Plants	REGDOC-2.6.1	2017	2020-09-15
CNSC	Aging Management	REGDOC-2.6.3	2014	2017-07-15
CSA	Periodic inspection of CANDU nuclear power plant components	N285.4*	2014 (2019†)	2019-07-01
CSA	Periodic inspection of CANDU nuclear power plant containment components	N285.5**	2018	2022-05-02
CSA	Technical requirements for in-service inspection evaluation of zirconium alloy in pressure tubes in CANDU reactors	N285.8	2023††	2024-04-05
CSA	In-service examination and testing requirements for concrete containment structures for CANDU nuclear power plants	N287.7***	2008 (Reaffirmed 2013)	2016-01-01
CSA	Requirements for safety related structures for CANDU nuclear power plants	N291****	2008 and update no. 2, 2011	2016-01-01

** OPG has committed to transitioning to the 2023 edition of CSA N285.4, and intends to be fully compliant by 14 November 2029 [e-Doc 7417204, CD# N-CORR-00531-24211].*
*** OPG has committed to transitioning to the 2022 edition of CSA Standard N285.5, by 02 June 2027 [e-Doc 7253021, CD# N-CORR-00531-23903].*
****OPG intends to transition Darlington NGS to the 2017 edition (R2022) of CSA N287.7, In-service examination and testing requirements for concrete containment structures for nuclear power plants, by 30 May 2025 [e-Doc 7245645, CD# NK38-CORR-00531-25234].*

***** OPG intends to transition to the 2019 edition of CSA N291, Requirements for nuclear safety-related structures, and has committed to be compliant with the standard by 1 January 2027 [e-Doc 7227986, CD# N-CORR-00531-23959].*
† Compliance with the 2019 edition is only for the clauses specified under "CVC related to CSA N285.4" in this LCH.
†† Compliance with the 2023 edition is required unless an alternative approach to meet certain Clauses of CSA N285.8-23 is explicitly stated in the accepted compliance plan (N-REP-31100-10061 R006; e-Doc 7251842).

Maintenance

An NPP maintenance program consists of policies, processes and procedures that provide direction for maintaining structures, systems or components (SSCs) of the plant.

The intent of a maintenance program is to ensure that the SSCs remain capable of maintaining their function as described in the safety analysis. A maintenance program uses organized activities, both administrative and technical, to keep SSCs in good operating condition, and to ensure that they function as per design.

CNSC regulatory document REGDOC-2.6.2, *Maintenance Programs for Nuclear Power Plants* outlines the requirements for a maintenance program. In 2017, this document replaced RD/GD-210, *Maintenance Programs for Nuclear Power Plants* in the regulatory framework. Given that REGDOC-2.6.2 has no material changes from RD/GD-210, for compliance purposes where RD/GD-210 is referenced in OPG governing documents, it shall be taken to mean REGDOC-2.6.2. OPG will update the references to RD/GD-210 in their governance in accordance with their regular document review cycle.

Implementation of REGDOC-2.6.2 is verified by CNSC staff through the maintenance-related findings from routine inspections, cross-cutting system inspections and monitoring of maintenance related performance indicators.

Maintenance activities include planning and scheduling, SSC monitoring and work execution. Maintenance performance indicators are monitored and compared to best industry practice where practicable.

Management of Planned Outages:

The maintenance program shall include provisions for the management of planned outages. The licensee's program related to management of planned outages is documented in N-PROC-MA-0013, *Planned Outage Management*.

The licensee shall make outage-related information (including Level 1 and Level 2 Outage Plans, detailing all major work on safety related structures, systems and components to be carried out during the planned outage) available to CNSC staff.

Planned outages represent a key activity that has a high regulatory significance. Therefore a review is required to ensure proper scoping (of safety-related commitments), planning and execution of the commitments (e.g., for heat sinks, dose control, etc.).

Reliability of Systems Important to Safety

CNSC regulatory document REGDOC-2.6.1, *Reliability Programs for Nuclear Power Plants* outlines the requirements for a maintenance program. In 2017, this document replaced RD/GD-98, *Reliability Programs for Nuclear Power Plants* in the regulatory framework. Given that REGDOC-2.6.1 has no material changes from RD/GD-98, for compliance purposes where RD/GD-98 is referenced in OPG governing documents, it shall be taken to mean REGDOC-2.6.1. OPG will update the references to RD/GD-98 in their governance in accordance with their regular document review cycle.

The licensee shall establish a reliability program that includes setting reliability targets, performing reliability assessments, testing and monitoring, and reporting for plant systems whose failure affect the risk of a release of radioactive or hazardous material.

The reliability program assures that the risk-related system functions credited in the PSA and systems important to safety at the plant, can, and will, meet the availability and reliability requirements as stated or assumed in the PSA throughout the lifetime of the facility.

Chemistry Control

The chemistry control sub-program shall specify processes, specifications, overall requirements, parameter monitoring, data trending and evaluation to ensure effective control of plant chemistry during operational and lay-up conditions. The licensee shall maintain a set of technical basis documents describing the design basis for chemistry control.

Aging Management

OPG is compliant with the 2014 version of REGDOC-2.6.3, *Aging Management*.

SSC-specific aging management plans (AM plans - also in some cases referred to as life cycle management plans (LCMPs)), shall be implemented in accordance with the overall integrated aging management program framework, and address the attributes of an effective aging management program as listed in REGDOC-2.6.3. The SSC-specific AM plans or LCMPs shall include structured, forward looking inspection and maintenance schedules, requirements to monitor and trend aging effects and any preventative actions necessary to minimize and control aging degradation of the SSCs.

The SSC-specific AM plans or LCMPs which are submitted with, or in support of, the application are licensing basis documents. As such any changes to the SSC-specific AM plans or LCMPs will be reviewed by CNSC staff to confirm that they remain within the licensing basis and provide adequate justification for changes to prior licensee commitments with respect to the inspection scope and other relevant commitments related to the continued operation of the facility. When considering possible changes to activities identified in the AM plans or LCMPs, the licensee shall engage CNSC staff early and provide confirmation that the changes are within the licensing basis prior to implementing the change. Administrative or other such changes to the documents are subject to normal notification requirements as indicated in the WN table for this section.

Fuel Channel Aging Management

The current operating limit for the Darlington NGS pressure tubes is to a maximum of 235,000 Effective Full Power Hours (EFPH), which was approved by the Commission on December 23, 2015. For further details see the Summary Record of Decision (e-Doc 4908897). Operation of any unit beyond 235,000 EFPH is not permitted unless approved by the Commission in accordance with LC G.1.

Continued use of Fracture Toughness Model(s)

CNSC staff accepted the use of the Revision 2 Engineering Fracture Toughness model for Probabilistic Core Assessments (PCAs) for flaws, Leak-Before-Break and Fracture Protection evaluations, provided OPG meets the following conditions (e-doc 6795279):

1. The model is only applied to pressure tube material containing a maximum hydrogen equivalent concentration (Heq) up to 100 ppm within 1.5 m from the front end of the tube and up to 140 ppm in the remainder of the pressure tube.
2. The lower bound predictions from the Revision 2 model are adopted for deterministic fracture protection and deterministic leak-before-break evaluations.
3. For PCAs for flaws, Probabilistic Fracture Protection (PFP) and Probabilistic Leak-Before-Break (PLBB) evaluations, the fracture toughness probability distributions used as inputs in the evaluations are obtained from the Revision 2 model with the distributions truncated so the maximum value of fracture toughness for a defined set of input parameters does not exceed the best estimate prediction.

OPG shall submit an impact assessment for CSA N285.8-23 Clause 7 evaluations whenever a fracture toughness test result challenges the model's lower prediction bound, and where the model is applied in the Clause 7 evaluation(s).

Periodic and In-Service Inspection Programs

OPG shall carry out the periodic inspections programs (PIPs) in accordance with the accepted PIP documents. If a deviation from the accepted PIP program is anticipated during inspection planning activities OPG shall obtain CNSC acceptance of the deviation prior to conducting the affected inspections. However, for any findings, discoveries or deviations from the accepted PIP that are identified when conducting an inspection, OPG shall follow OPG governance to provide justification to CNSC in the inspection report submission, based on OPEX and best industry practices. For permanently required exemptions to the requirements of CSA PIP standards, OPG shall document these exemptions in a revised PIP document and submit to the CNSC for acceptance.

When PIP requirements are addressed exclusively within an AMP or LCMP document, only those elements of the document that directly address the PIP requirements of the governing CSA standard require acceptance from CNSC staff prior to implementation.

Personnel conducting non-destructive examinations shall be certified in accordance with the edition of CAN/CGSB 48.9712/ISO 9712 currently adopted for use by the National Certification Body (NCB) of Natural Resources Canada for the appropriate examination method. If the NCB does not offer certification for a specific inspection method, the relevant alternate requirements of Clause 5 of CSA N285.4 or Clause 6 of CSA N285.5, as applicable, shall apply, to ensure that personnel are appropriately trained and qualified.

Selection Criteria for Pressure Tube Inspection

In reference to inspected pressure tubes, and to resolve probabilistic core assessment flaw removal assumptions, OPG is to continue to provide evidence that a sample of the pressure tubes with the highest cumulative probability of developing through-wall cracking determined from probabilistic core assessments is included in their pressure tube volumetric inspection program (CNSC letter 6415008; N-CORR-00531-22440). To validate probabilistic core assessment predictions, OPG is to include consideration for higher risk tubes from the probabilistic core assessments in the selection criteria for fuel channel inspection campaigns.

CVC Related to CSA N285.4:

OPG shall comply with the 2014 edition of this standard, May 2014, with the exception of Clauses (including the sub-Clauses) 6.1.4.2, 7.6.1, 8.2.2, 8.2.5(b), 8.3.1, 8.3.2, 8.3.3, 9.4 and Table 5 for which OPG shall comply with the 2019 edition of this standard (see CNSC letter e-Doc 6067846) and any applicable exemptions accepted by the CNSC. The Darlington NGS CSA N285.4 PIP is divided into four system/component groups addressing specific clauses of CSA N285.4 including the General Pressure Boundary Components, Fuel Channel Pressure Tubes, Fuel Channel Feeder Pipes, and Steam Generators Tubes. CNSC staff have accepted the Darlington NGS PIP documents listed in the WN table for this section. Notable elements of the acceptance process for the PIP documents are discussed below.

Fuel Channel (FC) Pressure Tubes (PT) (N285.4 Clause 12)

CNSC staff have accepted OPG's PIP documents for Darlington Fuel Channels (e-Doc 5853238; NK38-CORR-00531-20684).

Evaluation of results and dispositions for Darlington NGS pressure tubes

With respect to CSA N285.4-14 clause 12.2.5.1.3, CNSC staff have reviewed and accepted OPG's compliance plan N-REP-31100-10061 R006 (N-CORR-00531-23853, e-Doc 7176834) for the use of CSA N285.8-23, *Technical requirements for in-service evaluation of zirconium alloy pressure tubes in CANDU reactors*, as the evaluation method used for the fitness-for-service assessment of Darlington fuel channels[1].

Probabilistic Leak-Before-Break (PLBB) Assessments (CSA N285.8)

With respect to Clause 7.4.3.2 of CSA N285.8-23, the maximum allowable conditional probability over the evaluation period of pressure tube failure caused by a growing axial crack exceeding the critical crack length during the sequence of events from pressure tube through-wall penetration to reactor shutdown shall be less than or equal to 0.10 ruptures per through-wall crack. This applies to the assessed most limiting pressure tube in the reactor core. The acceptance criterion will be revisited by CNSC staff periodically, and adjustments will be made as necessary.

Probabilistic Fracture Protection Assessments (CSA N285.8)

[1] CNSC staff acceptance of the revised plan is documented in CNSC staff letter e-Doc 7251842 (N-CORR-00531-23996).

Probabilistic Fracture Protection (PFP) evaluations completed for pressure tubes in accordance with CSA Standard N285.8 Clause 4.3.2.2 shall use the acceptance criteria and evaluation process documented in the August 21, 2023, correspondence from OPG (e-Doc 7110527, CD# N-CORR-00531-23737).

Fuel Channel Feeder Pipes (N285.4 Clause 13)

With respect to CSA N285.4 clause 8.2.1(d) and clause 13.2.5.1.3, CNSC staff have accepted OPG's request to use COG report COG-JP-4107-V06-R03, *Fitness-for-Service Guidelines (FFSG) for Feeders in CANDU Reactors*, (e-Docs 3922168 and 4001054).

Steam Generator Tubes (N285.4 Clause 14)

CNSC staff have accepted OPG's steam generator tubes PIP for Darlington station.

CNSC staff have accepted the revised "*performance based disposition process*" (e-Doc 6344283) for steam generator inspections and dispositions, which allows the restart of the NGS without a formal CNSC approval of the disposition before restart, subject to an agreed upon set of conditions. Under this process, OPG will analyze and assess the inspection results and disposition the findings using the applicable FFSG. Prior to returning the steam generators to service, OPG is required to confirm, in writing, that the current CNSC accepted disposition for the unit has not been invalidated by the latest inspection findings.

With respect to CSA N285.4 clause 14.2.5.1.3, CNSC staff has accepted OPG's request to use COG report COG-07-4089–R02, *Fitness-for-Service Guidelines for Steam Generator and Preheater Tubes*, with the following conditions (e-Doc 5503070):

- Paragraph IB-2 (d), Requirements for Application of FFSG: Before the CNSC can grant regulatory acceptance of a steam generator disposition using steam generator tube loading based on actual operating transient data rather than on design basis transients, the licensee must justify that the loads used are conservatively bounding for future operation. OPG is expected to provide the necessary supporting information with a request for acceptance of a disposition.
- Table ID-2, Maximum Allowable Probabilities of Not Satisfying Leak-before-Break for a Reactor Unit: If the licensee intends to use probabilistic assessment methods for Leak-Before-Break as described in Section ID-2.3.2.2 then it must be demonstrated that the probabilistic acceptance criteria in Table ID-2 (10-2) appropriately demonstrates that steam generator tube structural integrity margins are maintained when compared to deterministic Leak-Before-Break acceptance criteria

CVC Related to CSA N287.7

CNSC staff have accepted the Darlington NGS CSA N287.7 PIP documents listed in the "Document Version Control" table of this section including the leakage rate test documents for the concrete containment structures and the technical specification for the post-tensioning system inspection (e-Doc 4788314).

OPG shall carry out the inspections and tests of the vacuum building, the dousing system and the pressure relief duct at least once every twelve years, as agreed upon in CNSC correspondence "Vacuum Building Test and Inspection Frequency" (e-Doc 967920).

OPG conducted a Vacuum Structure Positive Pressure Test in 2015 based on CNSC staff acceptance of OPG's request to defer it from the 2009 Vacuum Building Outage (VBO). OPG also performed a test to measure the leakage rate, at full positive design pressure, of the Main Containment Structure in 2015. These tests shall be repeated every twelve years (e-Doc 4429280).

In addition, OPG shall inspect the concrete structures of the Main Containment Structures and their components once every six years in accordance with the CSA N287.7 PIP.

In-service Inspection of Balance of Plant

The licensee shall have adequate knowledge of the current state of BOP pressure retaining systems, components and safety-related structures to ensure that they are capable of operating within their design intent and perform required safety functions if called upon.

The licensee shall develop, implement and maintain in-service inspection program(s) and LCMPs for these systems in keeping with industry best practices including:

a) An ISI sub-program for safety-significant BOP pressure retaining systems and components; and
b) An ISI sub-program for BOP safety-related structures, excluding concrete containment structures in accordance with CSA standard N291-08, *Requirements for safety-related structures for CANDU nuclear power plants*.

N-PROG-MA-0017, *Components and Equipment Surveillance*, includes a comprehensive set of activities to evaluate, inspect, test and report on the health of specific safety-significant BOP component groups which forms part of the pressure-retaining system and components.

N-PROG-MP-0008, *Integrated Aging Management*, defines and provides the requirements for the establishment of the aging management scope related to safety-related BOP civil structures.

OPG has committed to implementing the 2021 edition of CSA Standard N285.7, *Periodic inspection of CANDU nuclear power plant balance of plant systems and components*. OPG intends to be fully compliant by 12 September 2029 [CD# N-CORR-00531-24090, e-Doc 7373576].

The following documents require written notification of change:

Document Title	Document #	Notification Status
Maintenance		
Conduct of Maintenance	N-PROG-MA-0004	TI
Component and Equipment Surveillance	N-PROG-MA-0017	TI
Production Work Management	N-PROG-MA-0019	TI
Integrated Aging Management	N-PROG-MP-0008	TI
Planned Outage Management	N-PROC-MA-0013	TI

Document Title	Document #	Notification Status
Forced Outage Management	N-PROC-MA-0049	TI
Reliability		
Equipment Reliability	N-PROG-MA-0026	TI
Risk and Reliability Program	N-PROG-RA-0016	TI
Reliability Monitoring and Reporting of Systems Important to Safety	N-STD-RA-0033	TI
List of Safety Related Systems and Functions	NK38-LIST-06937-10001	PI
Aging Management		
Major Components	N-PROG-MA-0025	TI
Feeders Life Cycle Management Plan	N-PLAN-01060-10001	PI*
Feeders Life Cycle Management Plan: Technical Basis Document	N-PLAN-01060-10007	TI
Fuel Channel Life Cycle Management	N-PROC-MA-0044	TI
Feeders		
Darlington Nuclear Unit 1 Fuel Channel Feeder Pipes Periodic Inspection Program Plan	NK38-PIP-33160-10001	PI
Darlington Nuclear Unit 2 Fuel Channel Feeder Pipes Periodic Inspection Program Plan	NK38-PIP-33160-10002	PI
Darlington Nuclear Unit 3 Fuel Channel Feeder Pipes Periodic Inspection Program Plan	NK38-PIP-33160-10003	PI
Darlington Nuclear Unit 4 Fuel Channel Feeder Pipes Periodic Inspection Program Plan	NK38-PIP-33160-10004	PI
Fitness-for-Service Guidelines (FFSG) for Feeders in CANDU Reactors	COG-JP-4107-V06-R03	PI
Pressure Boundary		
Steam Generators Life Cycle Management Plan	N-PLAN-33110-10009	PI*
Steam Generators		
Darlington Units 1-4 Steam Generator Life Cycle Management Plan	NK38-PLAN-33110-00001	PI*
Fitness-for-Service Guidelines for Steam Generator and Preheater Tubes	COG-07-4089–R02	PI**
Fuel Channels		
Fuel Channels Life Cycle Management Plan	N-PLAN-01060-10002	PI*
Darlington Nuclear 1-4, Unit 1 Fuel Channel Pressure Tubes Periodic Inspection Program Plan	NK38-PIP-31100-10001	PI

Document Title	Document #	Notification Status
Darlington Nuclear 1-4, Unit 2 Fuel Channel Pressure Tubes Periodic Inspection Program Plan	NK38-PIP-31100-10002	PI
Darlington Nuclear 1-4, Unit 3 Fuel Channel Pressure Tubes Periodic Inspection Program Plan	NK38-PIP-31100-10003	PI
Darlington Nuclear 1-4, Unit 4 Fuel Channel Pressure Tubes Periodic Inspection Program Plan	NK38-PIP-31100-10004	PI
Reactor Components and Structures Life Cycle Management Plan	N-PLAN-01060-10003	PI
Long Term Darlington Life Management Plan for Inconel X-750 Annulus Spacers	NK38-PLAN-31160-10000	PI
Compliance Plan for Long-Term Use of CSA N285.8 For In-Service Evaluation of Zirconium Alloy Pressure Tubes	N-REP-31100-10061	PI
Acceptance Criteria and Evaluation Procedures for Material Surveillance Pressure Tube	N-REP-31100-10041	PI
Periodic Inspection Plans		
Darlington Nuclear Generating Station Periodic Inspection Plan for Unit 1	NK38-PIP-03641.2-10001	PI
Darlington Nuclear Generating Station Periodic Inspection Plan for Unit 2	NK38-PIP-03641.2-10002	PI
Darlington Nuclear Generating Station Periodic Inspection Plan for Unit 3	NK38-PIP-03641.2-10003	PI
Darlington Nuclear Generating Station Periodic Inspection Plan for Unit 4	NK38-PIP-03641.2-10004	PI
Darlington Nuclear Generating Station – Periodic Inspection Program for Unit 0 and Units 1 To 4 Containment Components	NK38-PIP-03642.2-10001	PI
Darlington Nuclear – Unit 0 Containment Periodic Inspection Program	NK38-PIP-03643.2-10002	PI
Aging Management Plan for Concrete Containment Structures and Safety Related Structures	N-PLAN-01060-10004	PI
Darlington Nuclear – Reactor Building Periodic Inspection Program	NK38-PIP-03643.2-10001	PI
Darlington Nuclear – Vacuum Building Periodic Inspection Program	NK38-PIP-03643.2-10003	PI
Inspection of Post Tensioning Tendons on DNGS Vacuum Building	NK38-TS-03643-10001	PI
Administrative Requirements for In-Service Inspection and Testing for Concrete Containment Structures	N-PROC-MA-0066	PI
Non-Destructive Examination	I-STD-AS-0003	TI
Balance of Plant		
Darlington NGS Main Containment Structure In-Service Leakage Rate Test Requirements in Accordance with CSA N287.7-08	NK38-REP-34200-10066	PI

Document Title	Document #	Notification Status
Darlington NGS Vacuum Structure In-Service Leakage Rate Test Requirements in Accordance with CSA N287.7-08	NK38-REP-26100-10005	PI

**Prior notification is only required when changes to the document result in changes to the PIP that has received regulatory acceptance.*
***With the exceptions listed under the CVC for steam generator tubes.*

<u>Recommendations and Guidance</u>

Maintenance

The range of maintenance activities includes monitoring, inspecting, testing, assessing, calibrating, servicing, overhauling, repairing, and parts replacing. The type of maintenance activity and frequency applied to each SSC should be commensurate with importance to safety, design function and required performance.

Outage Management

The outage program should have designated criteria that the licensee will follow to confirm that planned and discovery work has been satisfactorily completed during the planned outage, and that all safety-significant SSCs are available to ensure the continued safe operation of the facility.

CNSC staff located at the site offices should be invited to the restart meetings in order to verify that all appropriate reviews for restart of the reactor have occurred.

Management of Planned Outages

Outage completion assurance statement should include the status of planned work that was identified in the notification of regulatory undertakings but not completed.

Reliability of Systems Important to Safety

CSA standard N290.9, *Reliability and maintenance programs for nuclear power plants*, mirrors the requirements in REGDOC-2.6.1 and contains additional guidance.

Inspection Programs for Balance of Plant

The licensee should document the current status of all of the safety-significant pressure-retaining components and develop aging management or LCMPs following the regulatory requirements of CNSC regulatory document REGDOC-2.6.3, *Aging Management*. The licensee may elect to use alternative approaches, provided the elements identified in REGDOC-2.6.3 are addressed in an equivalent manner, and are demonstrated to be effective in managing aging. The plans should apply a systematic and integrated approach to establish, implement and improve programs to manage aging and obsolescence of SSCs. SSC-specific LCMPs and AMPs should be implemented in accordance with the licensee's overall integrated AMP framework.

Non-destructive examination (NDE) procedures used in the Components and Equipment Surveillance sub-program should be developed and implemented using a level of rigour consistent with the safety significance of systems and components and the nature of the degradation. For NDE procedures necessary to carry out inspections in the BOP programs, guidance may be obtained from NDE requirements for the PIP program addressed in CSA standard N285.4, *Periodic inspection of CANDU nuclear power plant components*.

Aging Management

Whenever a revision to the AMP, SSC-specific AMP or LCMP is submitted to CNSC for review, the licensee should identify whether the revision(s), affects the previously planned inspection and maintenance activities, with supporting technical basis for the change.

The licensee should maintain a roadmap outlining the programs and procedures that ensure a well-documented overall integrated aging management framework exists.

7 SCA – RADIATION PROTECTION

The safety and control area "Radiation Protection" covers the implementation of a radiation protection program in accordance with the *Radiation Protection Regulations*. This program must ensure that contamination and radiation doses received are monitored and controlled, and maintained as low as reasonably achievable (ALARA).

Performance Objective(s)

The health and safety of persons inside the facility are protected through the implementation of a radiation protection program that ensures that occupational exposures are below regulatory dose limits and are optimized and maintained ALARA.

7.1 Radiation Protection Program and Action Levels

Licence Condition 7.1:

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

Preamble

The *Radiation Protection Regulations* require that the licensee implement a radiation protection program and also ascertain and record doses for each person who perform any duties in connection with any activity that is authorized by the *Nuclear Safety and Control Act* or is present at a place where that activity is carried on. The program must ensure that doses to workers do not exceed prescribed dose limits and are kept As Low As Reasonably Achievable (the ALARA principle), social and economic factors being taken into account.

Note that the regulatory dose limits are explicitly provided in the *Radiation Protection Regulations*.

Action Levels (ALs) are designed to alert licensees before regulatory dose limits are reached. By definition, if an action level referred to in a licence is reached, a loss of control of some part of the associated radiation protection program may have occurred, and specific action is required, as defined in the *Radiation Protection Regulations* and the licence. ALs are not intended to be static and are to reflect operating conditions in the station.

Administrative Dose Limits (ADLs) are the licensee's internal dose limits designed to ensure individuals do not exceed regulatory dose limits. Certain ADLs that are exceeded without prior approval from the designated licensee authority are considered AL exceedances, as defined in the *Radiation Protection Regulations*.

Compliance Verification Criteria

Radiation Protection Program

Provisions for respiratory protection are captured in OPG-PROC- 0132, *Respiratory Protection*, identified as a document requiring written notification under LC 8.1.

Additionally, the radiation protection program shall ensure that occupational exposures are ascertained and recorded in accordance with the *Radiation Protection Regulations*, through the establishment of dosimetry requirements.

Radiation Protection Action Levels

The ALs and ADLs are considered part of the licensing basis. Changes to these limits are subject to LC G.1. The current ALs and ADLs for this facility are extracted from N-STD-RA-0044, *Occupational Radiation Protection Action Levels for Power Reactor Operating Licences*, and N-PROC-RA-0019, *Dose Limits and Exposure Control*, summarized in the table below. In the event of a discrepancy between these tables below and the licensee documentation upon which they are based, the licensee documentation shall be considered the authoritative source (assuming that the licensee has followed its own change control process).

Action Levels: Worker Dose

Field of application	**Value**	**Action Level**
DOSE TO WORKERS: Individual worker external radiation dose received on a job greater than planned	2mSv (200 mrem)	A person receives an external whole body dose that equals or exceeds 2 mSv (200 mrem) above the Electronic Personal Dosimeter (EPD) dose alarm set point.
DOSE TO WORKERS: Individual worker internal exposures greater than planned	2400 kBq/L (65 µCi/L) [2 mSv or (200 mrem)]	A person receives a single intake of tritium oxide (tritiated water) in which the unplanned component of the initial concentration immediately after intake is estimated to equal or exceed 2400 kBq/L (65 µCi/L) (representing an unplanned exposure of 2 mSv (200 mrem)).
DOSE TO WORKERS: Individual worker internal exposure to radionuclides (other than tritium as tritium oxide) greater than planned	0.1 ALI for a radionuclide other than tritium (tritium oxide). [2 mSv or (200 mrem)]	A person receives an intake of a radionuclide other than tritium (in the form of tritium oxide) attributable to a single event that equals or exceeds an unplanned exposure of 2 mSv [200 mrem]
DOSE TO WORKERS: Cumulative annual Individual radiation dose exceeds annual administrative dose limits without approval.	The Administrative Dose Limits (ADLs) are shown in the Table below.	An individual's total whole body radiation dose accumulated over a calendar year exceeds his annual Administrative Dose Limit (ADL) without approval. Doses that are to be compared with the ADLs include doses received at all places of employment during the year.

Administrative Dose Limits:

Whole Body Dose (Effective) limits (one calendar year)		
Category of Worker	**Ontario Power Generation Employees**	**Contract and Building Trades Union Employees**
Nuclear Energy Workers (NEW)	20 mSv (2 rem)	40 mSv (4 rem)
NEW with a lifetime whole body dose greater than 500 mSv (50 rem)	10 mSv (1 rem)	Not applicable
Non-New	0.5 mSv (0.05 rem)	0.5 mSv (0.050 rem)
Whole Body Dose (Effective) limits (rolling 5 calendar years)		
NEW	50 mSv (5 rem)	90 mSv (9 rem)

Action Levels: Surface Contamination Levels

Field of application	**Action Level**	**Observations**
CONTAMINATION CONTROL: Alpha or Beta-gamma surface contamination levels beyond limits in Zone 1.	37 kBq/m^2 (1 µCi/m^2) (beta-gamma); 0.5 kBq/m^2 (0.01 µCi/m^2) (alpha); 7.4 kBq (200 nCi) Cs-137-equivalent beta/gamma (for a DRP)	Total (fixed and loose) surface contamination levels greater than 37 kBq/m^2 (1 µCi/m^2) (beta-gamma) or 0.5 kBq/m^2 (0.01 µCi/m^2) (alpha) are found in Zone 1 or a Discrete Radioactive Particle (DRP) of 7.4 kBq (200 nCi) Cs-137 equivalent activity found in Zone 1.

The following documents require written notification of change:

Document Title	Document #	Notification Status
Radiation Protection	N-PROG-RA-0013	PI
Controlling Exposure As Low As Reasonably Achievable	N-STD-RA-0018	TI
Occupational Radiation Protection Action Levels for Power Reactor Operating Licences	N-STD-RA-0044	PI
Dose Limits and Exposure Control	N-PROC-RA-0019	PI
Radioactive Work Planning, Execution and Close Out	N-PROC-RA-0027	TI
Radiation Dosimetry Program – General Requirements	N-MAN-03416-10000	TI
Radiation Dosimetry Program – External Dosimetry	N-MAN-03416.1-10000	TI

Document Title	Document #	Notification Status
Radiation Dosimetry Program – Internal Dosimetry	N-MAN-03416.2-10000	TI
Respiratory Protection	OPG-PROC-0132	TI

Recommendations and Guidance

CNSC regulatory document REGDOC-2.7.1, *Radiation Protection*, provides the licensee guidance for developing, implementing and maintaining a radiation protection program to ensure that exposures will be ALARA. REGDOC-2.7.1 also provides the licensees guidance for developing ALs in accordance with the *General Nuclear Safety and Control Regulations* and section 6 of the *Radiation Protection Regulations*.

The licensee should conduct a documented review and, if necessary, revise the ALs specified above at least once every five years in order to validate their effectiveness. The results of such reviews should be provided to CNSC staff. If the review results in a revision to a CVC document, the revised document will be subject to LC G.2.

8 SCA – CONVENTIONAL HEALTH AND SAFETY

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

Performance Objective(s)

Conventional health and safety work practices and conditions achieve a high degree of personnel safety.

8.1 Conventional Health and Safety Program

Licence Condition 8.1:

The licensee shall implement and maintain a conventional health and safety program.

Preamble

The *Class I Nuclear Facilities Regulations* require that a licence application contain the proposed worker health and safety policies and procedures.

NPPs in Ontario are regulated by the *Ontario Occupational Health and Safety Act* and the *Labour Relations Act*.

Compliance Verification Criteria

The licensee has the prime responsibility for safety at all times. This responsibility cannot be delegated or contracted to another organization or entity. The licensee shall ensure that contractors and other organizations present on site are informed of and uphold their roles and responsibilities related to conventional health and safety.

N-PROG-RA-0012, *Fire Protection*, and NK38-LIST-78000-10001, *Application of CSA N293 to Structures, System and Components for Darlington Nuclear*, may identify specific SSCs in the protected area or exclusion zone to which the requirements of CSA standard N293, *Fire protection for CANDU nuclear power plants*, are not applied, in which case the requirements of the 2010 edition of the *National Building Code of Canada* and the 2010 edition of the *National Fire Code* shall be applied. See LC 10.2 for version control of CSA N293.

The following documents require written notification of change:

Document Title	Document #	Notification Status
Work Protection	N-PROG-MA-0015	TI
Employee Health and Safety Policy	OPG-POL-0001	TI
Environment Health and Safety Managed Systems	OPG-PROG-0005	TI
Respiratory Protection	OPG-PROC- 0132	TI

Document Title	Document #	Notification Status
Fire Protection	N-PROG-RA-0012	PI
Application of CSA N293 to Structures, System and Components for Darlington Nuclear	NK38-LIST-78000-10001	PI

Recommendations and Guidance

It is expected that OPG will apply the Ontario Building and Fire Codes to SSCs within the exclusion zone but external to the protected area. For fire protection, N-PROG-RA-0012, *Fire Protection*, and NK-38-LIST-78000-10001, *Application of CSA N293 to Structures, Systems and Components for Darlington Nuclear*, may identify specific SSCs in the exclusion zone to which the requirements of CSA N293 are applied.

Additional information can be found in CNSC regulatory document REGDOC-2.8.1, *Conventional Health and Safety*.

9 SCA – ENVIRONMENTAL PROTECTION

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

Performance Objective(s)

The environment and the health and safety of persons are protected by the licensee taking all reasonable precautions, including identifying, controlling and monitoring the release of nuclear substances and hazardous substances to the environment.

9.1 Environmental Protection Program

Licence Condition 9.1:

The licensee shall implement and maintain an environmental protection program, which includes a set of action levels. When the licensee becomes aware that an action level has been reached, the licensee shall notify the Commission within 7 days.

Preamble

The *Class I Nuclear Facilities Regulations* set out requirements related to environmental protection that must be met by the applicant.

The *General Nuclear Safety and Control Regulations* require every licensee to take all reasonable precautions to protect the environment and to control the release of radioactive nuclear substances or hazardous substances within the site of the licensed activity and into the environment as a result of the licensed activity.

CNSC regulatory policy P-223, *Protection of the Environment* and CNSC regulatory document REGDOC-2.9.1, *Environmental Protection: Environmental Principles, Assessments and Protection Measures, Version 1.1*, 2017, describes the principles and factors that guide the CNSC in regulating the development, production and use of nuclear energy and the production, procession and use of nuclear substances, prescribed equipment and prescribed information in order to prevent unreasonable risk to the environment in a manner that is consistent with Canadian environmental policies, acts and regulations and with Canada's international obligations.

The release of hazardous substances is regulated by the Province of Ontario and Environment and Climate Change Canada (ECCC) through various acts and regulations, as well as the CNSC.

Derived Release Limits

Derived Release Limits (DRLs) are calculated or derived using environmental transfer modeling that describes transfer of radioactive materials through environmental pathways to humans. DRLs are required for the purpose of protecting members of the public from unreasonable risk resulting from releases of radionuclides into the environment from the normal operation of the licensed facility.

The release of hazardous substances is regulated by the CNSC as well as both the Ontario Ministry of Environment, Conservation and Parks (MECP) and Environment and Climate Change Canada (ECCC) through various acts and regulations.

Action Levels

OPG has set Environmental Action Levels (EAL) and related parameters, to provide early warnings of any actual or potential losses of control of the Environmental Protection Program. EALs are precautionary levels and are set far below the actual DRLs. EALs are designed to alert licensees before DRLs are reached. They are required by regulations to be specific doses of radiation or other parameter that, if reached, may indicate a loss of control of the licensee's Environmental Protection Program.

Compliance Verification Criteria

The licensee shall implement and maintain programs to ensure environmental protection as set out in the licensing basis (LCH Section G.1). These programs shall comply with the requirements set out in:

- CNSC regulatory document REGDOC-2.9.1, *Environmental Protection Policies, Programs and Procedures*;
- CSA standard N288.1, *Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities*;
- CSA standard N288.4, *Environmental monitoring programs at nuclear facilities and uranium mines and mills*;
- CSA standard N288.5, *Effluent and emissions monitoring programs at nuclear facilities*; and
- CSA standard N288.6, *Environmental risk assessments at class I nuclear facilities and uranium mines and mills*.

Relevant documents that require version control:

Source	Document Title	Document #	Revision #	Effective Date
Effluent and Emissions Control (Releases)				
CSA	Effluent and emissions monitoring programs at nuclear facilities	N288.5	2022	2023-02-15
CSA	Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities	N288.1*	2014 (Reaffirmed 2019)	2019-01-01
CSA	Performance Testing of Nuclear Air-Cleaning Systems at Nuclear Facilities	N288.3.4	2013 (Reaffirmed 2022)	2017-12-14
CSA	Establishing and implementing action levels for releases to the environment from nuclear facilities	N288.8	2017 (Reaffirmed 2022)	2023-12-31

Environmental Management System (EMS)				
CNSC	Environmental Protection Policies, Programs and Procedures	REGDOC-2.9.1**	2013	2016-01-01
CSA	Environmental management of nuclear facilities: Common requirements of the CSA N288 series of Standards	N288.0	2022	2023-02-15
Assessment and Monitoring				
CSA	Environmental monitoring programs at nuclear facilities and uranium mines and mills	N288.4	2019	2024-03-19
CSA	Groundwater protection programs at Class I nuclear facilities and uranium mines and mills	N288.7†	2015 (Reaffirmed 2020)	2022-12-31
Environmental Risk Assessment (ERA)				
CSA	Environmental risk assessments at Class I nuclear facilities and uranium mines and mills	N288.6††	2012 (Reaffirmed 2017)	2016-12-01

**OPG intends to transition Darlington NGS to the 2020 edition of the standard. The DRLs will be revised by December 31, 2027, and Darlington NGS will be compliant with CSA N288.1-20 when the station has implemented the new DRLs. OPG will submit the revised Darlington NGS DRLs and planned implementation date to CNSC staff by 14 January 2028 [e-Doc 7245645, CD# NK38-CORR-00531-25234].*

***REGDOC-2.9.1 Version 1.1, Environmental Protection: Environmental Principles, Assessments and Protection Measures was published in April 2017. As described in OPG letter N-CORR-00531-22251 (e-Doc 6355265), OPG has developed a plan to implement REGDOC-2.9.1 Version 1.1 by December 31, 2022. CNSC staff consider the implementation date of the REGDOC to be effective as of December 31, 2022.*

†OPG has committed to transitioning Darlington NGS to the 2023 edition of CSA N288.7 and intends to be compliant by 30 June 2025 [e-Doc 7406530, CD# N-CORR-00531-24282].

††OPG has committed to be compliant with the 2022 edition of CSA N288.6 once the next Environmental Risk Assessment (ERA) is completed. The next Darlington site ERA is due by 30 November 2026 [e-Doc 7245645, CD# NK38-CORR-00531-25234].

OPG-POL-0021, *Environmental Policy*, and OPG-PROG-0005, *Environment Health and Safety Managed Systems*, are key documents of the "Environmental Protection" program. CSA N286-12 defines additional requirements needed to adequately address environmental protection. Refer to LCH Section 1.1 for version details regarding the implementation of N286.

Effluent and Emissions Control (Releases)

The licensee shall ensure effluent monitoring for nuclear and hazardous substances is designed, implemented and managed to respect applicable laws and to incorporate best practices. The effluent monitoring program shall incorporate airborne and waterborne effluents. Effluent monitoring is a risk-informed activity which assures quantifying of the important releases of the nuclear and hazardous substances into the environment.

OPG Darlington's Effluent Monitoring Program shall be compliant with CSA N288.5-22 Effluent and emissions monitoring programs at nuclear facilities.

Measures to Control Releases of Nuclear and Hazardous Substances

Nuclear Substances – Derived Release Limits

The licensee shall control radiological releases to ALARA, within the DRLs, and take action to investigate cause(s) and correct the cause(s) of increased releases. The licensee shall also monitor and report these releases.

The licensee shall establish the DRLs in accordance with CSA N288.1. If any of the individual radionuclide DRLs are exceeded, or if the sum of individual releases (expressed as a fraction of the relevant DRL) exceeds unity, it indicates that the licensee is in non-compliance with the public dose limit of 1mSv/year as per the CNSC *Radiation Protection Regulations*.

The DRLs are considered part of the licensing basis. Changes to these limits are subject to LC G.1. The DRLs for this facility are summarized in the table below. In the event of a discrepancy between these tables below and the licensee documentation upon which they are based, the licensee documentation shall be considered the authoritative source (assuming that the licensee has followed its own change control process).

Release Category	Radionuclide	DRL(Becquerel/year)
Air	Tritium (HTO)	3.91E+16
	Elemental Tritium (HT)	6.26E+17
	Iodine (mixed fission products)	1.74E+12
	Carbon-14	7.68E+14
	Noble Gases	3.46E+16
	Particulate – Gross Beta-Gamma	5.51E+11
	Particulate – Gross Alpha	9.82E+10
Water	Tritium	6.36.E+18
	Carbon-14	6.97E+14
	Gross Alpha	4.39E+11
	Gross Beta-Gamma	3.47E+13

These DRLs for radionuclides and radionuclide groups account for the most significant releases and are the focus of monitoring and reporting requirements.

Note: During refurbishment of Darlington NPP, OPG is reporting % of DRL as % of Flow Adjusted Release Limits (FARLS) for liquid releases in the Safety Performance Indicator reports.

Nuclear Substances – Environmental Action Levels (EAL)

The EALs are considered part of the licensing basis. Changes to these limits are subject to LC G.1. In accordance with the requirements of LC 3.3 and REGDOC-3.1.1, OPG shall notify the Commission within seven days of becoming aware that an action level has been reached. The current EALs (effective as of 30 December 2023) for this facility are summarized in the table below. In the event of a discrepancy between these tables below and the licensee documentation upon which they are based, the licensee documentation shall be considered the authoritative source (assuming that the licensee has followed its own change control process).

Release Category	Radionuclide	Action Levels: Gaseous releases (Becquerel/week)
Air	Tritium (HTO)	1.78E+13
	Elemental Tritium (HT)	3.81E+13
	Iodine (mixed fission products)	6.11E+6
	Carbon-14	1.08E+11
	Noble Gases*	3.30E+12
	Particulate	4.51E+06
Release Category	Radionuclide	Action Levels: Liquid releases (Becquerel/month)
Water	Tritium (HTO)	1.17E+14
	Carbon-14	NA
	Gross Beta-Gamma	7.99E+09

** Units for noble gas action level are Bq-MeV/week*

Hazardous Substances

The licensee shall control hazardous substances releases according to the limits defined in the licensing basis in accordance with the applicable environmental compliance approvals, provincial and other federal legislation and take action to investigate and correct the cause(s) of increased releases.

Environmental Management System (EMS)

The objective of the environmental protection policies, programs and procedures is to establish adequate provisions for protection of the environment. This shall be accomplished through an integrated set of documented activities of an environmental management system (EMS).

OPG shall implement and maintain an environmental management program to assess environmental risks associated with its nuclear activities, and to ensure these activities are conducted in such a way that adverse environmental effects are prevented or mitigated. OPG environmental management program shall be compliant with REGDOC-2.9.1, *Environmental Protection Policies, Programs and Procedures,* version 2013.

OPG shall ensure that all aspects of its environmental management program are effectively implemented in order to assure compliance with environmental regulatory requirements and expectations, including those set in the International Organization for Standardization 14001, *Environmental Management Systems*. OPG's EMS is registered to the ISO-14001. Having the ISO-14001 certification is not part of the

CNSC requirement; however, it shows that a third party recognized OPG's Environmental Management System as being in accordance with the standard.

Assessment and Monitoring

An environmental monitoring program consists of a risk-informed set of integrated and documented activities to sample, measure, analyze, interpret, and report the following:

- the concentration of hazardous and/or nuclear substances in environmental media to assess one or both of
    - exposure of receptors to those substances; and
    - the potential effects on human health, safety, and the environment;
- the intensity of physical stressors and/or their potential effect on human health and the environment; and
- the physical, chemical, and biological parameters of the environment normally considered in design of the EMP.

OPG Darlington's Environmental Monitoring Program shall be compliant with CSA N288.4-19 Environmental monitoring programs at nuclear facilities and uranium mines and mills.

Protection of people

The *Radiation Protection Regulations* prescribe the radiation dose limits for the general public of 1 mSv per calendar year. The licensee reports the estimated dose to the public from the Darlington site annually, in accordance with REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants* [LC 3.3], in the Environmental Protection report.

Environmental Risk Assessment

In accordance with CSA N288.4 and N288.5, the ERA establishes the basis for both the environmental monitoring program and the effluent monitoring program. The ERA shall be updated periodically with the results from the environmental and effluent monitoring programs in order to confirm the effectiveness of any additional mitigation measures needed.

OPG Darlington's ERA shall be compliant with CSA N288.6- 2012 Environmental risk assessments at Class I nuclear facilities and uranium mines and mills.

The following documents require written notification of change:

Document Title	Document Number	Prior Notification
Effluent and Emissions Control (Releases)		
Monitoring of Nuclear and Hazardous Substances in Effluents	N-STD-OP-0031	TI
Environment Manual	NK38-MAN-03480-10001	TI

Document Title	Document Number	Prior Notification
Derived Release Limits for Darlington Nuclear Generating Station	NK38-REP-03482-10001	PI
Environmental Approvals	N-PROC-OP-0037	TI
Environmental Management System (EMS)		
Environmental Policy	OPG-POL-0021	TI
Environment Health and Safety Managed Systems	OPG-PROG-0005	TI
Contaminated Lands Management	N-PROC-OP-0044	TI
Hazardous Material Management	OPG-PROC-0126	TI
Abnormal Waterborne Tritium Emission Response	N-PROC-OP-0038	TI
Assessment and Monitoring		
Management of the Environmental Monitoring Programs	N-PROC-OP-0025	TI
Darlington Environmental Monitoring Program	NK38-MAN-03443-10002	TI
Groundwater Protection and Monitoring Program	N-STD-OP-0046	PI
Environmental Risk Assessment (ERA)		
2020 Environmental Risk Assessment for the Darlington Nuclear Site	D-REP-07701-00001	TI
2024 Environmental Risk Assessment Addendum for the Darlington Nuclear Site	D-REP-07701-00002	TI

<u>Recommendations and Guidance</u>

Guiding principles and factors for CNSC staff consideration are also given in CNSC Regulatory policy P-223, *Protection of the Environment* and CNSC regulatory document REGDOC-2.9.1, *Environmental Protection: Environmental Principles, Assessments and Protection Measures, Version 1.1*, 2017.

It is recommended that the licensee provide to the CNSC a copy of the reports sent to the Ministry of the Environment and Environment Canada on hazardous releases.

The licensee should review and, if necessary, revise and reissue the DRLs & EALs specified above at least once every five years, in accordance with CSA N288.2, *Guidelines for Calculating the Radiological Consequences to the Public of a Release of Airborne Radioactive Material for Nuclear Reactor Accidents*, 2019.

CNSC staff use the criteria set out in CSA N288.1, *Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities*, as guidance to help assess the adequacy of DRLs established by the licensee.

CNSC staff use the criteria set out in CSA N288.8, *Establishing and implementing action levels for releases to the environment from nuclear facilities*, as guidance to help assess the adequacy of EALs established by the licensee.

10 SCA – EMERGENCY MANAGEMENT AND FIRE PROTECTION

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

Performance Objective(s)

The licensee is ready to respond effectively to any fire or emergency situation.

10.1 Emergency Preparedness Program

Licence Condition 10.1:

The licensee shall implement and maintain an emergency preparedness program.

Preamble

The *Class I Nuclear Facilities Regulations* require that a licence application contain information on the licensee’s proposed mitigating measures for on-site and off-site events. This includes measures to prevent or mitigate the effects of accidental releases of nuclear and hazardous substances to the environment, to protect the health and safety of persons, to ensure the maintenance of national security, as well as measures to assist off-site planning authorities regarding an accidental release for:

- Planning and preparing to limit the effects;
- Notification;
- Reporting of information during and after;
- Assisting off-site authorities with dealing with effects; and
- Testing the implementation of the measures to prevent or mitigate the effects.

As part of the emergency preparedness program, the licensee shall have a public information program consistent with CNSC regulatory document REGDOC-3.2.1, *Public Information and Disclosure*. This is addressed in licence condition G.6.

The licensee also has processes in place to ensure business continuity in the event of an emergency (see LC 2.1).

In addition to the nuclear emergency plan, the licensee maintains a set of emergency operating procedures and abnormal plant operating procedures. This aspect is covered under licence condition 3.1.

A security response to malevolent acts is governed by a separate plan under OPG’s nuclear security program (LC 12.1) but provisions of the licensee’s site security report apply to any associated potential threat of release of radioactive material - for example, the need for off-site notification, situation updates and confirmation of any radioactive releases.

Liquid release response and radioactive materials transportation emergency response plan are also governed by separate plans (LCs 9.1 and 14.1, respectively).

<u>Compliance Verification Criteria</u>

The licensee shall implement and maintain programs to ensure emergency preparedness. These programs shall comply with the requirements set out in CNSC regulatory document REGDOC-2.10.1, *Nuclear Emergency Preparedness and Response*.

Relevant documents that require version control:

Source	Document Title	Document #	Revision #	Effective Date
CNSC	Nuclear Emergency Preparedness and Response, Version 2	REGDOC-2.10.1	2016	2021-09-24

The emergency program consists of a description to cope with accidental releases. This program encompasses both emergency preparedness and emergency response measures. It ensures that appropriate emergency response capabilities are developed and maintained available for use.

The emergency preparedness program consists of:

- Basis for emergency planning;
- Personnel selection and qualification;
- Emergency preparedness and response organizations;
- Staffing levels;
- Emergency training, drills and exercises;
- Emergency facilities and equipment;
- Emergency procedures;
- Assessment of emergency response capability;
- Assessment of accidents;
- Activation and termination of emergency responses;
- Protection of facility personnel and equipment,
- Interface with off-site organizations;
- Recovery program;
- Public information program; and
- Public education program.

The licensee’s Consolidated Nuclear Emergency Plan (CNEP) deals with emergency situations that could endanger the safety of on-site staff, the environment and the public. It is predominantly conceived to deal with releases of radioactive materials from fixed facilities and to outline interfaces with the Provincial Nuclear Emergency Response Plan (PNERP). The licensee shall maintain equipment, procedures and staff to support off- site response activities for an accidental release. Infrastructures defined within the PNERP may be used in planning and response to virtually all emergencies. The licensee’s Nuclear Emergency Plan also represents a basis for controlling changes and modifications to the licensee’s nuclear emergency preparedness program.

OPG is required to conduct Emergency Exercises and Drills as described in the CNEP. Drills and/or exercises are required at least annually in most areas. The drill and exercise program details the requirements for corporate exercises, testing of drill and exercise objectives, and coordination with non-OPG facilities. Participation by municipal and provincial emergency response groups is scheduled by mutual agreement.

The licensee implements and maintains a "Business Continuity Program", to support minimum shift complement staffing and makes provisions should a labour dispute arise by implementing and maintaining strike contingency documentation, "Contingency Guideline for Maintaining Staff in Key Positions When Normal Station Access is Impeded" (refer to LC 1.1).

The licensee shall provide the necessary resources and support to provincial and municipal authorities in implementing the provincial and municipal plans to do the following, or the licensee shall do the following:

- Ensure that a sufficient quantity of iodine thyroid blocking (ITB) agents are pre-distributed, to all residences, businesses and institutions within the primary zone, together with instructions on their proper administration;
- Ensure that a sufficient quantity of ITB agent is pre-stocked and available within the secondary zone to the extent practicable. This pre-stocked inventory of ITB agents shall be located so that it can be promptly and efficiently obtained by, or provided to, members of the public with particular consideration to sensitive populations such as children and pregnant women;
- Ensure that pre-distributed and pre-stocked ITB agents are maintained within their expiry date;
- Ensure that pre-distribution plans are supported by a robust, ongoing, and cyclical public education program; and
- Ensure that public emergency preparedness information is provided to all residences, businesses and institutions within the primary zone and readily available to the general public, including online.

The following documents require written notification of change:

Document Title	Document #	Notification Status
Consolidated Nuclear Emergency Plan	N-PROG-RA-0001	PI
OPG Nuclear Emergency Response Organization Drills and Exercises	N-PROC-RA-0045	TI

<u>Recommendations and Guidance</u>

The licensee should provide emergency communications outlining what surrounding community residents need to know and do before, during and after a nuclear emergency. Information should be in plain language, readily accessible and include the following:

- How the public is notified of an emergency;
- What protective actions may be required during an emergency;

- What the public is expected to do, and why, when directed to take protective actions;
- What the public can do now to be better prepared for an emergency; and
- Where can the public get more information on emergency plans.

Regarding the distribution of ITB agents, recognizable locations with credible persons within the community, such as fire stations, police stations and pharmacies should be considered in the selection of pre-stocking locations.

10.2 Fire Protection Program

<u>Licence Condition 10.2:</u>

The licensee shall implement and maintain a fire protection program.

<u>Preamble</u>

Licensees require a comprehensive Fire Protection Program (FPP) to ensure the licensed activities do not result in unreasonable risk to the health and safety of persons and to the environment due to fire and to ensure that the licensee is able to efficiently and effectively respond to emergency fire situations.

Fire protection provisions, including response, are required for the design, construction, commissioning, operation, and maintenance nuclear facilities, including structures, systems, and components (SSCs) that directly support the plant and the protected area. External events such as an aircraft crash or threats are addressed by LC 12.1.

<u>Compliance Verification Criteria</u>

The licensee shall implement and maintain programs to ensure fire protection. These programs shall comply with the requirements set out in CSA standard N293, *Fire protection for CANDU nuclear power plants*.

Relevant documents that require version control:

Source	Document Title	Document #	Revision #	Effective Date
CSA	Fire protection for nuclear power plants	N293*	2012 and Update No.1 (R2022)	2023-06-30

**OPG is conducting a gap analysis for the 2023 edition of CSA N293 and has committed to providing CNSC staff with an implementation plan by 03 September 2025 [CD# NK38-CORR-00531-25642, e-Doc 7372903].*

Fire Protection

The licensee shall assess the Fire Hazard Assessment and Fire Safe Shutdown Analysis revisions against the requirements of CSA N293 and provide a justification of any non-conformances found and development a plan for the execution of corrective actions to address the identified gaps.

As required by CSA N293, the licensee shall ensure that a qualified third party performs a plant condition inspection annually and an FPP audit every three years. The resulting inspection and audit reports shall be submitted to CNSC staff.

As per the Integrated Safety Review (ISR) process and as permitted by CSA N293, CNSC staff concurred with OPG's request for Fire Protection Acceptable Deviations and Alternate Compliances related to the Refurbishment project in July of 2015 (e-Doc 4806897). Per CSA N293, CNSC staff have subsequently provided concurrence to additional fire protection related alternate compliances (e-Docs 5296647, 4996509, 4995266, 4994520, 4982486, 4950896, 4940772).

Fire Response

As required by CSA N293, a review of the Industrial Fire Brigade (IFB) governance and performance shall be included in the fire protection program audit described above. The fire protection program audit shall include direct observation and assessment of at least one IFB fire response drill. The IFB drill assessment is to analyze and ensure competencies of the IFB against the CSA N293 standard and NFPA standards referenced therein.

An independent third party auditor is required to be an expert in their discipline, normally firefighting and qualified through specific education and relevant experience. The third party auditor is required to be independent or at "arm's length" from the facility to ensure total impartiality. The review shall be of sufficient depth and detail that the reviewer can attest with reasonable confidence on the competencies of the IFB at the facility.

The following documents require written notification of change:

Document Title	Document #	Notification Status
Fire Protection	N-PROG-RA-0012	PI
Fire Hazard Assessment of the DNGS Retube Waste Processing Building (RWPB)	NK38-REP-09701-10338	PI

<u>Recommendations and Guidance</u>

The Nuclear Energy Institute in NEI 00-01, *Guidance for Post Fire Safe Shutdown Circuit Analysis*, is used by CNSC staff to help determine the adequacy of safe shutdown electrical circuit analysis.

The results of the Third Party Audit report will typically consist of a report which compares the requirements of the applicable codes and standards against the implementation of the FPP or the Fire Response exercised (based on the scope of the audit). The report should identify any non-compliance and formulate a conclusion if the licensee's FPP or IFB meets the requirements of CSA N293.

As a guideline the report should provide sufficient detail to support the conclusion and to convey that the requirements of CSA N293 are met. As a minimum, the documentation for a Third Party Audit should include:

- Scope and objective of the review;
- A list of applicable codes and standards;
- Summary of the review methodology, including areas and documents reviewed;
- Detailed observations or issues that have been identified;
- Conclusion should identify whether the FPP or the IFB response meets applicable requirements, achieves the FPP or IFB response objectives;
- Summary of any non-compliance, recommendations (if any) and the corrective action plan; and

- The report to be signed by the person taking responsibility for the review.

11 SCA – WASTE MANAGEMENT

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

Performance Objective(s)

There is full development, implementation and auditing of a facility- and waste stream- specific waste management program to control and minimize the volume of nuclear waste generated by the licensed activity; waste management is included as a key component of licensee's corporate and safety culture; and a decommissioning plan is maintained.

11.1 Waste Management Program

Licence Condition 11.1:

The licensee shall implement and maintain a waste management program.

Preamble:

The *General Nuclear Safety and Control Regulations* require that a licence application contain information related to the in-plant management of radioactive waste or hazardous waste resulting from the licensed activities.

The *Class I Nuclear Facilities Regulations* require that a licence application contain the proposed procedures for handling, storing, loading and transporting nuclear substances and hazardous substances.

CNSC Regulatory Document REGDOC-2.11 *Framework for Radioactive Waste Management and Decommissioning in Canada*, defines radioactive waste as any material (liquid, gaseous or solid) that contains a radioactive "nuclear substance," as defined in section 2 of the *NSCA* and which the owner has declared to be waste. In addition to containing nuclear substances, radioactive waste may also contain non-radioactive "hazardous substances," as defined in section 1 of the *General Nuclear Safety and Control Regulations*.

Compliance Verification Criteria:

The licensee shall implement and maintain a program for waste management that includes strategies for waste minimization. Low and intermediate level waste shall be managed in accordance with CSA standard N292.3, *Management of low and intermediate-level radioactive waste*.

Relevant documents that require version control:

Source	Document Title	Document #	Revision #	Effective Date
CSA	Management of low and intermediate-level radioactive waste	N292.3	2014 (Reaffirmed 2019)	2024-12-04
CSA	General principles for the management of radioactive waste and irradiated fuel	N292.0	2019 (Reaffirmed 2024)	2024-12-04

OPG has committed to implementing CSA N292.4-23, *Storage of radioactive waste and irradiated fuel*, and will be providing CNSC staff with an implementation plan by 28 March 2025 [CD# NK38-CORR-00531-25234; e-Doc 7245645]. Note: CSA N292.4-23, *Storage of radioactive waste and irradiated fuel*, is a consolidation of, and replaces each, CSA N292.1 and CSA N292.2.

Further, as communicated in OPG letter N-CORR-00531-24041 (e-Doc 7293387), OPG has committed to be compliant with CSA N292.8-21, *Characterization of radioactive waste and irradiated fuel* by 19 December 2025.

The licensee shall:

- Characterize its waste streams and minimize the production of all wastes taking into consideration the health and safety of workers and the environment;
- Integrate waste management programs as a key element of the facility's safety culture; and
- Audit on a regular basis its program to maximize its efficiency.

OPG shall ensure that the Retube Waste Processing Building (RWPB) is operated in accordance with the Darlington Nuclear Generating Station PROL and the applicable documents included below as requiring written notification of change:

- Operations & Maintenance Plan - Retube Waste Processing Building
- RWPB Safety Analysis Summary Report (see LC 4.1)
- Darlington Retube Waste Processing Building – Safety Assessment (see LC 4.1)
- RWPB Worker Dose During Normal Operation and Under Accident Conditions (see LC 4.1)
- Fire Hazard Assessment of the DNGS Retube Waste Processing Building (RWPB) (see LC 10.2)

The following documents require written notification of change:

Document Title	Document #	Notification Status
Environment Health and Safety Managed Systems	OPG-PROG-0005	TI
Management of Waste and Other Environmentally Regulated Materials	OPG-STD-0156	TI

Document Title	Document #	Notification Status
Segregation and Handling of Radioactive Waste	N-PROC-RA-0017	TI
Operations & Maintenance Plan - Retube Waste Processing Building	NK38-PLAN-09701-10293	PI
Retube Waste Processing Building Safety Analysis Summary Report	NK38-REP-09701-10344	PI
Darlington Retube Waste Processing Building - Safety Assessment	NK38-REP-09701-10326	PI
RWPB Worker Dose During Normal Operations and Under Accident Conditions	NK38-CORR-09701-0597849	PI
Fire Hazard Assessment of the DNGS Retube Waste Processing Building (RWPB)	NK38-REP-09701-10338	PI

Recommendations and Guidance:

Additional guidance related to this LC can be found in CSA standard N292.2, *Interim dry storage of irradiated fuel*.

With respect to the storage and management of spent nuclear fuel, the waste management practices should reflect the fundamental safety concerns related to criticality, exposure, heat control, containment and retrievability. Namely, the systems that are designed and operated should assure subcriticality, control radiation exposure, assure heat removal, assure containment and allow retrievability.

11.2 Program for Planning the Decommissioning of the Nuclear Facility

Licence Condition 11.2:

The licensee shall implement and maintain a decommissioning plan.

Preamble:

The *Class I Nuclear Facilities Regulations* require that a licence application contain the proposed plan for decommissioning of the nuclear facility.

The decommissioning plan includes strategies for the management of low and intermediate level waste, reactor and waste storage facility decommissioning, and the used fuel arising from the operation of the nuclear facility.

Compliance Verification Criteria:

CSA standard N294, *Decommissioning of facilities containing nuclear substances*, provides direction on the decommissioning of licensed facilities and specifies requirements for the planning, preparation, execution and completion of decommissioning.

Relevant documents that require version control:

Source	Document Title	Document #	Revision #	Effective Date
CSA	Decommissioning of facilities containing nuclear substances	N294	2019	2021-12-31
CNSA	Waste Management, Volume I: Management of Radioactive Waste	REGDOC-2.11.1	2021	2024-12-04

The following documents require written notification of change:

Document Title	Document #	Notification Status
Decommissioning Program	W-PROG-WM-0003	PI
Darlington Nuclear Site Preliminary Decommissioning Plan	NK38-PLAN-00960-10001	PI

CNSC REGDOC-2.11.2, *Decommissioning*, was published in January 2021. As detailed in OPG letter NK38-CORR-00531-25234 (e-Doc 7245645), OPG will implement REGDOC-2.11.2 at Darlington NGS by 30 December 2027, and reflect this implementation in the next decommissioning plan.

The decommissioning plan shall be kept current to reflect any changes in the site or nuclear facility. The decommissioning plan shall be revised at a minimum every five years, unless specified otherwise by the Commission. NK38-PLAN-00960-10001, *Darlington Nuclear Site Preliminary Decommissioning Plan*, will be revised and submitted to the CNSC by 31 January 2027.

Recommendations and Guidance:

This section has no contents applicable to this LC.

12 SCA – SECURITY

The safety and control area "Security" covers the programs required to implement and support the security requirements stipulated in the *Nuclear Security Regulations*, the licence, orders, or expectations for the facility or activity.

Performance Objective(s)

Loss, theft or sabotage of nuclear material or sabotage of the licensed facility are prevented.

12.1 Nuclear Security Program

Licence Condition 12.1:

The licensee shall implement and maintain a security program.

Preamble

The *General Nuclear Safety and Control Regulations* require that a licence application contain information related to site access control and measures to prevent loss or illegal use, possession or removal of the nuclear substance, prescribed equipment or prescribed information.

The *Class I Nuclear Facilities Regulations* require that a licence application contain the proposed measures to prevent acts of sabotage or attempted sabotage at the nuclear facility.

The *Nuclear Security Regulations* require that a licence application contain specific information related to nuclear security, stipulates the requirements for High-Security Sites, and contains specific requirements pertaining to the transportation of Category I, II or III nuclear material.

The *Nuclear Security Regulations* require that a licensee of a high security site:

- Maintain at all times a qualified onsite nuclear response force;
- Obtain the applicable certifications, before issuing an authorization to a nuclear security officer;
- Prevent unauthorized removal of nuclear material;
- Prevent and detect unauthorized entry into a protected area or inner area; and
- Prevent unauthorized entry of weapons and explosive substances into a protected area or inner area.

The *Nuclear Security Regulations* require every licensee to: conduct, at least once every 12 months, a threat and risk assessment specific to a facility where it carries on licensed activities in order to determine the adequacy of its physical protection system; make modifications to its physical protection system, as necessary, to counter any credible threat identified as a result of the threat and risk assessment; keep a written record of each threat and risk assessment that it conducts and provide a copy of the written record, together with a statement of actions taken as a result of the threat and risk assessment, to the Commission upon request (within 60 days) after completion of the assessment.

CNSC regulatory document REGDOC-2.12.1, *High Security Facilities, Volume I: Nuclear Response Force*, describes how, when required by a CNSC licence or order, a trained and equipped on-site nuclear response force shall be established and deployed at a nuclear facility.

Compliance Verification Criteria

The licensee shall implement and maintain programs to ensure security of the nuclear facility. These programs shall comply with the requirements set out in CNSC regulatory documents:

- CNSC regulatory document REGDOC-2.12.1, *High Security Facilities, Volume I: Nuclear Response Force*;
- CNSC regulatory document REGDOC-2.12.1, *High-Security Sites, Volume II: Criteria for Nuclear Security Systems and Devices*;
- CNSC regulatory document REGDOC-2.12.2, *Site Access Security Clearance*;
- CNSC regulatory document REGDOC-2.2.4, *Fitness for Duty, Volume III: Nuclear Security Officer Medical, Physical, and Psychological Fitness*.

Relevant documents that require version control:

Source	Document Title	Document #	Revision #	Effective Date
CNSC	High Security Facilities, Volume I: Nuclear Response Force, *Version 2*	REGDOC-2.12.1, Volume I	2018	2020-12-31
CNSC	High-Security Sites, Volume II: Criteria for Nuclear Security Systems and Devices	REGDOC-2.12.1, Volume II	2018	2024-03-19
CNSC	Site Access Security Clearance	REGDOC-2.12.2	2013	2016-01-01
CNSC	Fitness for Duty, Volume III: Nuclear Security Officer Medical, Physical, and Psychological Fitness	REGDOC-2.2.4	2018	2020-12-31
CNSC	Security of Nuclear Substances: Sealed Sources and Category I, II and III Nuclear Material, Version 2.1	REGDOC-2.12.3	2020	2024-03-19
CSA	Cyber security for nuclear power plants and small reactor facilities	N290.7	2014 (Reaffirmed 2021)	2019-11-30

The licensee shall ensure the identified vital areas within the nuclear facility are protected against design basis threats and any other credible threat identified in their Threat and Risk Assessment documentation. The prime functions that must be maintained to prevent unacceptable radiological consequences are those of control, cool, and contain.

The licensee shall maintain the operation, design and analysis provisions credited in the above assessments as required to ensure adequate engineered safety barriers for the protection against malevolent acts. The provisions for the protection against malevolent acts shall be documented as part of a managed sub-program or process within the management system. The licensee shall summarize changes in design, analysis or operational procedures that are credited for the protection against malevolent acts in the annual threat and risk assessment, and submit a copy to the Commission upon request.

All detection devices shall be installed, operated and maintained in accordance with manufacturers' specifications and meet the criteria in REGDOC-2.12.1, Volume II .

The licensee shall, in accordance with REGDOC-2.2.4, ensure that the required documentation and necessary medical, physical, and psychological certification of a person is obtained before authorizing that person to act as a nuclear security officer.

The licensee shall implement measures for the purpose of preventing and detecting unauthorized entry into a protected area or inner area at a high-security site, including:

- Vehicle barriers and vehicle access control points;
- Perimeter intrusion detection systems and devices;
- Closed-circuit video systems/ devices for applications in a protected area or inner area;
- Security monitoring rooms; and
- Security monitoring room systems and devices.

Cyber Security

The licensee's cyber security program shall be designed, implemented, and maintained to protect the cyber essential assets (CEAs) that perform or impact nuclear safety, nuclear security, emergency preparedness, or safeguard functions from cyber attacks.

The following documents require written notification of change:

Document Title	Document #	Notification Status
Darlington Nuclear Generating Station Security Report	8300-REP-61400-10003	PI
Darlington Nuclear Security Tactical Plan	8300-PLAN-61400-10012	PI
Nuclear Security	N-PROG-RA-0011	PI
Darlington Nuclear Generating Station and Nuclear Sustainability Services - Darlington - Harmonized Threat Vulnerability and Risk Assessment	NK38-REP-08160.3-00001	TI
Cyber Security	N-PROC-RA-0135	TI
Cyber Essential Asset Identification and Classification	N-STI-08161-10017	TI
Cyber Security Controls for Cyber Essential Assets	N-INS-08161-10011	TI
Cyber Security	OPG-PROG-0042	TI

<u>Recommendations and Guidance</u>

CNSC guidance document G-274, *Security Programs for Category I or II Nuclear Material or Certain Nuclear Facilities*, provides guidance for preparing, submitting and revising the Station Security Report.

CNSC guidance document G-208, *Transportation Security Plans for Category I, II, or III Nuclear Material*, provides guidance to the licensee on how to prepare and submit a "written transportation security plan".

Guidance may be obtained in the IAEA Nuclear Security Series No. 4, *Technical Guidance: Engineering Safety Aspects of the Protection of Nuclear Power Plants Against Sabotage*, IAEA Nuclear Security Series No.13, *Recommendations: Nuclear Security Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities (INFCIRC/225/Revision 5)*, and IAEA Nuclear Security Series No. 17, *Technical Guidance: Computer Security at Nuclear Facilities*.

13 SCA – SAFEGUARDS AND NON-PROLIFERATION

The safety and control area "Safeguards and Non-Proliferation" covers the programs required for the successful implementation of the obligations arising from the Canada/IAEA Safeguards Agreement, as well as all other measures arising from the *Treaty on the Non-Proliferation of Nuclear Weapons*.

Performance Objective(s)

Conformity with measures required by the facility to meet Canada's international safeguards obligations through:

- Timely provision of accurate reports and information;
- Provision of access and assistance to IAEA inspectors for verification activities;
- Submission of annual operational information and accurate design information of plant structures, processes and procedures;
- Development and satisfactory implementation of appropriate facility safeguards procedures; and
- Demonstration of capability, as confirmed through CNSC onsite evaluations, to meet all requirements in support of physical inventory verifications of nuclear material by the IAEA.

13.1 Safeguards Program

Licence Condition 13.1:

The licensee shall implement and maintain a safeguards program.

Preamble

Safeguards is a system of inspection and other verification activities undertaken by the IAEA in order to evaluate a Member State's compliance with its obligations pursuant to its safeguards agreements with the IAEA.

The *General Nuclear Safety and Control Regulations* require the licensee to take all necessary measures to facilitate Canada's compliance with any applicable safeguards agreement, and defines reporting requirements for safeguards events.

The *Class I Nuclear Facilities Regulations* require that a licence application contain information on the licensee's proposed measures to facilitate Canada's compliance with any applicable safeguards agreement.

Canada has entered into a Safeguards Agreement and an Additional Protocol (hereafter referred to as "safeguards agreements") with the IAEA pursuant to its obligations under the *Treaty on the Non-Proliferation of Nuclear Weapons* (INFCIRC/140). The objective of the Canada-IAEA safeguards agreements is for the IAEA to provide assurance on an annual basis to Canada and to the international community that all declared nuclear materials are in peaceful, non-explosive uses and that there is no indication of undeclared nuclear materials or activities. This conclusion confirms that Canada is in compliance with its obligations under the following Canada-IAEA safeguards agreements:

- *Agreement Between the Government of Canada and the International Atomic Energy Agency for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons; and*
- *Protocol Additional to the Agreement Between Canada and the International Atomic Energy Agency for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons.*

These are reproduced in information circulars INFCIRC/164, and INFCIRC/164/Add. 1.

The scope of non-proliferation activities carried out under this licence is limited to tracking and reporting of foreign obligations and origins of nuclear material. Additionally, the import and export of controlled nuclear substances, equipment and information identified in the *Nuclear Non-proliferation Import and Export Control Regulations* require separate authorization from the CNSC, consistent with the *General Nuclear Safety and Control Regulations*.

Compliance Verification Criteria

The licensee shall ensure that accounting and reporting of nuclear materials is carried out in accordance with CNSC regulatory document REGDOC-2.13.1, *Safeguards and Nuclear Material Accountancy*.

Relevant documents that require version control:

Source	Document Title	Document #	Revision #	Effective Date
CNSC	Safeguards and Nuclear Material Accountancy	REGDOC-2.13.1	2018	2021-10-25

To avoid a potential non-compliance with REGDOC-2.13.1, section 8.1.1, when the Nuclear Material Accountancy Reporting (NMAR) e-business system is not available, OPG is to contact the CNSC International Safeguards Division (safeguardsofficial-garantiesofficiel@cnsc-ccsn.gc.ca) to inform them of the issue and to seek guidance on how to fulfill reporting requirements. When OPG inventory change documents and physical-key measurement point inventory summaries are submitted using an alternative method, OPG will still be required to re-submit using the NMAR e-business system once the NMAR system becomes available. For additional information see CNSC letter e-Doc 6032545.

The licensee shall not make changes to operation, equipment or procedures that would affect the implementation of safeguards measures, except with the prior written approval of the Commission or CNSC staff as follows:

- Director, International Safeguards Division;
- Director General, Directorate of Security and Safeguards;
- Vice-President, Technical Support Branch; and
- Executive Vice-President and Chief Regulatory Operations Officer, Regulatory Operations Branch.

With respect to the implementation of safeguards measures, changes made by the licensee to operation, equipment or procedures as of the result of agreement between the licensee, the CNSC and the IAEA are considered routine.

If a requested change would adversely impact Canada's compliance its safeguards agreements, CNSC staff does not have the authority to give approval, as this would violate the obligations arising from the Canada-IAEA safeguards agreement.

The following documents require written notification of change:

Document Title	Document #	Notification Status
Safeguards and Nuclear Material Accountancy	N-PROG-RA-0015	PI
Safeguards and Nuclear Material Accountancy Implementation	N-STD-RA-0024	PI
OPG Safeguards and Nuclear Material Accountancy Requirements	N-PROC-RA-0136	PI

Recommendations and Guidance

This section has no contents applicable to this LC.

14 SCA – PACKAGING AND TRANSPORT

The safety and control area "Packaging and Transport" covers programs for the safe packaging and transport of nuclear substances to and from the licensed facility.

Performance Objective(s)

All radioactive shipments leaving the site adhere to the *Packaging and Transport of Nuclear Substances Regulations* and the *Transportation of Dangerous Goods Regulations*.

14.1 Packaging and Transport Program

Licence Condition 14.1:

The licensee shall implement and maintain a packaging and transport of nuclear substances program.

Preamble

The *Class I Nuclear Facilities Regulations* require that a licence application contain information on the proposed procedures for transporting nuclear substances.

Every person who transports radioactive material, or requires it to be transported, shall act in accordance with the requirements of the *Transportation of Dangerous Goods Regulations* (TDGR) and the *Packaging and Transport of Nuclear Substances Regulations*, *2015* (PTNSR 2015).

The *PTNSR* and the *TDGR* provide specific requirements for the design of transport packages, the packaging, marking and labeling of packages and the handling and transport of nuclear substances.

Compliance Verification Criteria

The licensee shall implement and maintain a packaging and transport program that will ensure compliance with the requirements of the TDGR and the PTNSR.

The following documents require written notification of change:

Document Title	Document #	Notification Status
Radioactive Material Transportation	W-PROG-WM-0002	TI
Radioactive Materials Transportation Emergency Response Plan	N-STD-RA-0036	TI

Recommendations and Guidance

This section has no contents applicable to this LC.

15 NUCLEAR FACILITY -SPECIFIC

15.1 Tritium Removal Facility Operations

Licence Condition:

The licensee shall implement and maintain an operations program for the Tritium Removal Facility including a set of operating limits.

Preamble

The Darlington NGS PROL authorizes OPG to operate the Tritium Removal Facility (TRF) housed in the Heavy Water Management Building on the site. Tritium is produced in the moderator and primary heat transport circuit of CANadian Deuterium Uranium (CANDU) reactors. The TRF is designed to reduce levels of radioactive tritium from these heavy water (deuterium oxide, D_2O) inventories. This in turn reduces the potential radiation exposure of licensee staff and reduces releases to the environment. The systems of the TRF have been designed to perform three primary functions: tritium extraction, tritium immobilization/storage and tritium clean up.

In addition to reducing tritium levels in Darlington NGS heavy water inventories, the TRF is also used to reduce tritium levels in heavy water inventories from the other Canadian NPPs.

Compliance Verification Criteria

The licensee shall ensure that the operation of the TRF is addressed in the operating policies and principles (OP&Ps).

The licensee shall ensure that the concentration of tritium in any tritiated deuterium oxide feedstock to be treated in the Darlington TRF does not exceed 1.26 TBq/kg D_2O (34 Ci/kg D_2O).

D-INS-39000-10003, *Tritium Removal Facility Planned Outage Management* is specific to managing outages in the TRF. While this document takes its authority from N-PROC-MA-0013, *Planned Outage Management* (listed under LC 6.1), the document also takes into account the specific nature and timing of TRF outages, allowing OPG to achieve a higher degree compliance with their own documentation.

Condition assessments of the TRF conducted by the OPG indicate that detritiation capacity may be extended to 2055 to match the end of extended life of Darlington NGS, instead of the currently expected end of design life in 2025. As per correspondence NK38-CORR-00531-21141 (e-Doc 6031691), dated 28 October 2019, OPG has elected to extend the operational life of the TRF beyond 2025, by undertaking refurbishment activities over a series of extended outages commencing in 2025.

The following documents require written notification of change:

Document Title	Document #	Notification Status
Operating Policies and Principles	NK38-OPP-03600	PI
Tritium Removal Facility Planned Outage Management	D-INS-39000-10003	TI
Heavy Water Management	N-PROG-AS-0008	TI

Recommendations and Guidance

This section has no contents applicable to this LC.

15.2 Refurbishment - Return to Service

Licence Condition:

The licensee shall implement a return to service plan for refurbishment.

Preamble

Reactor units will be removed from service for replacement of internal reactor components and other activities that can only be accomplished in a "refurbishment" outage. Refurbishment outages differ from planned maintenance outages in that the duration is longer, work activities are more complex, and the configuration of the unit is significantly altered to allow work to proceed.

Return to service (RTS) involves returning the reactor and associated nuclear and non-nuclear systems to commercial operation. The licensee must demonstrate that all regulatory requirements have been met and that the associated work has been done to the satisfaction of the CNSC.

Compliance Verification Criteria

The licensee's Return to Service Program Management Plan, NK38-NR-PLAN-09701-10001, Sheet: 0003, describes the processes, procedures, and organization that will be used during the Darlington Refurbishment Project to manage the modification and restart activities.

This plan identifies OPG internal restart control hold points (RCHPs) that will be the focus of the run-up activities leading up to full power and unit availability for commercial operation. For each RCHP, the licensee will produce a Completion Assurance Document (CAD) which provides confirmation that all pre-requisites, modification commissioning, testing, system restart activities and commitments have been addressed to the allow OPG's release of the specific hold point. The CAD will include references to the following reports with detail applicable to the specific activities associated with the RCHP:

- Construction Completion Declarations:
  - Confirm that construction and installation activities are sufficiently complete and that it is safe to proceed with modification commissioning and re-start testing on the affected SSCs.
- Modification Commissioning Reports:
  - Confirm that new or modified SSCs meets the design specifications and performance criteria.
- System Available for Service Packages:
  - Confirm that individual systems, or a group of systems, can be credited to safety and reliability perform their design functions.
- Re-start Testing:
  - Confirm that functional tests and system-level tests have been completed to confirm that non-modified SSCs are ready to return to normal operation after the refurbishment outage.
- Unit Readiness for Service Packages:

- Confirm that each unit is returned to service in a manner which demonstrates that new and existing plant SSCs conform to the defined physical, function, performance, safety and control requirements.

The following documents require written notification of change:

Document Title	Document #	Notification Status
Darlington Refurbishment Return to Service Program Management Plan	NK38-NR-PLAN-09701-10001, Sheet: 0003	TI
Engineering Change Control Process	N-PROC-MP-0090	PI

Recommendations and Guidance

OPG should apply the concepts described in REGDOC-2.3.1, *Conduct of Licensed Activities: Construction and Commissioning Programs*, to the extent practicable, when commissioning and returning SSCs to service. CNSC staff will consider pertinent sections of REGDOC-2.3.1 when evaluating OPG's commissioning and return to service activities related to the refurbishment.

OPG and CNSC staff have bilaterally issued Return to Service (RTS) protocols intended to manage prerequisites for Regulatory Hold Point (RHP) removal and for production of certain deliverables by both parties, to obtain certainty around the schedule and scope and management of anticipated changes to deliverables associated to a refurbished Unit's RTS.

The scope of work specified in the RTS protocols have been based on this Licence Conditions Handbook and agreed to with CNSC staff for implementation for refurbished Units' RTS.

The RTS protocols detail the administrative process to be used between the CNSC and OPG to manage the regulatory interaction for the listed deliverables in Appendix B of the protocols that comprise the assurance CNSC seeks as defined in this LCH for removal of the RHPs referenced in License Condition 15.4 of the Darlington PROL.

15.3 Integrated Implementation Plan

Licence Condition:

The licensee shall implement the Integrated Implementation Plan.

Preamble

The Integrated Implementation Plan (IIP) contains commitments, including the timeframes for implementation, resulting from the Environmental Assessment (EA) for Darlington Refurbishment and Continued Operations as well as the Darlington Integrated Safety Review (ISR). These commitments include, but are not limited to:

- Replacement of fuel channels, feeders, calandria tubes, and end fittings;
- Installation of two auxiliary shutdown cooling pumps per unit;
- Installation of a containment filtered venting system;
- Provision of shield tank overpressure protection;
- Enhancements to the powerhouse steam venting system;
- Installation of a 3rd emergency power generator;
- Provision of an alternate, independent supply of water as an emergency heat sink;
- Implementation of safety related recommendations from component condition assessments; and
- Implementation of mitigation and follow up activities stemming from the Environmental Assessment conducted under the *Canadian Environmental Assessment Act, 1992*.

Compliance Verification Criteria

In implementing the commitments identified in the Darlington ISR IIP, NK38-REP-03680-10185 R004 , *Darlington NGS Integrated Implementation Plan* (e-Doc 7139515), OPG shall provide formal progress reports on the status of all Darlington ISR IIP commitments on an annual basis to CNSC staff by March 31st of each year during the licence period.

In parallel to the Darlington ISR IIP, OPG has also provided an IIP based on the Darlington PSR completed in 2024. OPG is currently implementing NK38-REP-03680-11940-R000, *Darlington NGS Periodic Safety Review (D-PSR): Integrated Implementation Plan* (e-Doc 7125642) in compliance with REGDOC-2.3.3, Periodic Safety Reviews. As with the ISR IIP, OPG shall provide formal progress reports on the status of all Darlington PSR IIP commitments on an annual basis to CNSC staff by March 31st of each year during the licence period.

Any proposed non-intent changes to the Darlington IIPs shall be subject to the licensee's IIP Change Control Process Principles (CD# NK38-CORR-00531-16991, e-Doc 4575922); further developed in N-PROC-MA-0109, *Periodic Safety Review*.

The following documents require written notification of change:

Document Title	Document #	Notification Status
Periodic Safety Review	N-PROC-MA-0109	TI

Relevant documents that require version control:

Source	Document Title	Document #	Revision #
CNSC	Periodic Safety Reviews	REGDOC-2.3.3	2015

Recommendations and Guidance

This section has no contents applicable to this LC.

15.4 Regulatory Hold Points for Return to Service and Continued Operations

Licence Condition:

The licensee shall obtain the approval of the Commission, or consent of a person authorized by the Commission, prior to the removal of established regulatory hold points.

Preamble

CNSC selected four (4) regulatory hold points for which CNSC approval will be sought prior to proceeding to the subsequent commissioning phase. These hold points require regulatory verification to confirm operational readiness of the plant safety systems to satisfy regulatory requirements for staged progress through the commissioning phases up to full power operation. These regulatory hold points are consistent with the regulatory approach described in CNSC regulatory document RD-360, *Life Extension of Nuclear Power Plants*.

Compliance Verification Criteria

The licensee shall seek approval of the Commission or consent of a person authorized by the Commission prior to the removal of the following regulatory hold points for the return to service of each unit. The regulatory hold points that mark the completion of the commissioning phases are as follows:

1. Prior to **Fuel Load - Phase A**
2. Prior to removal of **Guaranteed Shutdown State - Phase B**
3. Prior to exceeding **1% Full Power - Phase C**
4. Prior to exceeding **35% Full Power - Phase D**

For each of the regulatory hold points, the licensee shall submit Completion Assurance Documents (CAD). In addition to these CAD's, the licensee shall submit CADs following sustained operation at 100% full power that will specify activities that were completed between 35% and 100% full power. Each CAD shall present evidence that all pre-established conditions for removal have been met.

Prior to GSS removal, all plant personnel who work on the refurbished reactor shall have completed update training appropriate to the knowledge and skill requirements of the applicable position covering the changes to facility systems, equipment and procedures made during refurbishment.

For each ANO, CRSS and SM this includes, at a minimum:

- Principles of reactor operation with new fuel;
- Principles of nuclear safety relevant to the operation of the reactor unit with new fuel;
- Operating constraints and limits associated with the operation of the reactor unit with new fuel;
- The initial approach to criticality and power increase until control by the reactor regulating system is established, including the systems and equipment required and their operation; and
- Changes in fuel composition and core reactivity until reaching equilibrium fuel conditions.

This training shall include formal knowledge and performance evaluations that confirm and document that, at the time of GSS removal, the person has the required knowledge and skills to perform the duties of the applicable position.

Low power testing (Phase C) shall be carried out at the lowest possible power level, with a maximum of 1% of full power.

Pre-requisites for Removal of Hold Points:

Pre-requisites for Fuel Load

1. All IIP commitments required prior to fuel load are complete;
2. All SSCs required for safe operation beyond fuel load are available for service;
3. Staffing levels to safety operate the unit are adequate;
4. Specified operating procedures for fuel load have been formally validated;
5. Specified training for fuel load is complete and staff qualified;
6. Specified SSCs meet the quality and completion requirements of CSA standard N286, *Management system requirements for nuclear facilities*;
7. All non-conformances and open items identified leading up to the fuel load are addressed; and
8. Verification by CNSC staff that all construction, commissioning, re-start, and available for service activities required prior to fuel load have been successfully completed.

With respect to pre-requisite #3: Staffing levels refers to a sufficient number of qualified workers present at all times to ensure the safe operation of the nuclear facility and to ensure adequate emergency response capability. The licensee should have adequate staff available such that absences due to vacation, sick leave and training do not cause violations of the minimum shift complement levels.

Pre-requisites for GSS Removal

1. All IIP commitments required prior to GSS removal are complete;
2. All SSCs required for safe operation beyond GSS removal are available for service;
3. Specified operating procedures for GSS removal have been formally validated;
4. Specified training for GSS removal is complete and staff qualified;
5. All non-conformances and open items identified leading up to GSS removal are addressed;
6. Specified SSCs meet the quality and completion requirements of CSA N286; and
7. Verification by CNSC staff that all construction, commissioning, re-start, and available for se*rvice activities required prior to GSS removal have been successfully completed.*

Pre-requisites for Reactor Power Increases Prior to exceeding 1% Full Power

1. All IIP commitments required prior to increasing reactor power are complete;
2. All SSCs required for safe operation are available for service;
3. Specified operating procedures have been formally validated;
4. Specified training is complete and staff qualified;
5. All non-conformances and open items identified leading up to reactor power increases are addressed;
6. Specified SSCs meet the quality and completion requirements of CSA N286; and

7. Verification by CNSC staff that all construction, commissioning, re-start, and available for service activities required prior to increasing reactor power have been successfully completed.

Pre-requisites for Reactor Power Increases Prior to exceeding 35 % Full Power

1. All IIP commitments required prior to normal operation are complete;
2. All SSCs required for safe operation are available for service;
3. Specified operating procedures have been formally validated;
4. Specified training is complete and staff qualified;
5. All non-conformances and open items identified leading up to reactor power increases are addressed;
6. Specified SSCs meet the quality and completion requirements of CSA N286; and
7. Verification by CNSC staff that all construction, commissioning, re-start, and available for service activities required prior to increasing reactor power have been successfully completed.

The licensee's criteria for the removal of hold points are contained in NK38-INS-09701-10006, *Nuclear Refurbishment Unit Readiness for Service Process*.

The following documents require written notification of change:

Document Title	Document #	Notification Status
Nuclear Refurbishment Unit Readiness for Service Process	NK38-INS-09701-10006	PI

Recommendations and Guidance

OPG and CNSC staff have bilaterally issued Return to Service (RTS) protocols intended to manage prerequisites for Regulatory Hold Point (RHP) removal and for production of certain deliverables by both parties, to obtain certainty around the schedule and scope and management of anticipated changes to deliverables associated to a refurbished Unit's RTS.

The scope of work specified in the RTS protocols have been based on this License Conditions Handbook and agreed to with CNSC staff for implementation for a refurbished Unit's RTS.

The RTS protocols detail the administrative process to be used between the CNSC and OPG to manage the regulatory interaction for the listed deliverables in Appendix B of the protocol that comprise the assurance CNSC seeks as defined in this LCH for removal of the RHPs referenced in License Condition 15.4 of the Darlington PROL.

The RTS protocol for Unit 4 is defined in *Ontario Power Generation Protocol with the Canadian Nuclear Safety Commission for Darlington Nuclear Generating Station Unit 4 Return to Service*, e-Doc 7064148.

The operating procedures to be validated and the staff training to be completed are specified in the RTS protocols.

Objective evidence should be provided to support the confirmation that SSCs meet the quality and completion requirements of CSA N286, including Design, Engineering, Procurement, Construction, Installation and Implementation activities are complete, their results deemed safe for the intended use and their respective critical characteristics and requirements have been met.

15.5 Import and Export of Nuclear Substances

<u>Licence Condition:</u>

The licensee shall limit the activities of import and export of nuclear substances to those occurring as contaminants in laundry, packaging, shielding or equipment.

<u>Preamble</u>

OPG is authorized to import and export nuclear substances other than controlled nuclear substances as defined in the *Nuclear Non-Proliferation Import and Export Control Regulations*. The nuclear substances are materials consisting primarily of contaminated laundry originating from Darlington NGS. In addition to contaminated laundry, the licence condition allows for import and export of packaging, shielding or equipment with low levels of contamination similar to laundry.

<u>Compliance Verification Criteria</u>

The following documents require written notification of change:

Document Title	Document #	Notification Status
Radioactive Material Transportation	W-PROG-WM-0002	TI
Radiation Protection	N-PROG-RA-0013	PI

The licensee shall limit the activities of import and export of nuclear substances to the isotopes and quantities listed in Table 1 as follows:

Table 1: Nuclear Substances and Quantity Limits for Import and Export

Nuclear Substance	**Maximum Total Quantity**
Americium 241	10 MBq
Antimony 122	10 GBq
Antimony 124	50 GBq
Antimony 125	20 GBq
Carbon 14	10 GBq
Cerium 141	1 GBq
Cerium 144	1 GBq
Cesium 134	1 GBq
Cesium 137	5 GBq
Chromium 51	50 GBq

Nuclear Substance	Maximum Total Quantity
Cobalt 57	10 MBq
Cobalt 58	100 MBq
Cobalt 60*	50 GBq
Curium 242	1 MBq
Curium 244	100 kBq
Deuterium	350 mg
Europium 154	50 MBq
Europium 155	50 MBq
Gadolinium 153	100 MBq
Gadolinium 159	500 MBq
Hafnium 181	10 MBq
Hydrogen 3	10 GBq
Iodine 129	200 kBq
Iodine 131	2 MBq
Iodine 133	2 MBq
Iron 55	10 GBq
Iron 59	50 GBq
Lanthanum 140	1 MBq
Manganese 54	5 GBq
Manganese 56	5 GBq
Molybdenum 99	1 MBq
Neptunium 237	1 kBq
Neptunium 239	500 kBq
Nickel 59	200 MBq
Nickel 63	500 MBq
Niobium 94	10 MBq
Niobium 95	5 GBq
Plutonium 238	1 MBq
Plutonium 239	50 MBq
Plutonium 240	1 MBq

Nuclear Substance	Maximum Total Quantity
Plutonium 241	58 MBq
Promethium 147	50 MBq
Ruthenium 103	1 GBq
Ruthenium 106	1 GBq
Scandium 46	50 MBq
Silver 108m	100 kBq
Silver 110m	10 MBq
Strontium 89	5 MBq
Strontium 90	10 MBq
Tantalum 182	50 kBq
Tin 113	50 MBq
Tungsten 187	1 MBq
Uranium 234	1 kBq
Uranium 235	1 kBq
Uranium 238	10 kBq
Zinc 65	5 MBq
Zirconium 93	100 GBq
Zirconium 95	100 GBq

** The Co-60 limits prescribed in this table do not pertain to packaging and transport of Co-60 produced through the irradiation of Co-59 Adjuster Absorber Rods*

The licensee is not authorized, subject to any restrictions or exemptions under the regulation, to import or export the items described in Parts A and B of the Schedule to the *Nuclear Non-Proliferation Import and Export Control Regulations*, such as:

(1) Special fissionable material, as described in paragraph A.1.1:

(i) Plutonium;

(ii) Uranium 233;

(iii) Uranium enriched in Uranium 233 or Uranium 235.

(2) Source material, as described in paragraph A.1.2:

(i) Uranium, containing the mixture of isotopes that occurs in nature;

(ii) Uranium, depleted in the isotope Uranium 235; and

(iii) Thorium.

(3) Deuterium and heavy water, as described in paragraph A.1.3.

(4) Tritium, as described in paragraph A.1.5.

(5) Alpha-emitting nuclear substances, as described in paragraph B.1.1.1, including but not limited to:

(i) Actinium 225, 227;

(ii) Californium 248, 250, 252, 253, 254;

(iii) Curium 240, 241, 242, 243, 244;

(iv) Einsteinium 252, 253, 254, 255;

(v) Fermium 257;

(vi) Gadolinium 148;

(vii) Mendelevium 258, 260;

(viii) Neptunium 235;

(ix) Polonium 208, 209, 210;

(x) Radium 223; and

(6) Radium-226, as described in paragraph B.1.1.16.

Recommendations and Guidance

This section has no contents applicable to this LC.

15.6 Molybdenum-99 Isotope Irradiation Program

Licence Condition:

> **The licensee shall implement and maintain an operations program for the use of the Target Delivery System to produce the radionuclides described in section IV (vi) (2).**

Preamble

The PROL authorizes OPG to *possess, transfer, process, package, manage and store molybdenum-99 radioisotope (Mo-99) and its associated decay isotopes*. Using the Mo-99 Isotope Irradiation System (IIS; also referred to as the TDS – target delivery system – in OPG documentation), OPG is only authorized to produce Mo-99 from natural molybdenum (Mo-98) at Darlington NGS Unit 2. Units 1, 3, and 4 do not produce Mo-99 as OPG has not established a Commission approved safety case for an IIS / TDS designed for these units.

Reactor units at Darlington NGS have eight of the original 24 adjuster rods permanently locked out of core. OPG has modified 4 of these out-of-service Adjuster Rod Ports (31780-AA1, AA8, AA17, and AA24) on Unit 2 by removing the adjuster rod assemblies, and installing target elevators which will raise and lower molybdenum targets into and out of the core. The Mo-99 IIS will interface with numerous existing systems including instrument air and class III & IV electrical power, and will form a part of the containment boundary. Redundant, interlocked containment valves will be used on both the inboard and outboard side of the target airlock to ensure the containment boundary is maintained at all times.

Compliance Verification Criteria

LC 15.6 provides the basis for regulatory oversight related to the licensed activity associated with the Mo-99 radioisotope production program. The Darlington PROL authorizes the production and possession of Mo-99 through normal commercial operations (Mo-99 as a result of the decay chain of CANDU fuel) and through operation of the Mo-99 IIS / TDS at Darlington NGS – Unit 2. Only Mo-99 produced with the IIS / TDS may be harvested, packaged, and transported off-site.

All activities associated with the operation of the Mo-99 IIS / TDS and flask handling are required to be integrated into the management system framework.

Operation of the Mo-99 IIS / TDS

In accordance with the Record of Decision,[2] the Commission has limited OPG to installing and operating the Mo-99 IIS / TDS on Unit 2 at Darlington NGS. OPG has been directed to return to the Commission if it wishes to expand the licensing basis supporting licence condition 15.6 to produce Mo-99 through the operation of a Mo-99 IIS / TDS on additional units at Darlington NGS.

[2] Record of Decision for Application by Ontario Power Generation Inc. for the Application to Amend the Power Reactor Operating Licence PROL 13.02/2025 to Authorize the Production of Molybdenum-99 at the Darlington Nuclear Generating Station, Date of Decision October 26, 2021. CNSC. 2021. e-Doc 6667685.

> *Due to the first-of-a-kind nature of the Mo-99 IIS design and to allow the public additional opportunity to participate, the Commission directs that OPG must obtain the approval of the Commission, rather than concurrence from CNSC staff, if it means to produce Mo-99 in a unit other than Unit 2.*

The licensee shall operate the Mo-99 IIS / TDS in accordance with NK38-OM-30550, *Target Delivery System (TDS)*; the operating parameters therein; and all associated operating procedures, including NK38-MMP-30550-13, *Target Delivery System Transport Package Flasking*. Operation is bounded by the conditions and reactor states assessed in N-REP-03500-0839983, *Integrated Nuclear Safety and Operational Assessment of the Target Delivery System in Darlington*. Prior to commercial operations, OPG is required to validate the assumptions made in developing the licensing basis though commissioning activities conducted in accordance with OPG's Engineering Change Control (ECC) process.

As required by REGDOC-3.1.1, deviations from established operating parameters, equipment configuration, predicted consequences of operation and unexpected RRS interactions, should be considered reportable under clauses D-14 or D-18.

Managing Packaged Mo-99

When managing Mo-99 produced at Darlington NGS Unit 2, OPG shall follow the operating manual NK38-OM-30550 and the relevant associated procedures. Applicable requirements regarding the preparation and shipment of Mo-99 off-site, in accordance with Transport Canada *Transportation of Dangerous Goods Regulations* and CNSC *Packaging and Transport of Nuclear Substances 2015 Regulations* shall be met before transferring Mo-99 and shipping it off-site.

At all times, Mo-99 produced and harvested by the Mo-99 IIS / TDS on Unit 2 is required to be stored in a certified transport flask. All other uses and storage practises are prohibited. When flasking, hoisting, managing, and storing[3] Mo-99 (effectively a sealed source), OPG shall follow NK38-MMP-30550-13, *Target Delivery System Transport Package Flasking*, and the relevant associated procedures under OPG's Radiation Protection Program and Nuclear Security program.[4]

Licensed Activities

<u>Prohibition of Use of Mo-99 and Decay Radioisotopes</u>

The licensee is not authorized by the licence to conduct activities related to nuclear medicine; therefore, OPG is prohibited to process Mo-99 and use nuclear substances in or on human beings. CNSC staff will verify by whatever means available that the licensee is not using radioactive prescribed substances in or on humans.

The following documents require written notification of change:

[3] In the event where transportation to remove the flask from Darlington NGS is unavailable, the alternative location for the storage of the flask will be at Combustible Material Storage (CMS) D-22-0004. In accordance with OPG correspondence NK38-CORR-00531-23164; e-Doc 6722668, this location has been designated for contingency storage of a loaded transportation flask containing irradiated targets.
[4] Implementing the requirements of REGDOC-2.12.3, *Security of Nuclear Substances: Sealed Sources*

Document Title	Document #	Notification Status
Target Delivery System (TDS)	NK38-OM-30550	TI
Target Delivery System Transport Package Flasking	NK38-MMP-30550-13	TI
Integrated Nuclear Safety and Operational Assessment of the Target Delivery System in Darlington	N-REP-03500-0839983	TI*

**Until the Darlington Analysis of Record or Safety Report is updated to reflect the addition of the Mo-99 IIS / TDS on Unit 2*

Regulatory Hold Points

In the 2021 Record of Decision for the Mo-99 related Darlington licence amendment, the Commission defined two regulatory hold points (RHPs), and delegated the authority for the removal of the regulatory hold points to the executive vice president and chief regulatory operations officer, regulatory operations branch. Specifically, the Commission stated:

> *In the administration of licence condition 15.6, the Commission also authorizes the Executive Vice-President and Chief Regulatory Operations Officer, Regulatory Operations Branch to release the two regulatory hold points, related to the installation and commissioning of the Mo-99 IIS, upon verifying that the prerequisite steps for release have been taken by the licensee.*

For the Mo-99 IIS / TDS on Unit 2, the RHPs established by the Commission are to be removed prior to:

RHP-1) Installation – Modifying the reactor or containment boundary through activities related to the installation of the Mo-99 IIS / TDS. **Note**: OPG is not precluded from installing components or performing work that remains within its licensing basis.

RHP-2) Commissioning – Commencing any on-power tests or commissioning activities of the Mo-99 IIS / TDS. **Note**: OPG is not prohibited from performing *in situ* testing or commissioning activities, before or during the Mo-99 IIS / TDS installation outage, in accordance with OPG's project documentation.

EVP-CROO removal of the RHPs may be recommended by CNSC staff when OPG:

1) Demonstrates that all actions are complete in accordance with CMD-21-H107.
2) Demonstrates that all appropriate OPG approvals have been issued
3) Demonstrates that any safety significant action items have been addressed

Process to remove regulatory hold points

The process for the removal of the regulatory hold point is as follows:

1) The licensee submits a request to CNSC staff for the removal of the hold point.
2) The licensee's request must include sufficient information to demonstrate that all pre-requisites have been satisfied.
3) CNSC staff will review the submitted information and verify the licensee's compliance with regulatory requirements and commitments.
4) Based on the submitted information, CNSC staff will provide a report, including recommendations, to the Delegated Authority specified by the Commission, regarding whether the pre-requisites, specified in the LCH, have or have not been met.
5) The Delegated Authority specified by the Commission will then consent or not consent to the removal of the requested regulatory hold point.
6) CNSC staff will administer the removal of the hold point through a confirmation letter to the licensee.

Recommendations and Guidance

This section has no contents applicable to this LC.

15.7 Cobalt-60 Operations Program

Licence Condition:

The licensee shall implement and maintain a Co-60 operations program for the activities described in part IV of the licence.

Preamble

This LC provides basis for regulatory oversight of activities associated with the production of Cobalt-60 (Co-60). OPG is authorized to produce Cobalt-60 at Darlington NGS Units 1 to 4. Irradiated AA rods containing Co-60 are disassembled and packaged in the irradiated fuel bay and shipped off-site to a processing facility. OPG is under contractual obligation to take back the spent Co-60 that has reached the end of its service life. Prior to the spent Co-60 being returned to OPG, it is expected to spend 25-30 years of cooling in the Irradiated Fuel Bay of Bruce B (LC 15.10 of the Bruce Power Licence and LCH). Following this cool-down period, the spent Co-60 arrives at an OPG licenced waste management facility in form of sealed sources and will be transferred to dry storage.

Compliance Verification Criteria

OPG intends to document the procedures and operating instructions for Co-60 harvests, disassembly and packaging, and flask handling in the following documents requiring notification of change. These documents have not yet been prepared and will need to be finalized and reviewed by CNSC staff prior to use. In the licensing proceeding 24-H101, OPG's commitment to the Commission identified REGM 28252894 which tracks submission of the Darlington NGS Co-60 operating manual and procedures to CNSC staff by August 29, 2025. Despite the delay, OPG's documentation shall be consistent with the information submitted to the Commission during the establishment of the licensing basis for the authorized activity to produce, possess, transfer, use, package, manage and store nuclear substances that are required for, associated with, or arise from the activities associated with the production of: (1) Co-60.

Licensee Documents that Require Notification of Change		
Document #	**Title**	**Prior Notification**
NK38-OM-31935-10001	Cobalt Harvest and Processing system - Table of Contents / Revision History	TI
NK38-CTP-31935-10001	CAEPS – Cobalt Processing Instructions	TI
NK38-OM-31935-10001 04.03.14	Cobalt Handling	TI

When managing Cobalt-60 produced at Darlington NGS Units 1 to 4 OPG shall follow the operating manual NK38-OM-31935-10001 and the relevant associated procedures. OPG's safety case is only valid for 3.5 years of irradiation.

Applicable requirements set out in the Transport Canada *Transportation of Dangerous Goods Regulations* and in the CNSC *Packaging and Transport of Nuclear Substances Regulations* shall be met before transferring Cobalt-60 and shipping it off-site.

Cobalt-60 sealed sources are recorded in the CNSC database (the Sealed Source Tracking System) that tracks the location of each significantly hazardous radioactive source (IAEA Category 1 and 2 sources) in Canada.

The licensee shall submit a report in writing within 48 hours of any receipt of a Cobalt-60 sealed source with an activity equal to, or greater than, 0.3 TBq in accordance with the requirements of REGDOC-3.1.1 (LC 3.3) under Situation/Event No. 25 in Appendix A. The report shall be submitted to the CNSC in accordance with standard communication protocols. The report shall include:

- (i) The date of receipt of a transfer,
- (ii) The name of the shipper and licence number,
- (iii) The address of the shipper's authorized location,
- (iv) The nuclear substance,
- (v) Activity (radioactivity) (Bq) per source on the reference date,
- (vi) The reference date,
- (vii) The number of sealed source(s), and
- (viii) The aggregate activity (Bq).

Licensed Activities

Prohibition of Use of Co-60

The licensee is not authorized by the licence to conduct activities related to nuclear medicine; therefore, OPG is prohibited to process[5] Co-60 and use nuclear substances in or on human beings. CNSC staff will verify by whatever means available that the licensee is not using radioactive prescribed substances in or on humans.

Recommendations and Guidance

This section has no contents applicable to this LC.

[5] OPG documentation uses the verb process to describe activities conducted in the IFB which include disassembly the rods, separating the cobalt pencils from the zirconium caps, and cutting / breaking the rods to a length appropriate for the transport flask, but it does not overlap with processing activities that would be authorized under a Nuclear Substance Processing Facility Operating Licence.

APPENDIX A – ADMINISTRATIVE PROCESSES

This appendix describes the administrative process necessary for managing the LCH, such as delegation of authority, change control, reporting to Commission, document version control, record-keeping and dispute resolution.

A.1 Delegation of Authority

Throughout the licence, the statement "or consent of a person authorized by the Commission" reflects to whom the Commission may delegate certain authority (hence "consent") to CNSC staff. Unless otherwise specified, the delegation of authority by the Commission to act as a "person authorized by the Commission" is only applied to the incumbents of the following positions:

- DPRR Regulatory Program Directors;
- Director General (DG), Directorate of Power Reactor Regulation (DPRR); and
- Executive Vice-President and Chief Regulatory Operations Officer, Regulatory Operations Branch.

Delegations of authority are recorded in the Commission "Record of Proceedings, Including Reasons for Decision", but they may be documented elsewhere by the Commission.

A.2 LCH Change Control

The CNSC will apply a change control process, with clear procedures to the LCH in accordance with the CNSC Management System to ensure that:

- Preparation and use of the LCH is properly controlled;
- All referenced documents are correctly identified and maintained;
- Changes are conducted in accordance with CNSC regulatory policy P-299, *Regulatory Fundamentals*; and
- Procedures for modifying the LCH are followed.

The licensing basis is defined at licence issuance/renewal. The principles for achieving compliance with the licensing basis will not change greatly during the licence period. However, changes to the LCH may be requested by either CNSC staff or the licensee, which impact the specific details of these principles in order to achieve greater clarity and achieve an equivalent level of safety. Whenever CNSC staff request a change to the LCH the licensee will be consulted.

The following are examples of LCH change requests:

- Operating experience with the LCH may reveal instances where the Compliance Verification Criteria text may leave room for varying interpretation between the licensee and CNSC staff, Such instances would require further clarity.
- The transitional provisions for new codes, standards and regulatory documents, which are documented in the compliance verification criteria, may be revised. Assuming that the implementation plan was part of the licence application (and hence part of the licensing basis), such a development would result in a LC non-compliance (reportable in CNSC regulatory document REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants*, as such) and CNSC staff modifying the date and taking any necessary other actions, including possible enforcement action, based on the time at risk.
- As a result of a licensing decision being issued by the Commission. (i.e., amendment to the licence). One example is the inclusion of, or revision to, regulatory documents, codes and standards. These amendments may involve amending the CVC in the LCH.
- An Environmental Assessment relevant to the licensed facility may lead to licensee commitments that should be recorded as CVC in the LCH.
- Changes to recommendations and guidance, such as the inclusion or amendment of CNSC regulatory guidance documents or recommendations.

For licensee-requested changes to the LCH, that include the licensee's alternative cost effective approach where applicable, CNSC staff will review the proposed changes, as required by CNSC regulatory policy P-242, *Considering Cost-benefit Information*, and decide if the LCH should be modified. The CNSC document, *Risk Informed Approach for the CNSC Power Reactor Regulatory Program – Basis Document*, contains information on how to consider cost benefit information in licensee submissions.

The Director General, Directorate of Power Reactor Regulation, has the authority to approve changes to the LCH.

In order to effect a modification to the LCH, the CNSC Regulatory Program Officer will:

- Initiate a request using the Document Change Request (DCR) Form;
- Liaise with the Power Reactor Licensing and Compliance Integration Division (PRLCID);
- Coordinate the review by the identified Subject Matter Expert;
- Consult licensee, as required;
- Obtain endorsement from the Regulatory Program Director;
- Obtain approval and signature from the DG of DPRR;
- Update the LCH; and
- Distribute the updated version of the LCH.

If the change involves the revision of a WN document, the Regulatory Program Division will also update the registry it uses to track the version history and e-Doc number of the WN documents.

The Power Reactor Licensing and Compliance Integration Division (PRLCID) will:

- assess if the request is generic to the Power Reactor Regulatory Program;
- endorsement of the change by the PRLCID Director; and
- update the generic LCH, if required.

A.3 Reporting to the Commission

Changes to the LCH will be tracked through the DCR. CNSC staff will summarize all the changes made to the LCH and report them to the Commission for information in the CNSC staff's annual report entitled "Integrated Safety Assessment of Canadian Nuclear Power Plants". This report is presented annually in a public proceeding of the Commission at a scheduled date. The report should emphasize instances where the CVC were relaxed (such as modifying target dates as discussed above).

CNSC staff will review the content of the LCH annually to ensure that the collective changes made to the document did not result in an unauthorized change of scope. For example, CNSC staff will ensure that the LCH continues to maintain a clearly-documented set of compliance verification criteria and that any changes remain within the licensing basis. The results of this review should also be reported to the Commission annually.

A.4 Document Control and Approval/Consent

A.4.1 Document Control and Oversight

Whenever proposed changes to version control documents are accepted by the CNSC, the compliance verification criteria in the LCH must be updated (per the LCH change control process described in Appendix A.2). The Director General, Directorate of Power Reactor Regulation, has the authority to make the changes to the compliance verification criteria as long as the changes remain within the licensing basis.

The CNSC uses a risk-informed process to determine the type of regulatory oversight that is appropriate for each licensee document in the licensing basis. WN documents do not require prior Commission approval or CNSC staff consent of changes, but the changes are still reviewed by CNSC staff. Changes to WN documents are not tracked through the LCH; they are tracked by the CNSC licensing division using the registry described in Section A.2.

A.4.2 Approval/Consent of Changes (other than document changes)

CNSC facility operating licences may include LCs that address situations where the licensee has to apply to make, or at least provide notification before making, a change that is not linked to a specific document. The LCH may also specify similar mechanisms. These situations could include potential design, organizational, or operational changes. The LC or LCH could indicate that the change must be approved by the Commission.

Alternately, the LC or LCH may indicate the circumstances under which consent for the change can be granted by a delegated authority. In some cases, the associated compliance verification criteria in the LCH may indicate specific criteria that the Commission and/or delegated authority would assess when considering the request for approval/consent.

A.4.3 CNSC Review Criteria Related to Document Changes and Approvals/Consent

For the approvals of document changes or other changes described above in Sections A.4.1 and A.4.2, the CNSC checks that the licensee submission includes the appropriate level of information with regards to the proposed changes or action, to the extent relevant:

- A summary description;
- An indication of the duration (temporary or permanent);
- A justification;
- Any relevant supporting documentation;
- An evaluation of the impact on health, safety, security, the environment and Canada's international obligations; and
- An evaluation to determine if the resultant effects remain within the limits defined by the licensing basis.

The CNSC then assesses whether the following general criteria would be met for the proposed change/action:

- The proposed change or action will be made or done in accordance with licensee's quality assurance and change control processes, applicable design guides, design requirements, standards, operating documentation, regulatory documents, applicable safety principles and applicable safeguards agreement.
- Following the proposed change or action, the licensee remains in compliance with the requirements set out in the applicable laws, regulations and licence conditions, including appendices of the licence.
- The proposed change or action is in the safe direction.
- Following the proposed change or action:
    - The licensee remains qualified to carry out the licensed activity;
    - The licensee has adequate provision for the protection of the health and safety of persons, protection of the environment, maintenance of national security and measures required to implement international obligations to which Canada has agreed; and
    - The licensed activity remains within the limits defined by the licensing basis.

(The above criteria can also apply when CNSC staff review a notification of a licensee change that was already made.)

If the licensee's request is being assessed by a delegated authority and it is found that the request for change or action does not meet all of the above criteria, the delegated authority will address the situation with the licensee to determine if adjustments to the proposal can satisfy all the criteria. If not, consideration of the change must be turned from the delegated authority back to the Commission.

A.5 Record Keeping

A.5.1 Records Management

The DCR and accompanying documentation will be archived in Records and referenced in the Revision History section of the LCH. Marked-up documents by the reviewers and any other supporting information will be kept in Records Office (File No. 2.01). Electronic communication related to the change, such as comments from reviewers will be stored in the CNSC's "e-Access."

A.5.2 Distribution

A copy of the updated version of the LCH will be provided to the following:

- Responsible Regulatory Program Director;
- Responsible Site Office;
- Responsible Administrative Assistant; and
- Licensee's single point of contact.

A.6 Dispute Resolution

In the event of disagreement on a proposed change to the LCH, staff and the licensee will attempt to resolve the issue. The following steps will be followed:

- A meeting with the appropriate parties, including Directors, will be scheduled by the Regulatory Program Officer;
- The rationale supporting the decision and the decision will be documented; and
- If any party is not satisfied with the decision, the disagreement will be brought to the next level of authority, Directors General or Vice-Presidents, as required.

Any unresolved issue will be referred to the Commission.

APPENDIX B – GLOSSARY OF TERMS

B.1 – Acronyms

The following is the list of acronyms used in the LCH:

ADL	Administrative Dose limits
AIA	Authorized Inspection Agency
AL	Action Levels
ALARA	As Low As Reasonably Achievable
ASME	American Society of Mechanical Engineers
CANDU	Canadian Deuterium Uranium
CMD	Commission Member Document
CNSC	Canadian Nuclear Safety Commission
COG	CANDU Owners Group
CSA	Canadian Standards Association
CVC	Compliance Verification Criteria
DBA	Design Basis Accident
DCR	Document Change Request
DG	Director General
DPRR	Directorate of Power Reactor Regulation
DRL	Derived Release Limits
EAL	Environmental Action Levels
EQ	Environmental Qualification
GSS	Guaranteed Shutdown State
IAEA	International Atomic Energy Agency
LCH	Licence Conditions Handbook
LCMP	Life Cycle Management Plans
NDE	Non-destructive Examination
NEW	Nuclear Energy Worker
NFPA	National Fire Protection Association
NGS	Nuclear Generating Station
NPP	Nuclear Power Plant
OP&P	Operating Policies and Principles
OPEX	Operating Experience
OSR	Operational Safety Requirements
PCB	Polychlorinated Biphenyls
PIP	Periodic Inspection Program
PRA	Probabilistic Risk Assessment
PROL	Nuclear Power Reactor Operating Licence
PSA	Probabilistic Safety Assessment
RPD	Regulatory Program Division
SAT	Systematic Approach to Training
SCA	Safety and Control Area
SOE	Safe Operating Envelope
SSCs	Systems, structures and components
WN	Written Notification

B.2 – Definitions

The following is a list of definitions of words or expressions used in the LCH that may need clarification. Unless a reference source is provided in parenthesis, the words or expressions have been defined for the purpose of the LCH.

Accept/ed/able/ance
Meet regulatory requirements, which mean it is in compliance with regulatory documents or technical standards referenced in the licence.

Approval
Commission's permission to proceed, for situations or changes where the licensee would be:

- Not compliant with a regulatory requirements set out in applicable laws and regulations;
- Not compliant with a licence condition; and
- Not in the safe direction but the objective of the licensing basis is met.

Boundary conditions
Procedural, administrative rules and operating limits for ensuring safe operation of the facility based on safety analysis. It also includes any applicable regulatory requirements.

Certified Staff
Trained licensee staff, certified by the Commission to be competent in completing tasks identified in their respective roles.

Compliance verification criteria
Criteria used to verify compliance with a licence condition. CVC provides the licensee and CNSC staff with detailed information to clarify regulatory requirements for compliance purposes.

Consent
Written permission to proceed, given by CNSC delegated authority, for situations or changes where the licensee would:

- Comply with a regulatory requirements set out in applicable laws and regulations;
- Comply with a licence condition; and
- Not adversely impact the licensing basis.

Defense-in-depth
The application of more than one protective measure for a given safety objective, such that the objective is achieved even if one of the protective measures fails.

Design basis
The range of conditions and events taken into account in the design of the facility, according to established criteria, such that the facility can withstand them without exceeding authorized limits for the planned operation of safety systems.

[CNSC regulatory document RD-360, *Life Extension of Nuclear Power Plants*]

Design basis accident
Accident conditions against which an NPP is designed according to established design criteria, and for which the damage to the fuel and the release of radioactive material are kept within authorized limits.

[CNSC regulatory document RD-310, *Safety Analysis for Nuclear Power Plants*]

Effective Date
The date that a given document becomes effective within the licensing period. The effective date is either set to the licence issue date or to a future date when the given document becomes effective.

Extent of condition
An evaluation to determine if an issue has potential or actual applicability to other activities, processes, equipment, programs, facilities, operations or organizations.

Graduated enforcement
A process for escalating enforcement action. If initial enforcement action does not result in timely compliance, gradually more severe enforcement actions may need to be used. It takes into account such things as:

- The risk significance of the non-compliance with respect to health, safety, security, the environment and international obligations;
- The circumstances that lead to the non-compliance (including acts of willfulness);
- Previous compliance record;
- Operational and legal constraints (for example, Directive on the Health of Canadians); and
- Industry specific strategies.

[CNSC process document, *Assure Compliance: Select and Apply Enforcement Tools*]

Human factors engineering
Is the application of knowledge about human capabilities and limitations to plant or facility, system, and equipment design. Human factors engineering ensures that the plant or facility, system, or equipment design, human tasks, and work environment, are compatible with the sensory, perceptual, cognitive, and physical attributes of the personnel who operate, maintain, and support it.

[CNSC guidance document G-276, *Human Factors Engineering Program Plans*]

Important to safety
Items important to safety include, but are not limited to:

- Structures, Systems or Components (SSC) whose malfunction or failure could lead to undue radiation exposure of the facility/site personnel, or members of the public;
- SSCs that prevent anticipated operational occurrences from leading to accident conditions;
- Those features that are provided to mitigate the consequences of malfunctions or failures of SSCs; and
- Tasks, duties, activities, aging mechanisms, findings, or any work that improperly performed could lead to radiation exposure of the facility/site personnel, or members of the public.

Levels 1 and 2 Outage Plans A level 1 outage plan is a schedule which identifies the key components of the finalized critical path, major projects and programs. A level 2 outage plan is a schedule which identifies the system windows with durations.

Licensee documents requiring notification of change
As determined by CNSC staff, these are documents needed to support the licence application which contain the necessary safety and control measures. Depending on the risk significance of the document, changes may require either a “notification” or a “notification prior to implementation”.

Program(s)
A documented group of planned activities, procedures, processes, standards and instructions coordinated to meet a specific purpose.

Programmatic failure
A programmatic failure (or programmatic non-compliance), arises under one or more of the following circumstances:

- Failure to establish a required program or program element;
- Failure of a program or program element to meet a mandated standard;
- Failure to comply with a specific, objective provision of a program; and
- Aggravated or systemic failure(s) to adhere to applicable procedures.

[*OPG governance Regulatory Interpretation* CNSC-024]

Probabilistic safety assessment (PSA)
For a NPP or nuclear fission reactor, a comprehensive and integrated assessment of the safety of the plant or reactor. The safety assessment considers the probability, progression and consequences of equipment failures or transient conditions to derive numerical estimates that provide a consistent measure of the safety of the plant or reactor, as follows:

(i) A Level 1 PSA identifies and quantifies the sequences of events that may lead to the loss of core structural integrity and massive fuel failures.
(ii) A Level 2 PSA starts from Level 1 results, and analyses the containment behaviour, evaluates the radionuclides released from the failed fuel and quantifies the releases to the environment.
(iii) A Level 3 PSA starts from the Level 2 results, and analyses the distribution of radionuclides in the environment and evaluates the resulting effect on public health.

A PSA may also be referred to as a Probabilistic Risk Assessment (PRA).

[CNSC standard document S-294, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants*]

Qualified Staff
Trained licensee staff, deemed competent and qualified to carry out tasks associated to their respective positions.

Recommendation and Guidance

Non-mandatory suggestions on how to comply with the licence condition. Recommendations and guidance may include regulatory advice and/or recommended industry best practices to guide the licensee towards a higher level of safety and/or fully satisfactory performance/implementation of its programs.

Regulatory undertakings
Refers to high level commitments that ensure safety, not component work orders or regulatory predefined maintenance tasks. The licensee's deferral and Station Condition Record process focus on these lower level commitments.

Restart of the reactor
Removal of the Guaranteed Shutdown State (GSS).

Safe direction
Changes in plant safety levels which would not result in:

- A reduction in safety margins;
- A breakdown of barrier;
- An increase (in certain parameters) above accepted limits;
- An increase in risk;
- Impairment(s) of special safety systems;
- An increase in the risk of radioactive releases or spills of hazardous substances;
- Injuries to workers or members of the public;
- Introduction of a new hazard;
- Reduction of the defense-in-depth provisions;
- Reducing the capability to control, cool and contain the reactor while retaining the adequacy thereof; and
- Causing hazards or risks different in nature or greater in probability or magnitude than those stated in the safety analysis of the nuclear facility.

Safety and control measures
Measures or provisions that demonstrate that the applicant:

(i) Is qualified to carry on the licensed activities; and
(ii) Has made adequate provision for the protection of the environment, the health and safety of persons, the maintenance of national security and any measures required to implement international obligations to which Canada has agreed.

Safety-related system(s)
A system, including its components and structures that, by failing to perform in accordance with the design intent, has the potential to impact on the radiological safety of the public or plant staff. Safety-related systems are associated with:

(i) The regulation (including controlled startup and shutdown) and cooling of the reactor core under all normal operating and shutdown conditions;
(ii) The regulation, shutdown, and cooling of the reactor core under anticipated transient conditions and accident conditions, and the maintenance of the reactor core in a safe shutdown state for an

extended period following such conditions; and

(iii) Limiting the release of radioactive material and the radiation exposure of plant staff and/or the public in accordance with the criteria established by the regulatory/licensing authority during and following normal, anticipated transient, and accident conditions.

[CSA standard N291-08, *Requirements for safety-related structures for CANDU nuclear power plants*]

Safety significance
Refers to the significance of a discovery/issue with respect to the impact on meeting the fundamental nuclear safety objectives as defined by the IAEA.

In general, a discovery/event has safety significance if it denotes a deviation away from the safety case accepted in the licence, in the direction detrimental to safety, such as:

- Reducing margins to, or exceeding the accepted limits;
- Increasing risk;
- Impairments (various degrees) of the special safety systems or of the safety functions for accident mitigation;
- Human factor issues; and
- Events causing radioactive releases and spills of hazardous substances, injuries to workers, public, etc.

[CNSC internal document, *Risk-Informing CNSC Planning, Licensing, and Compliance Activities*]

Version-controlled documents
Refers to documents which require a certain type of CNSC control and are captured in the Document Version Control subsection of the LCH. Such documents include regulatory/industry standards as referenced in the licence (may include regulatory/industry standards which require transition).

Worker
Any person adequately trained to work at the facility covered under the associated operating licence.

Written notification
A physical or electronic communication between a CNSC delegated authority and a person authorized to act on behalf of the licensee.

Written notification prior to implementation
CNSC must receive the WN for the proposed changes within a reasonable time (based on the extent of the proposed changes and the potential impact on safe operation of the facility) prior to the implementation. This will allow sufficient time for CNSC staff to review the submission and determine the acceptability.

APPENDIX C – LIST OF ALL VERSION-CONTROLLED DOCUMENTS

C.1 – All Canadian Standards Association (CSA) documents referenced in the LCH

Document #	Document Title	Version	L.C.
N286	Management system requirements for nuclear facilities	2012 (Reaffirmed 2022)	1.1 9.1
N290.15	Requirements for the safe operating envelope of nuclear power plants	2019	3.1
N286.7	Quality assurance of analytical, scientific and design computer programs	2016 (Reaffirmed 2021)	4.1
N291	Requirements for safety related structures for CANDU nuclear power plants	2008 (Reaffirmed 2013)	5.1
N290.0	General requirements for safety systems of nuclear power plants	2017 (Reaffirmed 2022)	5.1
N290.12	Human factors in design for nuclear power plants	2014	5.1
N290.14	Qualification of digital hardware and software for use in instrumentation and control applications for nuclear power plants	2015 (Reaffirmed 2020)	5.1
N285.0	General requirements for pressure-retaining systems and components in CANDU nuclear power plants	2008 and update no. 2	5.2
N290.13	Environmental qualification of equipment for CANDU nuclear power plants	2005 and update no. 1 (Reaffirmed 2015)	5.3
N289.1	General requirements for seismic design and qualification of CANDU nuclear power plants	2008 (Reaffirmed 2013)	5.3
N285.4	Periodic inspection of CANDU nuclear power plant components	2014 (2019†)	6.1
N285.5	Periodic inspection of CANDU nuclear power plant containment components	2018	6.1
N285.8	Technical requirements for in-service inspection evaluation of zirconium alloy in pressure tubes in CANDU reactors	2023	6.1
N287.7	In-service examination and testing requirements for concrete containment structures for CANDU nuclear power plant components	2008 (Reaffirmed 2013)	6.1
N288.0	Environmental management of nuclear facilities: Common requirements of the CSA N288 series of Standards	2022	9.1
N288.1	Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities	2014 (Reaffirmed 2019)	9.1

Document #	Document Title	Version	L.C.
N288.8	Establishing and implementing action levels for releases to the environment from nuclear facilities	2017 (Reaffirmed 2022)	9.1
N288.4	Environmental monitoring programs at nuclear facilities and uranium mines and mills	2019	9.1
N288.5	Effluent and emissions monitoring programs at nuclear facilities	2022	9.1
N288.6	Environmental risk assessments at class I nuclear facilities and uranium mines and mills	2012 (Reaffirmed 2017)	9.1
N293	Fire protection for nuclear power plants	2012 and Update No. 1 (R2022)	10.2
N292.3	Management of low and intermediate-level radioactive waste	2014 (Reaffirmed 2019)	11.1
N292.0	General principles for the management of radioactive waste and irradiated fuel	2019 (Reaffirmed 2024)	11.1
N294	Decommissioning of facilities containing nuclear substances	2019	11.2
N290.7	Cyber security for nuclear power plants and small reactor facilities	2014 (Reaffirmed 2021)	12.1
N288.3.4	Performance Testing of Nuclear Air-Cleaning Systems at Nuclear Facilities	2013 (Reaffirmed 2022)	9.1
N288.7	Groundwater protection programs at Class I nuclear facilities and uranium mines and mills	2015 (Reaffirmed 2020)	9.1

† Compliance with the 2019 edition is only for the clauses specified under "CVC related to CSA N285.4" in this LCH.

C.2 – All Canadian Nuclear Safety Commission (CNSC) documents referenced in the LCH

Document #	Document Title	Version	L.C.	e-Doc #
N/A	CNSC Financial Security and ONFA Access Agreement and Provincial Guarantee Agreement, effective January 1, 2013	2013	G.5	3501509
REGDOC-3.3.1	Financial Guarantees for Decommissioning of Nuclear Facilities and Termination of Licensed Activities	2021	G.5	CNSC Website
REGDOC-3.2.1	Public Information and Disclosure	2018	G.6	CNSC Website
REGDOC-2.1.1	Management Systems	2019	1.1	CNSC Website
REGDOC-2.1.2	Safety Culture	2018	1.1	CNSC Website
REGDOC-2.2.2	Personnel Training, Version 2	2016	2.3 2.4	CNSC Website
REGDOC-2.2.3	Personnel Certification, Volume III: Certification of Reactor Facility Workers	2023 (version 2)	2.1 2.4	CNSC Website
REGDOC-2.2.4	Fitness for Duty: Managing Worker Fatigue	2017	2.1	CNSC Website
REGDOC-2.2.4	Fitness for Duty, Volume II: Managing Alcohol and Drug Use, Version 3	2021	2.1	CNSC Website
REGDOC-2.2.4	Fitness for Duty, Volume III Nuclear Security Officer Medical, Physical, Psychological Fitness	2018	2.1 12.1	CNSC Website
REGDOC-2.3.2	Accident Management, Version 2	2015	3.1	CNSC Website
REGDOC-3.1.1	Reporting Requirements for Nuclear Power Plants, Version 2	2016	3.3	CNSC Website
REGDOC-2.3.3	Periodic Safety Reviews	2015	3.4	CNSC Website
REGDOC-2.4.1	Deterministic Safety Analysis	2014	4.1	CNSC Website
REGDOC-2.4.2	Probabilistic Safety Assessment (PSA) for Nuclear Power Plants	2014	4.1	CNSC Website
REGDOC-2.6.1	Reliability Programs for Nuclear Power Plants	2017	6.1	CNSC Website
REGDOC-2.6.2	Maintenance Programs for Nuclear Power Plants	2017	6.1	CNSC Website
REGDOC-2.6.3	Aging Management	2014	6.1	CNSC Website
REGDOC-2.9.1	Environmental Protection: Environmental Principles, Assessments and Protection Measures	2013	9.1	CNSC Website
REGDOC-2.10.1	Nuclear Emergency Preparedness and Response	2016	10.1	CNSC Website
REGDOC-2.11.1	Waste Management, Volume I: Management of Radioactive Waste	2021	11.2	CNSC Website

Document #	Document Title	Version	L.C.	e-Doc #
REGDOC-2.12.1	High Security Facilities, Volume I: Nuclear Response Force, *Version 2*	2018	12.1	Document contains prescribed information
REGDOC-2.12.1	High-Security Sites, Volume II: Criteria for Nuclear Security Systems and Devices	2018	12.1	Document contains prescribed information
REGDOC-2.12.2	Site Access Security Clearance	2013	12.1	CNSC Website
REGDOC-2.12.3	Security of Nuclear Substances: Sealed Sources and Category I, II and III Nuclear Material, Version 2.1	2020	12.1	CNSC Website
REGDOC-2.13.1	Safeguards and Nuclear Material Accountancy	2018	13.1	CNSC Website

APPENDIX D – LIST OF LICENSEE DOCUMENTS THAT REQUIRE NOTIFICATION OF CHANGE

Document #	Document Title	Notification Requirements	L.C.
GENERAL			
OPG-PROG-0001	Information Management	When implemented	G.2 1.1
NK38-SR-03500-10001	Darlington Safety Report Part 1 and 2	When implemented	G.3 4.1
NK38-D0H-10220-1001	Site and Improvements Site Plan General Arrangement	When implemented	G.3
NK38-D0H-10220-1002	Site Improvements Base Line Plan and Construction Grid	When implemented	G.3
LO4254-DZS-10162-0531	Darlington NGS-A Plant Survey	PRIOR to implementation	G.3
N-STD-AS-0013	Nuclear Public Information and Disclosure	When implemented	G.6
MANAGEMENT SYSTEM			
N-CHAR-AS-0002	Nuclear Management System	PRIOR to implementation	1.1
N-PROG-AS-0001	Nuclear Management System Administration	When implemented	1.1
OPG-PROG-0001	Information Management	When implemented	1.1 G.2
OPG-PROG-0039	Project Management	When implemented	1.1
OPG-PROG-0046	Construction Management	When implemented	1.1
OPG-STD-0140	Managing Change	When implemented	1.1
N-STD-AS-0020	Nuclear Management Systems Organizations	When implemented	1.1
OPG-PROC-0166	Organization Design Change	When implemented	1.1
N-POL-0001	Nuclear Safety & Security Policy	When implemented	1.1
N-STD-AS-0023	Nuclear Safety Oversight	When implemented	1.1
OPG-PROG-0005	Environment Health and Safety Managed Systems	When implemented	1.1
N-PROC-AS-0077	Nuclear Safety & Security Culture Assessment	When implemented	1.1

Document #	Document Title	Notification Requirements	L.C.
N-PROG-RA-0010	Independent Assessment	When implemented	1.1
N-GUID-09100-10000	Contingency Guideline for Maintaining Staff in Key Positions When Normal Station Access is Impeded	When implemented	1.1
OPG-PROG-0033	Business Continuity Program	When implemented	1.1
OPG-PROG-0009	Items and Services Management	When implemented	1.1
HUMAN PERFORMANCE MANAGEMENT			
N-PROC-OP-0047	Hours of Work Limits and Managing Worker Fatigue	PRIOR to implementation	2.1
N-LIST-09110-10005	Listing of Broad Population and Safety Sensitive Job Codes	PRIOR to implementation	2.1
N-PROG-AS-0002	Human Performance	When implemented	2.1
N-STD-AS-0002	Procedure Use and Adherence	When implemented	2.1
N-STD-OP-0002	Communications	When implemented	2.1
N-STD-OP-0004	Self-Check	When implemented	2.1
N-STD-OP-0012	Conservative Decision Making	When implemented	2.1
N-STD-RA-0014	Second Party Verification	When implemented	2.1
N-PROC-OP-0005	Pre-Job Brief / Safe Work Plan and Post-Job Debriefing	When implemented	2.1
N-CMT-62808-00001	Continuous Behaviour Observation Program (CBOP) – Participants Materials – Workbook Components	When implemented	2.1
OPG-PROC-0208	Fitness For Duty: Policy On Managing Alcohol and Drug Use	When implemented	2.1
D-PROC-OP-0009	Station Shift Complement	PRIOR to implementation	2.2
D-INS-09260-10001	Duty Crew Minimum Complement Assurance	PRIOR to implementation	2.2

Document #	Document Title	Notification Requirements	L.C.
N-PROG-TR-0005	Training	When implemented	2.3 2.4
N-PROC-TR-0008	Systematic Approach to Training	When implemented	2.3 2.4
N-INS-08920-10004	Written and Oral Initial Certification Examination for Shift Personnel	PRIOR to implementation	2.4
N-INS-08920-10002	Simulator-Based Initial Certification Examinations for Shift Personnel	When implemented	2.4
N-INS-08920-10001	Requalification Testing of Certified Shift Personnel	When implemented	2.4
N-MAN-08131-10000-CNSC-031	Responsible Health Physicist	PRIOR to implementation	2.4
N-MAN-08131-10000-CNSC-006	Shift Manager, Darlington Nuclear	PRIOR to implementation	2.4
N-MAN-08131-10000-CNSC-010	Authorized Nuclear Operator	PRIOR to implementation	2.4
N-MAN-08131-10000-CNSC-008	Control Room Shift Supervisor – Darlington Nuclear	PRIOR to implementation	2.4
N-MAN-08131-10000-CNSC-025	Unit 0 Control Room Operator	PRIOR to implementation	2.4
OPERATING PERFORMANCE			
NK38-OPP-03600	Operating Policies and Principles	PRIOR to implementation	3.1 3.2 15.1
N-STD-MP-0016	Safe Operating Envelope	PRIOR to implementation	3.1
N-STD-OP-0025	Heat Sink Management	When implemented	3.1
N-STD-OP-0024	Nuclear Safety Configuration Management	When implemented	3.1
N-PROG-OP-0001	Nuclear Operations	When implemented	3.1
N-PROG-OP-0004	Chemistry	When implemented	3.1
N-STD-OP-0012	Conservative Decision-Making	When implemented	3.1
N-STD-OP-0036	Operational Decision Making	When implemented	3.1
N-STD-MP-0019	Beyond Design Basis Accident Management	PRIOR to implementation	3.1 4.1

Document #	Document Title	Notification Requirements	L.C.
N-STD-OP-0011	Operations Performance Monitoring	When implemented	3.1
N-PROC-RA-0035	Operating Experience Process	When implemented	3.1
N-PROC-RA-0022	Processing Station Conditions Records	When implemented	3.1
N-PROG-RA-0003	Performance Improvement	When implemented	3.1
N-STD-OP-0017	Response to Transients	When implemented	3.1 3.2
N-PROG-MP-0014	Reactor Safety Program	When implemented	3.1 3.2 4.1
N-STD-OP-0009	Reactivity Management	When implemented	3.1
N-STD-OP-0021	Control of Fuelling Operations	When implemented	3.1
N-PROG-MP-0014	Reactor Safety Program	When implemented	3.2 3.1
N-STD-OP-0017	Response to Transients	When implemented	3.2 3.1
N-PROC-RA-0005	Written Reporting to Regulatory Agencies	When implemented	3.3
N-PROC-RA-0020	Preliminary Event Notifications	When implemented	3.3
NK38-OSR-08131.02-10001	Darlington Operational Safety Requirements: Emergency Coolant Injection System	PRIOR to implementation	3.1
NK38-OSR-08131.02-10002	Darlington Operational Safety Requirements: Emergency Service Water System	PRIOR to implementation	3.1
NK38-OSR-08131.02-10003	Operational Safety Requirements: Fuel and Reactor Physics	PRIOR to implementation	3.1
NK38-OSR-08131.02-10004	Shutdown Systems	PRIOR to implementation	3.1
NK38-OSR-08131.02-10005	Darlington Operational Safety Requirements: Main Steam Supply System	PRIOR to implementation	3.1
NK38-OSR-08131.02-10006	Darlington NGS: Negative Pressure Containment	PRIOR to implementation	3.1

Document #	Document Title	Notification Requirements	L.C.
NK38-OSR-08131.02-10007	Darlington Operational Safety Requirements: Steam Generator Emergency Cooling System	PRIOR to implementation	3.1
NK38-OSR-08131.02-10008	Darlington NGS Operational Safety Requirements: Moderator System	PRIOR to implementation	3.1
NK38-OSR-08131.02-10009	Operational Safety Requirements: Powerhouse Steam Venting System	PRIOR to implementation	3.1
NK38-OSR-08131.02-10010	Operational Safety Requirements: Reactor Regulating System	PRIOR to implementation	3.1
NK38-OSR-08131.02-10011	Darlington Operational Safety Requirements: Group 1 Service Water Systems	PRIOR to implementation	3.1
NK38-OSR-08131.02-10012	Darlington NGS Emergency Power Supply System	PRIOR to implementation	3.1
NK38-OSR-08131.02-10013	Darlington Operational Safety Requirements: Feedwater System	PRIOR to implementation	3.1
NK38-OSR-08131.02-10014	Darlington Operational Safety Requirements: Shutdown Cooling System	PRIOR to implementation	3.1
NK38-OSR-08131.02-10015	Darlington Operational Safety Requirements: Heat Transport System	PRIOR to implementation	3.1
NK38-OSR-08131.02-10016	Darlington NGS: Group 1 Electrical Power Systems	PRIOR to implementation	3.1
NK38-OSR-08131.02-10017	Darlington Operational Safety Requirements: Toxic Gas Monitoring and MCR Breathing Air	PRIOR to implementation	3.1
NK38-OSR-08131.02-10018	Darlington NGS Operational Safety Requirements: Fuel Handling System and Irradiated Fuel Bays	PRIOR to implementation	3.1
NK38-OSR-08131.02-10019	Darlington NGS Operational Safety Requirements: Powerhouse Steam and Flooding Protective Provisions	PRIOR to implementation	3.1

Document #	Document Title	Notification Requirements	L.C.
NK38-OSR-08131.02-10020	Darlington NGS Operational Safety Requirements: Annulus Gas System	PRIOR to implementation	3.1
NK38-OSR-08131.02-10021	Darlington NGS: Critical Safety Parameter Monitoring Instrumentation	PRIOR to implementation	3.1
NK38-OSR-08131.02-10022	Darlington NGS Operational Safety Requirements: Shield Cooling System	PRIOR to implementation	3.1
NK38-CALC-63432-10001	Darlington NGS ECIS Instrument Uncertainties and Allowable values	PRIOR to implementation	3.1
NK38-CALC-68200-10001	Darlington NGS SDS1 Instrument Uncertainties and Allowable values	PRIOR to implementation	3.1
NK38-CALC-68300-10001	Darlington NGS SDS2 Instrument Uncertainties and Allowable values	PRIOR to implementation	3.1
NK38-CALC-63420-10001	Darlington NPCS Instrument Uncertainties and Allowable values	PRIOR to implementation	3.1
NK38-CALC-63671-10001	Darlington NGS Steam Generator Emergency Cooling System Instrument Uncertainties and Allowable Values	PRIOR to implementation	3.1
NK38-CALC-63210-10001	Darlington NGS Moderator System Instrument Uncertainties and Allowable Values	PRIOR to implementation	3.1
NK38-CALC-67322-10001	Darlington PSVS Instrument Uncertainties and Allowable Values	PRIOR to implementation	3.1
NK38-CALC-63700-10001	Darlington NGS Reactor Regulating System Instrument Uncertainties and Allowable Values	PRIOR to implementation	3.1
NK38-CALC-64320-10001	Darlington NGS Feedwater System Instrument Uncertainties and Allowable Values	PRIOR to implementation	3.1

Document #	Document Title	Notification Requirements	L.C.
NK38-CALC-63341-10001	Darlington NGS Shutdown Cooling System Instrument Uncertainties and Allowable Values	PRIOR to implementation	3.1
NK38-CALC-63330-10001	Darlington HTS Instrument Uncertainties and Allowable Values	PRIOR to implementation	3.1
NK38-CALC-67320-10001	Darlington NGS Powerhouse Steam and Flooding Protective Provisions Instrument Uncertainties and Allowable Values	PRIOR to implementation	3.1
NK38-CALC-63488-10001	Darlington NGS Annulus Gas System Instrument Uncertainties and Allowable Values	PRIOR to implementation	3.1
NK38-CALC-60350-10001	Darlington NGS Critical Safety Parameter Monitoring Instrumentation Uncertainties and Allowable Values	PRIOR to implementation	3.1
NK38-CALC-63411-10001	Darlington NGS Shield Cooling System Instrument Uncertainties and Allowable Values	PRIOR to implementation	3.1
SAFETY ANALYSIS			
NK38-SR-03500-10001	Darlington Safety Report Part 1 and 2	When implemented	4.1 G.3
NK38-SR-03500-10002	Darlington Nuclear 1-4 Safety Report: Part 3-Accident Analysis	When implemented	4.1
NK38-REP-00531.7-10001	Darlington Analysis of Record	When implemented	4.1
N-STD-MP-0019	Beyond Design Basis Accident Management	PRIOR to implementation	4.1 3.1
N-PROG-MP-0014	Reactor Safety Program	When implemented	4.1 3.1 3.2
N-PROC-MP-0086	Safety Analysis Basis and Safety Report	When implemented	4.1
N-PROG-RA-0016	Risk and Reliability Program	When implemented	4.1 6.1
N-STD-RA-0034	Preparation, Maintenance and Application of Probabilistic Safety Assessment	When implemented	4.1

Document #	Document Title	Notification Requirements	L.C.
N-PROG-MP-0006	Software	When implemented	4.1
NK38-REP-09701-10344	Retube Waste Processing Building Safety Analysis Summary Report	PRIOR to implementation	4.1 11.1
NK38-REP-09701-10326	Darlington Retube Waste Processing Building - Safety Assessment	PRIOR to implementation	4.1 11.1
NK38-CORR-09701-0597849	RWPB Worker Dose During Normal Operations and Under Accident Conditions	PRIOR to implementation	4.1 11.1
COG-13-9035-R00	Derived Acceptance Criteria for Deterministic Safety Analysis	PRIOR to implementation	4.1
PHYSICAL DESIGN			
N-STD-MP-0028	Conduct of Engineering	When implemented	5.1
N-PROG-MP-0001	Engineering Change Control	When implemented	5.1
N-STD-MP-0027	Configuration Management	When implemented	5.1
N-PROG-MP-0009	Design Management	When implemented	5.1
N-PROG-MA-0016	Fuel	When implemented	5.1
N-INS-08173-10050	Procurement from Licensed Canadian Nuclear Utilities	When implemented	5.1
N-PROC-MP-0090	Engineering Change Control Process	PRIOR to implementation	5.1 15.2
N-PROG-MP-0004	Pressure Boundary	PRIOR to implementation	5.2
N-PROC-MP-0040	System and Item Classification	PRIOR to implementation	5.2
N-PROC-MP-0082	Design Registration	PRIOR to implementation	5.2
N-MAN-01913.11-10000	Pressure Boundary Program Manual	When implemented	5.2
N-LIST-00531-10003	Index to OPG Pressure Boundary Program Elements	When implemented	5.2
N-CORR-00531-22359	Authorized Inspection Agency for Pressure Boundary Inspection and Registration Services	PRIOR to implementation	5.2

Document #	Document Title	Notification Requirements	L.C.
N-CORR-00531-24236	OPG - Amendment to the Formal Agreement with the Authorized Inspection Agency for Pressure Boundary Inspection and Registration Services	PRIOR to implemented	5.2
N-PROG-RA-0006	Environmental Qualification	When implemented	5.3
FITNESS FOR SERVICE			
N-PROG-MA-0004	Conduct of Maintenance	When implemented	6.1
N-PROG-MA-0017	Component and Equipment Surveillance	When implemented	6.1
N-PROG-MA-0019	Production Work Management	When implemented	6.1
N-PROG-MP-0008	Integrated Aging Management	When implemented	6.1
N-PROC-MA-0013	Planned Outage Management	When implemented	6.1
N-PROC-MA-0049	Forced Outage Management	When implemented	6.1
N-PROG-MA-0026	Equipment Reliability	When implemented	6.1
N-PROG-RA-0016	Risk and Reliability Program	When implemented	6.1 4.1
N-STD-RA-0033	Reliability Monitoring and Reporting of Systems Important to Safety	When implemented	6.1
NK38-LIST-06937-10001	List of Safety Related Systems and Functions	PRIOR to implementation	6.1
N-PROG-MA-0025	Major Components	When implemented	6.1
N-PLAN-01060-10001	Feeders Life Cycle Management Plan	PRIOR to implementation**	6.1
N-PLAN-01060-10007	Feeders Life Cycle Management Plan: Technical Basis Document	When implemented	6.1
N-PROC-MA-0044	Fuel Channel Life Cycle Management	When implemented	6.1
NK38-PIP-33160-10001	Darlington Nuclear Unit 1 Fuel Channel Feeder Pipes Periodic Inspection Program Plan	PRIOR to implementation	6.1

Document #	Document Title	Notification Requirements	L.C.
NK38-PIP-33160-10002	Darlington Nuclear Unit 2 Fuel Channel Feeder Pipes Periodic Inspection Program Plan	PRIOR to implementation	6.1
NK38-PIP-33160-10003	Darlington Nuclear Unit 3 Fuel Channel Feeder Pipes Periodic Inspection Program Plan	PRIOR to implementation	6.1
NK38-PIP-33160-10004	Darlington Nuclear Unit 4 Fuel Channel Feeder Pipes Periodic Inspection Program Plan	PRIOR to implementation	6.1
COG-JP-4107-V06-R03	Fitness-for-Service Guidelines (FFSG) for Feeders in CANDU Reactors	PRIOR to implementation	6.1
N-PLAN-33110-10009	Steam Generators Life Cycle Management Plan	PRIOR to implementation*	6.1
NK38-PLAN-33110-00001	Darlington Units 1-4 Steam Generator Life Cycle Management Plan	PRIOR to implementation*	6.1
COG-07-4089–R02	Fitness-for-Service Guidelines for Steam Generator and Preheater Tubes	PRIOR to implementation	6.1
N-PLAN-01060-10002	Fuel Channels Life Cycle Management Plan	PRIOR to implementation*	6.1
NK38-PIP-31100-10001	Darlington Nuclear 1-4, Unit 1 Fuel Channel Pressure Tubes Periodic Inspection Program Plan	PRIOR to implementation	6.1
NK38-PIP-31100-10002	Darlington Nuclear 1-4, Unit 2 Fuel Channel Pressure Tubes Periodic Inspection Program Plan	PRIOR to implementation	6.1
NK38-PIP-31100-10003	Darlington Nuclear 1-4, Unit 3 Fuel Channel Pressure Tubes Periodic Inspection Program Plan	PRIOR to implementation	6.1
NK38-PIP-31100-10004	Darlington Nuclear 1-4, Unit 4 Fuel Channel Pressure Tubes Periodic Inspection Program Plan	PRIOR to implementation	6.1

Document #	Document Title	Notification Requirements	L.C.
N-PLAN-01060-10003	Reactor Components and Structures Life Cycle Management Plan	PRIOR to implementation	6.1
NK38-PLAN-31160-10000	Long Term Darlington Life Management Plan for Inconel X-750 Annulus Spacers	PRIOR to implementation	6.1
N-REP-31100-10061	Compliance Plan for Long-Term Use of CSA N285.8 For In-Service Evaluation of Zirconium Alloy Pressure Tubes	PRIOR to implementation	6.1
N-REP-31100-10041	Acceptance Criteria and Evaluation Procedures for Material Surveillance Pressure Tube	PRIOR to implementation	6.1
NK38-PIP-03641.2-10001	Darlington Nuclear Generating Station Periodic Inspection Plan for Unit 1	PRIOR to implementation	6.1
NK38-PIP-03641.2-10002	Darlington Nuclear Generating Station Periodic Inspection Plan for Unit 2	PRIOR to implementation	6.1
NK38-PIP-03641.2-10003	Darlington Nuclear Generating Station Periodic Inspection Plan for Unit 3	PRIOR to implementation	6.1
NK38-PIP-03641.2-10004	Darlington Nuclear Generating Station Periodic Inspection Plan for Unit 4	PRIOR to implementation	6.1
NK38-PIP-03642.2-10001	Darlington Nuclear Generating Station - Periodic Inspection Program for Unit 0 and Units 1 to 4 Containment Components	PRIOR to implementation	6.1
NK38-PIP-03643.2-10002	Darlington Nuclear - Unit 0 Containment Periodic Inspection Program	PRIOR to implementation	6.1
N-PLAN-01060-10004	Aging Management Plan for Concrete Containment Structures and Safety Related Structures	PRIOR to implementation	6.1
NK38-PIP-03643.2-10001	Darlington Nuclear – Reactor Building Periodic Inspection Program	PRIOR to implementation	6.1

Document #	Document Title	Notification Requirements	L.C.
NK38-PIP-03643.2-10003	Darlington Nuclear - Vacuum Building Periodic Inspection Program	PRIOR to implementation	6.1
NK38-TS-03643-10001	Inspection of Post Tensioning Tendons on DNGS Vacuum Building	PRIOR to implementation	6.1
N-PROC-MA-0066	Administrative Requirements for In-Service Inspection and Testing for Concrete Containment Structures	PRIOR to implementation	6.1
I-STD-AS-0003	Non-Destructive Examination	When implemented	6.1
NK38-REP-34200-10066	Darlington NGS Main Containment Structure In-Service Leakage Rate Test Requirements In Accordance With CSA N287.7-08	PRIOR to implementation	6.1
NK38-REP-26100-10005	Darlington NGS Vacuum Structure In-Service Leakage Rate Test Requirements In Accordance With CSA N287.7-08	PRIOR to implementation	6.1
RADIATION PROTECTION			
N-PROG-RA-0013	Radiation Protection	PRIOR to implementation	7.1 15.5
N-STD-RA-0018	Controlling Exposure As Low As Reasonably Achievable	When implemented	7.1
N-STD-RA-0044	Occupational Radiation Protection Action Levels for Power Reactor Operating Licences	PRIOR to implementation	7.1
N-PROC-RA-0019	Dose Limits and Exposure Control	PRIOR to implementation	7.1
N-PROC-RA-0027	Radioactive Work Planning, Execution and Close Out	When implemented	7.1
N-MAN-03416-10000	Radiation Dosimetry Program – General Requirements	When implemented	7.1
N-MAN-03416.1-10000	Radiation Dosimetry Program – External Dosimetry	When implemented	7.1
N-MAN-03416.2-10000	Radiation Dosimetry Program – Internal Dosimetry	When implemented	7.1
OPG-PROC-0132	Respiratory Protection	When implemented	7.1

Document #	Document Title	Notification Requirements	L.C.
CONVENTIONAL HEALTH AND SAFETY			
N-PROG-MA-0015	Work Protection	When implemented	8.1
OPG-POL-0001	Employee Health and Safety Policy	When implemented	8.1
OPG-PROG-0005	Environment Health and Safety Managed Systems	When implemented	8.1
OPG-PROC-0132	Respiratory Protection	When implemented	8.1
N-PROG-RA-0012	Fire Protection	PRIOR to implementation	8.1 10.2
NK-38-LIST-78000-10001	Application of CSA N293 to Structures, System and Components for Darlington Nuclear	PRIOR to implementation	8.1
ENVIRONMENTAL PROTECTION			
OPG-POL-0021	Environmental Policy	When implemented	9.1
OPG-PROG-0005	Environment Health and Safety Managed Systems	When implemented	9.1 11.1
NK38-MAN-03480-10001	Environment Manual	When implemented	9.1
N-PROC-OP-0025	Environmental Monitoring Programs	When implemented	9.1
OPG-PROC-0126	Hazardous Material Management	When implemented	9.1
N-STD-OP-0031	Monitoring of Nuclear and Hazardous Substances in Effluents	When implemented	9.1
N-PROC-OP-0044	Contaminated Lands Management	When implemented	9.1
NK38-REP-03482-10001	Derived Release Limits for Darlington Nuclear Generating Station	PRIOR to implementation	9.1
N-PROC-OP-0037	Environmental Approvals	When implemented	9.1
N-PROC-OP-0038	Abnormal Waterborne Tritium Emission Response	When implemented	9.1
NK38-MAN-03443-10002	Darlington Environmental Monitoring Program	When implemented	9.1
N-STD-OP-0046	Groundwater Protection and Monitoring Program	PRIOR to implementation	9.1

Document #	Document Title	Notification Requirements	L.C.
DREP-07701-00001	2020 Environmental Risk Assessment for the Darlington Nuclear Site	When implemented	9.1
D-REP-07701-00002	2024 Environmental Risk Assessment Addendum for the Darlington Nuclear Site	When implemented	9.1
EMERGENCY MANAGEMENT AND FIRE PROTECTION			
N-PROG-RA-0001	Consolidated Nuclear Emergency Plan	PRIOR to implementation	10.1
N-PROC-RA-0045	OPG Nuclear Emergency Response Organization Drills and Exercises	When implemented	10.1
N-PROG-RA-0012	Fire Protection	PRIOR to implementation	10.2 8.1
NK38-REP-09701-10338	Fire Hazard Assessment of the DNGS Retube Waste Processing Building (RWPB)	PRIOR to implementation	10.2 11.1
WASTE MANAGEMENT			
OPG-PROG-0005	Environment Health and Safety Managed Systems	When implemented	11.1 9.1
OPG-STD-0156	Management of Waste and Other Environmentally Regulated Materials	When implemented	11.1
N-PROC-RA-0017	Segregation and Handling of Radioactive Waste	When implemented	11.1
NK38-PLAN-09701-10293	Operations & Maintenance Plan - Retube Waste Processing Building	PRIOR to implementation	11.1
NK38-REP-09701-10344	Retube Waste Processing Building Safety Analysis Summary Report	PRIOR to implementation	11.1 4.1
NK38-REP-09701-10326	Darlington Retube Waste Processing Building - Safety Assessment	PRIOR to implementation	11.1 4.1
NK38-CORR-09701-0597849	RWPB Worker Dose During Normal Operations and Under Accident Conditions	PRIOR to implementation	11.1 4.1
NK38-REP-09701-10338	Fire Hazard Assessment of the DNGS Retube Waste Processing Building (RWPB)	PRIOR to implementation	11.1 10.2

Document #	Document Title	Notification Requirements	L.C.
W-PROG-WM-0003	Decommissioning Program	PRIOR to implementation	11.2
NK38-PLAN-00960-10001	Darlington Nuclear Site Preliminary Decommissioning Plan	PRIOR to implementation	11.2
SECURITY			
8300-REP-61400-10003	Darlington Nuclear Generating Station Security Report	PRIOR to implementation	12.1
8300-PLAN-61400-10012	Darlington Nuclear Security Tactical Plan	PRIOR to implementation	12.1
N-PROG-RA-0011	Nuclear Security	PRIOR to implementation	12.1
NK38-REP-08160.3-00001	Darlington Nuclear Generating Station and Nuclear Sustainability Services - Darlington - Harmonized Threat Vulnerability and Risk Assessment	When implemented	12.1
N-PROC-RA-0135	Cyber Security	When implemented	12.1
N-STI-08161-10017	Cyber Essential Asset Identification and Classification	When implemented	12.1
N-INS-08161-10011	Cyber Security Controls for Cyber Essential Assets	When implemented	12.1
OPG-PROG-0042	Cyber Security	When implemented	12.1
SAFEGUARDS			
N-PROG-RA-0015	Safeguards and Nuclear Material Accountancy	PRIOR to implementation	13.1
N-STD-RA-0024	Safeguards and Nuclear Material Accountancy Implementation	PRIOR to implementation	13.1
N-PROC-RA-0136	OPG Safeguards and Nuclear Material Accountancy Requirements	PRIOR to implemented	13.1
PACKAGING AND TRANSPORT			
W-PROG-WM-0002	Radioactive Material Transportation	When implemented	14.1 15.5
N-STD-RA-0036	Radioactive Materials Transportation Emergency Response Plan	When implemented	14.1

Document #	Document Title	Notification Requirements	L.C.
SITE SPECIFIC			
NK38-OPP-03600	Operating Policies and Principles	PRIOR to implementation	15.1 3.1 3.2
D-INS-39000-10003	Tritium Removal Facility Planned Outage Management	When implemented	15.1
N-PROG-AS-0008	Heavy Water Management	When implemented	15.1
NK38-NR-PLAN-09701-10001, Sheet: 0003	Darlington Refurbishment Return to Service Program Management Plan	When implemented	15.2
N-PROC-MP-0090	Engineering Change Control Process	PRIOR to implementation	15.2 5.1
N-PROC-MA-0109	Periodic Safety Review	When implemented	15.3
NK38-INS-09701-10006	Nuclear Refurbishment Unit Readiness for Service Process	PRIOR to implementation	15.4
W-PROG-WM-0002	Radioactive Material Transportation	When implemented	15.5 14.1
N-PROG-RA-0013	Radiation Protection	PRIOR to implementation	15.5 7.1
NK38-OM-30550	Target Delivery System (TDS)	When implemented	15.6
NK38-MMP-30550-13	Target Delivery System Transport Package Flasking	When implemented	15.6
N-REP-03500-0839983	Integrated Nuclear Safety and Operational Assessment of the Target Delivery System in Darlington	When implemented	15.6

**Prior notification is only required when changes to the document result in changes to the PIP that has received regulatory acceptance.*

APPENDIX E – LIST OF DOCUMENTS USED AS GUIDANCE OR CRITERIA

E.1 – All Canadian Standards Association (CSA) documents referenced in the LCH in Recommendations and Guidance

Document #	Document Title	L.C.
CSA N290.11	Requirements for heat sink removal capability during outage of nuclear power plants	3.1
CSA N290.16	Requirements for beyond design basis accidents	3.1
CSA N290.18	Periodic safety review for nuclear power plants	3.4
CSA N290.17	Probabilistic safety assessment for nuclear power plants	4.1
CSA N287.1	General requirements for concrete containment structures for CANDU nuclear power plants	5.1
CSA N287.2	Material requirements for concrete containment structures for CANDU nuclear power plants	5.1
CSA N287.3	Design requirements for concrete containment structures for CANDU nuclear power plants	5.1
CSA N287.4	Construction, fabrication, and installation requirements for concrete containment structures for CANDU nuclear power plants	5.1
CSA N287.5	Examination and testing requirements for concrete containment structures for CANDU nuclear power plants	5.1
CSA N287.6	Re-operational proof and leakage rate testing requirements for concrete containment structures for CANDU nuclear power plants	5.1
CSA N289.2	Ground motion determination for seismic qualification of CANDU nuclear power plants	5.1 5.2 5.3
CSA N289.3	Design procedures for seismic qualification of CANDU nuclear power plants	5.1 5.2 5.3
CSA N289.4	Testing procedures for seismic qualification of CANDU nuclear power plants	5.1 5.2 5.3
CSA N289.5	Seismic instrumentation requirements for CANDU nuclear power plants	5.1 5.2 5.3
CSA N290.1	Requirements for the shutdown systems of nuclear power plants	5.1
CSA N290.2	General requirements for emergency core cooling systems for nuclear power plants	5.1
CSA N290.3	Requirements for containment system of nuclear power plants	5.1
CSA N290.4	Requirements for reactor control systems of nuclear power plants	5.1
CSA N290.5	Requirements for electrical power and instrument air systems of CANDU nuclear power plants	5.1
CSA N290.6	Requirements for monitoring and display of nuclear power plant safety functions in the event of an accident	5.1

Document #	Document Title	L.C.
CSA N286.10	Configuration management for high energy reactor facilities	5.1
CSA N285.6 Series	General requirements for pressure-retaining systems and components in CANDU nuclear power plants/material standards for reactor components for CANDU nuclear power plants	5.2
CSA N290.9	Reliability and maintenance programs for nuclear power plants	6.1
CSA N288.2	Guidelines for Calculating the Radiological Consequences to the Public of a Release of Airborne Radioactive Material for Nuclear Reactor Accidents	9.1
CSA B51	Boiler, Pressure Vessel and Piping	5.2
CSA N292.2	Interim dry storage of irradiated fuel	11.1

E.2 – Other Codes or Standards referenced in the LCH

Document #	Document Title	L.C.	e-Doc #
COG-09-9030-R03	Principles & Guidelines for Deterministic Safety Analysis, CANDU Owners Group, Safety Analysis Improvement Task Team	3.2 4.1	N/A
COG-12-2049	Fuel and Pressure Tube Fitness-For-Service Criteria for LOF, SBLOCA and Slow LORC	3.2	N/A
IAEA	Specific Safety Guide No. SSG-25 - Periodic Safety Review for Nuclear Power Plants	3.4	N/A
COG-11-9023-R00	Guidelines for Application of the Limit of Operating Envelope Methodology to Deterministic Safety Analysis	4.1	3966049
COG-06-9012-R01	Guidelines for Application of the Best Estimate Analysis and Uncertainty (BEAU) Methodology to Licensing Analysis	4.1	3367467
COG-08-2078-R00	Principles and Guidelines for NOP/ROP Trip Setpoint Analysis for CANDU Reactors	4.1	4251741
UFC 3-340-02	Structures to Resist the Effects of Accidental Explosions	5.1	N/A
ASME B31.1	Power Piping	5.2	N/A
ASME B31.3	Process Piping Code	5.2	N/A
ASME B31.5	Refrigeration Piping and Heat Transfer Component Code	5.2	N/A
ASME	Boiler and Pressure Vessel Code	5.2 6.1	N/A
NFPA 24	Standard for the Installation of Private Fire Service Mains and Their Appurtenances	5.2	N/A
NEI 00-01	Guidance for Post Fire Safe Shutdown Circuit Analysis	10.2	N/A
IAEA	Nuclear Security Series No. 4, Technical Guidance: Engineering Safety Aspects of the Protection of Nuclear Power Plants Against Sabotage	12.1	IAEA Website
IAEA	Nuclear Security Series No. 13, Recommendations: Nuclear Security Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities (INFCIRC/225/Revision 5)	12.1	IAEA Website

Document #	Document Title	L.C.	e-Doc #
IAEA	Nuclear Security Series No. 17, Technical Guidance: Computer Security at Nuclear Facilities	12.1	IAEA Website

E.3 – Other CNSC documents referenced in the LCH

Document #	Document Title	L.C.	e-Doc #
REGDOC-3.5.3	Regulatory Fundamentals, version 3 (2023)	G.1	CNSC Website
REGDOC-2.2.1	Human Factors	2.1	CNSC Website
REGDOC-2.5.1	General Design Considerations: Human Factors	2.1 2.2 5.1	CNSC Website
REGDOC-2.2.5	Minimum Shift Compliment	2.2	CNSC Website
CNSC-EG1, Rev.0	Requirements and Guidelines for Written and Oral Certification Examinations for Shift Personnel at Nuclear Power Plants	2.3	3402702
CNSC-EG2, Rev.0	Requirements and Guidelines for Simulator-Based Certification Examinations for Shift Personnel at Nuclear Power Plants	2.3	3402705
N/A	Requirements for the Requalification Testing of Certified Shift Personnel at Nuclear Power Plants, Revision 2	2.3	3436327
REGDOC-2.4.5	Nuclear Fuel Safety	3.2	CNSC Website
RD-360	Life Extension of Nuclear Power Plants	3.4 15.4 B.2	CNSC Website
REGDOC-1.1.3	Licence Application Guide: Licence to Operate a Nuclear Power Plant	3.4	CNSC Website
REGDOC-2.5.2	Design of Reactor Facilities: Nuclear Power Plants	5.1	CNSC Website
REGDOC-2.7.1	Radiation Protection	7.1	CNSC Website
REGDOC-2.8.1	Conventional Health and Safety	8.1	CNSC Website
P-223	Protection of the Environment	9.1	CNSC Website
G-274	Security Programs for Category I or II Nuclear Material or Certain Nuclear Facilities	12.1	CNSC Website
G-208	Transportation Security Plans for Category I, II or III Nuclear Material	12.1	CNSC Website
REGDOC-2.3.1	Conduct of Licensed Activities: Construction and Commissioning Programs	15.2	CNSC Website
P-299	Regulatory Fundamentals	A.2	CNSC Website

Document #	Document Title	L.C.	e-Doc #
P-242	Considering Cost-benefit Information	A.2	CNSC Website
N/A	Risk Informed Approach for the CNSC Power Reactor Regulatory Program – Basis Document	A.2	3466324
RD-310	Safety Analysis for Nuclear Power Plants	B.2	CNSC Website
N/A	Select and Apply Enforcement Tools	B.2	3320246
S-294	Probabilistic Safety Assessment (PSA) for Nuclear Power Plants	B.2	CNSC Website
N/A	Risk-Informing CNSC Planning, Licensing, and Compliance Activities	B.2	N/A

APPENDIX F – APPROVALS PURSUANT TO A PROL LC GRANTED BY THE COMMISSION

L.C	Subject of the Approval	e-Doc #	Licensee's reference #	Effective Date	Expiry Date

APPENDIX G – CONSENTS PURSUANT TO A PROL LC

L.C	Subject of the Consent	e-Doc #	Licensee's reference #	Effective Date	Expiry Date

APPENDIX H – RESOLUTION OF INCONSISTENCIES

L.C.	Subject of Conflict or Inconsistency	e-Doc #	Licensee's reference #	Identifier	Approved Date

Appendix A: Reference Documents

The references are provided on the following pages of the document.

ONTARIO POWER GENERATION

Allan Grace
Senior Vice President
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OPG Proprietary

September 24, 2024

CD# NK38-CORR-00531-25312 P

Mr. Andrew Mathai
Director,
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OTTAWA, Ontario, K1P 5S9

Ms. Sarah Watt
Director (Acting),
Wastes and Decommissioning Division
Canadian Nuclear Safety Commission
P.O. Box 1046
280 Slater Street
OTTAWA, Ontario, K1P 5S9

Dear Mr. Mathai and Ms. Watt:

Darlington NGS – 2024 Environmental Risk Assessment Addendum for the Darlington Nuclear Site

The purpose of this letter is to provide CNSC staff with the 2024 Environmental Risk Assessment (ERA) Addendum for the Darlington Nuclear Site. This submission provides written notification for Darlington NGS and prior written notification for the Darlington Waste Management Facility (DWMF) of the ERA addendum report, in accordance with Darlington's PROL 13.04/2025, Licence Conditions (LC) 3.3 and 9.1 and the DWMF Operating Licence WFOL-W4-355.00/2033, LC 9.1.

Enclosure 1 provides D-REP-07701-00002 R00, *"2024 Environmental Risk Assessment Addendum for the Darlington Nuclear Site"*. The ERA addendum report serves as an interim update to the *"2020 Environmental Risk Assessment for the Darlington Nuclear Site"* (Reference 1) and supports OPG's application for renewal of the Darlington NGS Power Reactor Operating Licence (Reference 2).

The ERA addendum evaluates the risk to relevant human and ecological receptors resulting from exposure to contaminants and stressors related to the Darlington Nuclear site and its activities, with a focus on the years 2020 to 2022 (or 2023, depending on data availability at the time that the addendum was being prepared). The addendum report was prepared following the guidance of Canadian Standards Association N288.6-22, *"Environmental Risk Assessments* *at Nuclear Facilities and Uranium Mines and Mills"*, and Version 1.2 of REGDOC 2.9.1, *"Environmental Protection: Environmental Principles, Assessments and Protection Measures"*.

Considering the additional data available since the preparation of the 2020 ERA, the results of the ERA addendum report demonstrate that Darlington Nuclear continues to be operating in a manner that is protective of human and ecological receptors residing in the surrounding area. There are no new risk management recommendations identified.

Please update the Darlington NGS and DWMF Licence Conditions Handbooks accordingly. D-REP-07701-00002 R00 will be issued no earlier than 30 days following this notification.

The next full update of the Darlington Nuclear site ERA is due to CNSC staff by November 30, 2026 and is tracked under Regulatory Obligation Action Request 28241798 (Reference 3).

This submission completes Regulatory Management Action Request 28269084.

Should you have any further questions, please contact Ms. Aditi Bhardwaj, Senior Manager, Regulatory Affairs, at 289-387-2110 or at aditi.bhardwaj@opg.com.

Sincerely,

Allan Grace
Senior Vice President
Darlington Nuclear
Ontario Power Generation Inc.

Encl.

cc: CNSC Site Supervisor – Darlington
Rebekah van Hoof (CNSC Ottawa)
forms-formulaires@cnsc-ccsn.gc.ca

References:

1. OPG email, A. Bhardwaj to N. Greencorn and J. Burta, “Darlington NGS – CNSC Staff’s Prior Written Notification of Document Changes: D-REP-07701-00001-R002, 2020 Environmental Risk Assessment for the Darlington Nuclear Site”, November 2, 2022, CD# NK38-CORR-00531-23774.

2. OPG letter, A. Grace to C. Salmon, “Darlington NGS – Application for Renewal of the Darlington Nuclear Generating Station Power Reactor Operating Licence 13.03/2025”, May 30, 2024, CD# NK38-CORR-00531-25450.

3. OPG letter, S. Gregoris to K. Hazelton and P. Burton, “Darlington NGS – Submission of the 2020 Environmental Risk Assessment for the Darlington Nuclear Site”, March 31, 2021, CD# NK38-CORR-00531-22311.

ENCLOSURE 1

OPG letter, A. Grace to A. Mathai and S. Watt, “Darlington NGS – 2024 Environmental Risk Assessment Addendum for the Darlington Nuclear Site”

CD# NK38-CORR-00531-25312

2024 Environmental Risk Assessment Addendum for the Darlington Nuclear Site

CD# D-REP-07701-00002 R00

(180 total pages)

ONTARIO POWER GENERATION

Report

Public Information	
Document Number: D-REP-07701-00002 R00	Usage Classification: Information
Sheet Number: N/A	Revision: R00

Title:
2024 Environmental Risk Assessment Addendum for the Darlington Nuclear Site

2024 Environmental Risk Assessment Addendum for the Darlington Nuclear Site

D-REP-07701-00002 R00
2024-09-20

Public Information

Accepted By: Cammie Cheng Sept 20, 2024

Cammie Cheng Date
Director
Nuclear Environment

2024 ENVIRONMENTAL RISK ASSESSMENT ADDENDUM FOR THE DARLINGTON NUCLEAR SITE

OPG REPORT: D-REP-07701-00002 R00

REPORT PREPARED FOR:

ONTARIO POWER GENERATION
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REPORT PREPARED BY:

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Mississauga, ON

Ref. 23-3275
20 September 2024

Ecometrix | Environmental INTELLIGENCE

2024 ENVIRONMENTAL RISK ASSESSMENT ADDENDUM FOR THE DARLINGTON NUCLEAR SITE

OPG REPORT: D-REP-07701-00002 R00

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LAND ACKNOWLEDGEMENT

The lands and waters on which the Darlington (DN) Site is situated are the traditional and treaty territory of the Michi Saagiig and Chippewa Nations, collectively known as the Williams Treaties First Nations.

The DN Site is within the territory of the Gunshot Treaty and the Williams Treaties of 1923. These Treaty Rights were reaffirmed in 2018 in a settlement with Canada and the Province of Ontario.

To acknowledge the treaty and traditional territory, is to recognize the rights of the First Nations. It is to recognize the history of the land, predating the establishment of the earliest European colonies. It is also to acknowledge the significance for the Indigenous peoples who lived and continue to live upon it, to acknowledge the people whose practices and spiritualties are tied to the land and water and continue to develop in relation to the territory and its other inhabitants today.

ALDERVILLE FIRST NATION | BEAUSOLEIL FIRST NATION | CURVE LAKE FIRST NATION | GEORGINA ISLAND FIRST NATION | HIAWATHA FIRST NATION | SCUGOG ISLAND FIRST NATION | RAMA FIRST NATION

List of Acronyms and Symbols

ACRONYMS

AAQC	ambient air quality criteria
ACB	Air Contaminants Benchmarks
ALARA	as low as reasonably achievable
ATSDR	Agency for Toxic Substances and Disease Registry
BAF	bioaccumulation factor
BAP	benzo(a)pyrene
BB	Boiler Blowdown
BCF	bioconcentration factor
BC MOE	British Columbia Ministry of the Environment
BM	Birds and Mammals
BTEX	benzene, toluene, ethylbenzene, and xylenes
C-14	Carbon-14
CAAQS	Canadian Ambient Air Quality Standards
CANDU	CANada Deuterium Uranium
CCME	Canadian Council of Ministers of the Environment
CCW	condenser cooling water
CDWG	Canadian Drinking Water Quality Guideline
CEAA	Canadian Environmental Assessment Act
CFU/100mL	colony forming units per 100 millilitres
CN	Canadian National Railway Company
CNSC	Canadian Nuclear Safety Commission
COG	CANDU Owners Group
COPC	contaminant of potential concern
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CSA	Canadian Standards Association
CSM	Conceptual Site Model
CSQG	Canadian Sediment Quality Guidelines
CWQG	Canadian water quality guideline
dB	decibels
dBA	A-weighted decibels
DC	dose coefficient
DFO	Department of Fisheries and Oceans Canada
DN	Darlington Nuclear
DNGS	Darlington Nuclear Generating Station
DNNP	Darlington New Nuclear Project
DRHD	Durham Region Health Department
DRL	derived release limit
DSC	dry storage container
DWMF	Darlington Waste Management Facility

DWP	Demineralized Water Plant
DYEC	Durham York Energy Centre
EA	environmental assessment
EC	Environment Canada
ECA	environmental compliance approval
ECCC	Environment and Climate Change Canada
EcoRA	ecological risk assessment
Eco-SSLs	Ecological Soil Screening Levels
EIS	Environmental impact statement
EMP	environmental monitoring program
ERA	environmental risk assessment
ESA	Endangered Species Act
ESDM	Emissions Summary and Dispersion Modelling
ESL	Effects Screening Levels
ESSB	Engineering Support and Services Building
FCSAP	Federal Contaminated Sites Action Plan
FEQG	Federal Environmental Quality Guideline
FFAA	fuelling facilities auxiliary areas
FUMP	Follow-Up Monitoring Program
GWMP	groundwater monitoring program
GWPP	groundwater protection program
HC	Health Canada
HHRA	human health risk assessment
HQ	hazard quotient
HT	elemental tritium
HTO	tritium oxide
IAD	inactive drainage
IARC	International Agency for Research on Cancer
ICSQC	Interim Canadian Soil Quality Criteria
ILCR	incremental lifetime cancer risk
IRIS	US EPA Integrated Risk Information System
Imfp	radioiodine mixed fission products
iPWQO	interim provincial water quality objective
ISO	International Organization for Standardization
LAS	linear alkylbenzene sulphonates
$logK_{ow}$	hydrophobicity
mbgs	metres below ground surface
MECP	Ministry of Environment, Conservation, and Parks
mGy/d	milligray per day
Mo-99	Molybdenum-99
MOE	Ontario Ministry of the Environment
MOECC	Ontario Ministry of the Environment and Climate Change
MOEE	Ontario Ministry of Environment and Energy
mSv/a	millisievert per annum

NND	New Nuclear-Darlington
NO_2	Nitrogen dioxide
NOAEL	no observed adverse effect level
NOx	Nitrogen oxides
NSCA	Nuclear Safety and Control Act
NSS-DWMF	Nuclear Sustainability Services – Darlington Waste Management Facility
OBT	organically bound tritium
ODWS	Ontario Drinking Water Standards
OPG	Ontario Power Generation
O.Reg.	Ontario Regulation
OTR_{98}	Ontario Typical Range
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PHC	petroleum hydrocarbons
$PM_{2.5}$	particulate matter with diameter of 2.5 micrometres or less
PM_{10}	particulate matter with diameter of 10 micrometres or less
POI	point of impingement
POR	point of reception
PQRA	preliminary quantitative risk assessment
PSO	Plants and Soil Organisms
PSQG	Provincial Sediment Quality Guidelines
PWQO	provincial water quality objective
QA	quality assurance
QSAR	Quantitative Structure-Activity Relationship
RCO	Refurbishment and Continued Operation
RfD	Reference Dose
RLW	Radioactive liquid waste
RSL	Regional Screening Level
RWSB	Retube Waste Storage Building
SAR	sodium adsorption ratio
SARA	Species at Risk Act
SARO	Species at Risk in Ontario
SG	Standby Generator
SMC	St. Mary's Cement
SMR	small modular reactor
SO_2	Sulphur dioxide
SPI	safety performance indicator
SQG_E	Soil Quality Guidelines for Environmental Health
SSA	site study area
SSC	structures, systems, and components
SQG	Soil Quality Guideline
TCEQ	Texas Commission on Environmental Quality
TDI	tolerable daily intakes
TDS	Target Delivery System

TF	transfer factor
THQ	target hazard quotient
TRC	total residual chlorine
TRF	Tritium Removal Facility
TRV	toxicity reference value
TSP	total suspended particulates
UCLM	upper confidence limit on the arithmetic mean
UFDS	used fuel dry storage
µGy/h	microgray per hour
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation
US EPA	United States Environmental Protection Agency
VEC	valued ecosystem component
VOC	volatile organic compounds
WHO	World Health Organization
WSP	water supply plant
WTFNs	Williams Treaties First Nations
WTP	Water Treatment Plant

SYMBOLS

Human Non-radiological Parameters

C	=	concentration of contaminant in drinking water (mg/L)
IR	=	receptor intake rate (L/d)
RAF_{GIT}	=	absorption factor from the gastrointestinal tract (unitless)
D_2	=	days per week exposed•(7 days)$^{-1}$ (d/d)
D_3	=	weeks per year exposed•(52 weeks)$^{-1}$ (wk/wk)
D_4	=	total years exposed to site (years) (for carcinogens only)
BW	=	body weight (kg)
C_{foodi}	=	concentration of contaminant in food I (mg/kg)
IR_{foodi}	=	receptor ingestion rate for food I (kg/d)
RAF_{GITi}	=	relative absorption factor from the gastrointestinal tract for contaminant i (unitless)
D_i	=	days per year during which consumption of food I will occur (d/a)
365	=	total days per year (constant) (d/a)
LE	=	life expectancy (years) (for carcinogens only)

Ecological Radiological Dose Parameters

D_{int}	=	internal radiation dose (µGy/d)
D_{ext}	=	external radiation dose (µGy/d)
DC_{int}	=	internal dose coefficient ((µGy/d)/(Bq/kg))
DC_{ext}	=	external dose coefficient ((µGy/d)/(Bq/kg))
$DC_{ext,s}$	=	external dose coefficient (in soil) ((µGy/d)/(Bq/kg))

$DC_{ext,ss}$	=	external dose coefficient (on soil surface) (µGy/d)/(Bq/kg))
C_m	=	media concentration (Bq/L or Bq/kg)
C_f	=	average concentration in food (Bq/kg fw)
C_w	=	water concentration (Bq/L)
C_s	=	soil/sediment concentration (Bq/kg fw)
C_t	=	whole body tissue concentration (Bq/kg fw)
C_x	=	concentration in the ingested item x (Bq/kg fw)
OF_w	=	occupancy factor in water (unitless)
OF_{ws}	=	occupancy factor at water surface (unitless)
OF_s	=	occupancy factor in soil/sediment (unitless)
OF_{ss}	=	occupancy factor at soil/sediment surface (unitless)
BAF	=	bioaccumulation factor (L/kg or kg/kg)
BMF	=	biomagnification factor (unitless)
I_x	=	ingestion rate of item x (kg fw/d)
TF	=	ingestion transfer factor (d/kg)
DW_a	=	dry/fresh weight ratio for animal products (kg-dw/kg fw)
$1\text{-}DW_a$	=	water content of the animal (L water /kg fw)
$1\text{-}DW_p$	=	water content of the plant/food (L water /kg fw plant)
BAF_{a_HTO}	=	aquatic animal BAFs for tritium (L/kg fw)
BAF_{p_HTO}	=	plant BAF for tritium (L/kg fw)
k_{af}	=	fraction of food from contaminated sources
k_{aw}	=	fraction of water from contaminated sources (assumed to be 1)
f_{OBT}	=	fraction of total tritium in the animal product in the form of OBT as a result of HTO ingestion
f_{w_w}	=	fraction of the animal water intake derived from direct ingestion of water
f_{w_pw}	=	fraction of the animal water intake derived from water in the plant feed
f_{w_dw}	=	fraction of the animal water intake that results from the metabolic decomposition of the organic matter in the feed
$P_{HTOwater\_animal}$	=	transfer of HTO to animals through water ingestion (L/kg fw)
$P_{HTOfood\_animal}$	=	transfer of HTO to animals through food ingestion
S_a	=	stable carbon content in the aquatic animal/invertebrate/plant (gC/kg fw)
S_w	=	mass of stable carbon in the dissolved inorganic phase in water (gC/L)
S_p	=	stable carbon content in the food (gC/kg fw)
$BAFa_{C14}$	=	C-14 BAF for aquatic animals, invertebrates, and plants (L/kg fw)
$P_{C14food\_animal}$	=	transfer of C-14 from food to animals

Ecological Non-Radiological Parameters

C_x	=	concentration in the ingested item (x) (mg/kg)
D_{ing}	=	dose from ingestion pathway (mg/kg body weight/d)
I_x	=	ingestion rate of item x (kg/d)
W	=	body weight of consumer (kg fw)
ΔT	=	change in temperature (ºC)

Executive Summary

This Addendum to the 2020 Environmental Risk Assessment (ERA) for Darlington Nuclear (DN) (hereinafter referred to as the "ERA Addendum" or "this Addendum") has been prepared to be compliant with CSA N288.6:22 "Environmental Risk Assessments at Nuclear Facilities and Uranium Mines and Mills" (CSA, 2022) and also meets the requirements for an ERA outlined in Section 4.1 of REGDOC-2.9.1 "Environmental Protection: Environmental Principles, Assessments and Protection Measures" (CNSC, 2020e). This ERA Addendum should be read in conjunction with the 2020 ERA for Darlington.

The DN site is located in the Municipality of Clarington, in the former township of Darlington, on the north shore of Lake Ontario at Raby Head. The DN site is about 5 km southwest of the community of Bowmanville and about 10 km east-southeast of the City of Oshawa. The DN site is comprised of the DN Generating Station, with four CANada Deuterium Uranium (CANDU) pressurized heavy water generating reactors, the Tritium Removal Facility (TRF), the Nuclear Sustainability Services - Darlington Waste Management Facility (NSS-DWMF), the Darlington New Nuclear Project (DNNP) Lands, and all other land under Ontario Power Generation (OPG) ownership within the property boundary at DN.

OPG has safely operated the DN Generating Station since 1990, meeting all regulatory, federal and provincial guidelines, including regulatory dose limits. OPG operates the DN Generating Station in a manner that ensures the health and safety of employees, the public and the environment.

This ERA Addendum focuses on activities that occurred on the DN site during the 2020 to 2022 period that encompass normal operations at DN during the operations and refurbishment phases of the facility. In some cases, data from 2023 were available at the time of writing the report and were included for completeness. The overall goals of this ERA Addendum are:

- To update existing conditions for the DN Site (2020 to 2022).
- To provide an interim update to the ERA in general accordance with the CSA N288.6:22 Standard (i.e., in the form of an ERA Addendum) prior to the next routine ERA update currently scheduled for submission in 2026.
- To provide focus for the environmental monitoring program on relevant chemicals and radionuclides (also known as contaminants of potential concern or COPCs), media, and ecological and human receptors.

The specific objectives of this ERA Addendum, consistent with CSA N288.6:22, are:

- To evaluate the risk to relevant human and ecological receptors resulting from exposure to contaminants and stressors related to the DN site and its activities with a focus on the years 2020 to 2022.
- To recommend potential further monitoring or assessment as needed based on the results of the ERA Addendum.

Environmental data for the ERA Addendum were generally obtained from the 2020 DN ERA, existing DN environmental assessments (EAs), Emission Summary and Dispersion Modelling (ESDM) reports from 2020 to 2022, Environmental Compliance Approvals (ECAs) from 2020 to 2022, and environmental monitoring data from 2020 to 2022, including environmental monitoring data collected to support DNNP licence renewal.

OPG integrates adaptive management into its environmental management system. Specifically, adaptive management is fundamental to the environmental monitoring program (EMP) to ensure that the monitoring activities remain valid, and to enable OPG to appropriately identify and address any adverse findings or areas of risk. EMP program design reviews, self-assessments and audits are regularly conducted to confirm effectiveness of environmental monitoring activities and to practice continual improvement. The ERA process is also a means for adaptive management as it is undertaken every 5 years and considers changes to site activities and environmental conditions to identify any areas where changes in mitigation or monitoring may be needed. Through the existing processes, if a risk to the environment is identified or predicted through the ERA, it can trigger changes to the EMP, supplementary studies, and/or mitigation measures, as required.

Human Health Risk Assessment (HHRA)

Predicted exposures to sources from DN were evaluated on the basis of toxicological effects from non-carcinogenic COPCs, potential cancer risk from carcinogens, and potential radiation exposure from radionuclides.

Human Receptors

The same human receptors identified in the 2020 DN ERA were adopted for this ERA Addendum. Human receptors evaluated in both the radiological and non-radiological assessment are off-site members of the public, specifically those potential critical groups used for dose calculations in the OPG Annual EMP Reports, including:

- Urban Residents (Oshawa/Courtice, Bowmanville, West/East Beach)
- Farm
- Dairy Farm
- Rural Resident
- Industrial/Commercial Worker
- Sport Fisher
- Camper

These potential critical groups are off-site members of the public who are most exposed to the radiological and non-radiological COPCs from DN. They are intended to be protective of the rest of the general population who are less exposed to radiological and non-radiological COPCs from DN. On-site receptors were not addressed in the HHRA, since human exposures on the site are kept within safe levels through OPG's Health and Safety Management System Program and Radiation Protection Program.

Screening of COPCs for Human Health

For this Addendum, human health risks are only calculated if, compared to the 2020 ERA, there is a new COPC, or there is a COPC with a higher maximum concentration based on the 2020 – 2022 data. The only chemical COPC retained for evaluation of human health risks is hydrazine in surface water. Selected radiological stressors are considered of public interest and therefore are carried forward quantitatively in the HHRA. The radionuclides identified as the limiting radionuclides based on their Derived Release Limits (DRLs) were considered appropriate for assessment in the HHRA. Radionuclides were evaluated based on the total public dose to the critical receptor. **Table ES-1** summarizes the COPCs that were carried forward to the exposure assessment in this Addendum.

Table ES-1: Summary of COPCs Selected for the HHRA

Category	Radiological COPC	Chemical COPC
Air	C-14, Co-60, elemental tritium (HT), tritium oxide (HTO), noble gases, radioiodine mixed fission products (Imfp)	None
Surface water	C-14, Cs-134, HTO	Hydrazine
Soil	C-14, Co-60, Cs-134, HTO, I-131	None
Groundwater	HTO, I-131	None
Sediment (beach sand)	C-14, Cs-134, HTO	None
Physical Stressors	None	

Results of HHRA

Radiological HHRA

For exposure of human receptors to radiological COPCs, the relevant exposure pathways and human receptors (potential critical groups) were those presented in the annual OPG EMP reports. The 2020-2022 public dose estimates for the critical groups are at most approximately 0.06% of the regulatory public dose limit of 1 mSv/a, and at most approximately 0.04% of the dose from background radiation (1.4 mSv/a) in the vicinity of DN. Demonstration that these critical groups are protected implies that other receptor groups near DN are also protected.

Non-radiological HHRA

Based on the COPC and media retained for quantitative evaluation in the HHRA (hydrazine in surface water), the only exposure pathways evaluated (i.e., the only exposure pathways that are complete for the relevant receptors) are ingestion of water and ingestion of fish. The relevant receptors are those that may utilize water from the Bowmanville or Oshawa Water Supply Plants (WSPs), specifically the Oshawa/Courtice Urban Resident, Bowmanville Urban Resident, West/East Beach Urban Resident, Rural Resident, Industrial/Commercial Worker, and the

Camper. Also relevant are those that may consume fish from Lake Ontario, including the West/East Beach Urban Resident, Sport Fisher, and Camper receptors.

Potential risks to human receptors were characterized quantitatively in terms of incremental lifetime cancer risk for hydrazine, a potential carcinogen. Consistent with CSA N288.6:22, the acceptable risk level is less than a cancer risk of 10^{-6}, which represents an essentially negligible risk compared to background cancer risks.

No risk to human receptors via drinking water is expected. The estimated cancer risk level for hydrazine for surface water ingestion based on mean and maximum hydrazine concentrations in the condenser cooling water (CCW) were below the one in one million cancer risk level for all human receptors. Although the concentrations of hydrazine at the CCW discharge point were greater compared to the 2020 ERA, cancer risks to human receptors from the concentrations of hydrazine in surface water have been assessed to be lower, as a 90% decay factor for hydrazine at the WSPs was applied in this assessment to account for hydrazine degradation at the WSPs.

No risk to the Sport Fisher, Camper, and West/East Beach Urban Resident via fish consumption is expected. The cancer risk level for hydrazine did not exceed the acceptable cancer risk level based on mean hydrazine concentration in fish near the CCW.

A recommendation from the 2020 ERA was to analyze Lake Ontario surface water samples for hydrazine using a lower detection limit. Since there are currently no commercial laboratories available to achieve a lower detection limit for hydrazine in surface water, OPG will look for opportunities to achieve a lower detection limit if hydrazine is measured in lake water in the future, to reduce the uncertainty in the hydrazine dataset.

Ecological Risk Assessment (EcoRA)

Ecological Receptors

The assessment for the EcoRA focused on the nearshore Lake Ontario (generally in the area surrounding the outfall from the DN diffuser) and the DN site and surrounding area. The assessment has been divided into polygons (AB – Coot's Pond, C, D – Treefrog Pond, and E), generally consistent with past EcoRAs.

Ecological receptors were selected for dose and risk analysis because they are known to exist on-site, and/or are representative of major taxonomic/ecological groups, major pathways of exposure, or have a special importance or value. The ecological receptors selected were based on previous ecological assessments for the DN site (the 2020 DN ERA, the New Nuclear-Darlington (NND) EA, and the Refurbishment and Continued Operation (RCO) EA), updated based on consideration of new species observed during the 2020 to 2023 period.

The model used for assessment of dose and risk is either specific to the selected ecological species or is a more generic biota assessment model that is appropriate to a number of ecological receptors with similar exposure characteristics. **Table ES-2** shows the selected ecological receptors, and the assessment models used in estimating their COPC exposure, dose, and risk. Protection of the ecological receptors implies that other species in the same ecological receptor category are also protected.

Table ES-2: Summary of Ecological Receptors and their Assessment Models used in the EcoRA

Receptor Category	Assessment Model	Representative Ecological Receptor
Fish	Bottom Feeding Fish	Northern Redbelly Dace
		Round Whitefish
		White Sucker
		American Eel
	Pelagic Fish	Alewife
		Lake Trout
Reptiles and Amphibians	Bottom Feeding Fish	Turtles
		Frogs
Aquatic Plants	Aquatic Plant	Aquatic Plants
Aquatic Invertebrates	Benthic Invertebrate	Benthic Invertebrates
Riparian Birds	Bufflehead	Bufflehead
	Mallard	Mallard
	Green Heron	Green Heron
Riparian Mammals	Muskrat	Muskrat
Terrestrial Invertebrates	Soil Invertebrate	Earthworm
Terrestrial Birds	American Robin	American Robin
	Bank Swallow	Bank Swallow
	Song Sparrow	Song Sparrow
	Yellow Warbler	Yellow Warbler
Terrestrial Plants	Terrestrial Plant	Grass
	Terrestrial Plant	Sugar Maple
Terrestrial Mammals	Eastern Cottontail	Eastern Cottontail
	Meadow Vole	Meadow Vole
	White-tailed Deer	White-tailed Deer
	Common Shrew	Common Shrew
	Raccoon	Raccoon
	Red Fox	Red Fox
	Short-tailed Weasel	Short-tailed Weasel

Each identified Species at Risk was assigned a representative species for the EcoRA.

Assessment endpoints are attributes of the receptors that we wish to protect in environmental programs (Suter et al., 1993). The purpose of an ERA is to evaluate whether these environmental protection goals are being achieved. Consistent with CSA N288.6, the assessment endpoint for all receptors (other than species at risk) in this ecological risk assessment is population abundance. The assessment endpoint for identified species at risk is the individual, since effects on even a few individuals of species at risk would not be acceptable.

Screening of COPCs for EcoRA

Contaminants were retained for evaluation of ecological health risks in this Addendum if they;

- Were a new COPC not previously identified in the 2020 ERA; or,
- Were a COPC evaluated in the 2020 ERA and the maximum concentration in 2020 – 2022 was greater than that evaluated in the 2020 ERA.

The framework for the chemical COPC screening process used in the EcoRA is consistent with the 2020 ERA, with updated guidelines applied where available. Selected radiological stressors are considered of public interest and, therefore, are carried forward quantitatively in the EcoRA. The radiological COPCs that were selected to evaluate radiological dose are consistent with those in the HHRA.

There were new non-radiological COPCs identified in soil (sodium adsorption ratio (SAR), petroleum hydrocarbons (PHC) F1, PHC F2, PHC F3) for polygon E. There were no COPCs retained for evaluation in other media, as there were no new COPCs and COPC concentrations were not greater than those in the 2020 ERA.

The relevant exposure pathway for the identified soil COPCs is direct contact with soil by plants and soil invertebrates. The SAR parameter is relevant to osmotic effects in soil organisms, which refers to an altered ability for soil organisms to take up nutrients from the soil. Thus, the SAR parameter only affects soil organisms and is not evaluated for terrestrial vertebrates. As described by the CCME, PHCs are "readily metabolized by vertebrates, modified into a more readily excretable form, and thus do not tend to accumulate in tissues" (CCME, 2008). As such, risks to mammals and birds based on PHC exposure are considered negligible and not evaluated herein.

All radionuclides retained in the 2020 ERA were also retained for the Addendum. As such, the same exposure pathways that were evaluated in the 2020 ERA for exposure to radiological COPCs are relevant for this ERA Addendum.

Results of EcoRA

For radiological COPCs, there were no exceedances of the 9.6 mGy/d radiation benchmark for aquatic biota at any location, nor any exceedances of the 2.4 mGy/d radiation benchmark for terrestrial or riparian biota at any location.

For non-radiological COPCs, the assessment focused on plants and soil invertebrates in Polygon E. The following is a summary of results:

- Based on upper confidence limit of the arithmetic mean (UCLM) exposure concentrations, the hazard quotients (HQs) were below 1; therefore, risks to plant and soil invertebrate populations are acceptable.

- Maximum concentrations of SAR, PHC F1, PHC F2, and PHC F3 exceeded benchmarks for ecological health. However, maximum concentrations assume that the entire ecological population of each receptor is only exposed to the maximum and not to a range of concentrations. Comparison to the UCLM is more representative of expected risks. Additionally, the terrestrial habitat in Polygon E is minimal with limited vegetation; therefore, any toxic effects at these discrete locations would have little population or community level impact.

Recommendation

Risks were deemed negligible for human and ecological receptors due to the exposure levels to both radiological and non-radiological COPCs. While no specific recommendations are required, OPG will look for opportunities to reduce the analytical detection limit of hydrazine in water, if hydrazine is measured in lake water in the future, to reduce the uncertainties in the hydrazine dataset for future assessments. A hydrazine detection limit of 0.05 µg/L in surface water is recommended for any future sampling programs.

There are no risk management recommendations based on the outcome of this ERA Addendum.

Conclusion

Overall, Darlington Nuclear is operating in a manner that is protective of human and ecological receptors residing in the surrounding area.

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1.0 Introduction

1.1 Background and Methodology

The Nuclear Safety and Control Act (NSCA) mandates the Canadian Nuclear Safety Commission (CNSC) to regulate the nuclear industry in a manner that prevents unreasonable risk to the environment and makes adequate provision for environmental protection, in conformity with international obligations. This mandate is reflected in the General Nuclear Safety and Control Regulations under the NSCA, and in the CNSC Regulatory Document REGDOC-2.9.1, Environmental Protection: Environmental Principles, Assessments and Protection Measures, Version 1.2.

Consistent with the CNSC REGDOC-2.9.1 (CNSC, 2020e) and REGDOC-3.1.1 (CNSC, 2016), Ontario Power Generation (OPG) is required to update their ERAs at least once every 5 years. The initial issuance of the most recent 2020 Darlington Nuclear (DN) environmental risk assessment (ERA) was in 2021 and it was last revised in 2022 (Ecometrix, 2022a).

The next routine ERA update is not due for submission to the CNSC until 2026 and the existing operating licence, PROL 13.03/2025, for the Darlington Nuclear Generating Station (DNGS) will expire in 2025 (CNSC, 2021e). Therefore, prior to the routine ERA update in 2026, OPG has voluntarily undertaken this ERA Addendum, which constitutes a one-time interim ERA update, to augment the 2020 ERA and better support the licence renewal. This ERA assesses any differences in environmental quality data collected between 2020 and 2022; in some cases, data from 2023 were available at the time of writing the report and were included for completeness.

This Addendum to the 2020 DN ERA (hereinafter referred to as the "ERA Addendum") has been prepared to be compliant with CSA N288.6:22 "Environmental Risk Assessments at Nuclear Facilities and Uranium Mines and Mills" (CSA, 2022) and also meets the requirements for an ERA outlined in Section 4.1 of REGDOC-2.9.1 "Environmental Protection: Environmental Principles, Assessments and Protection Measures" (CNSC, 2020e). The ERA Addendum, as in the 2020 DN ERA, has used IMPACT™, a proprietary exposure and risk modeling software, to perform the required calculations which comply with the above-noted regulatory requirements. The ERA Addendum has been developed with current science and current regulatory attitudes in mind.

1.1.1 Indigenous Engagement

OPG recognizes that while the assessment of effects from the DN Site has been satisfied from the Western scientific perspective, it may not fully address the impact on Indigenous inherent and treaty rights as they are understood today.

OPG has communicated their interest in engaging with the Williams Treaties First Nations (WTFNs) on the selection of receptors for the ERA. Between 2020 and 2023, OPG has coordinated several meetings during which the WTFNs and other Indigenous communities have participated and provided feedback, some of which has been directly relevant for this ERA Addendum and the future 2026 full ERA update (see **Table 1-1**):

Table 1-1: Indigenous Engagement Summary – Key Issues for ERA 2020-2023

Issue Raised by Indigenous Nation/Community	Response/Approach to Address the Issue by OPG
WTFNs recommended to incorporate Indigenous Knowledge into environmental monitoring programs.	OPG will explore the opportunity to incorporate Indigenous Knowledge into environmental monitoring, where this information is made available to OPG.
WTFNs requested consideration of the cumulative effects of a small modular reactor (SMR) positioned near DNGS, and the waste produced by SMR technology.	Cumulative effects from site preparation activities at the Darlington New Nuclear Project (DNNP), have been considered in this ERA Addendum (**Section 5.2**).
WTFNs have expressed the need to identify a project or facility's impacts on the environment as well as on inherent and treaty rights. The Nations have also expressed interest in collaborating and participating in monitoring activities.	OPG is working directly with the Nations to explore these areas.
Information from available or future Indigenous Knowledge studies could be reflected in the ERAs, if appropriate and with permission from the Nations/communities. One area this can be reflected is in the selection of representative ecological receptors. OPG has heard through engagement that the Nations view the different species and elements within an ecosystem as "all our relations", that they are all inter-related and protection of one should not be prioritized over another. OPG has also heard mention at times of certain species that are culturally significant.	OPG will continue to collaborate with the Nations on the selection of ecological receptors. Any feedback received will be incorporated into future ERAs.
OPG has received some initial feedback from the WTFNs regarding appropriate representation of Indigenous characteristics in a receptor group. There has been a recommendation for a distinct critical group to encompass First Nations individuals and also a recommendation to ensure the characteristics of the existing receptors are protective of all people around the station rather than have a separate receptor group.	OPG will continue to engage the WTFNs on this subject to further discussion on the approach and receptor characteristics.
OPG received in 2023 comments from the Mississaugas of Scugog Island First Nation on the 2022 Pickering Nuclear ERA and 2022 Addendum of the Predictive Effects Assessment Pickering Nuclear Safe Storage. A number of issues were raised related to terminology, questions on	OPG has addressed some of the concepts and suggestions identified through these comments in this ERA Addendum, if they are relevant to the DN site. Some examples include: • Moving away from using the term "baseline" to describe the current environmental conditions.

Issue Raised by Indigenous Nation/Community	Response/Approach to Address the Issue by OPG
environmental monitoring data, and explanation of ERA results.	• Inclusion of text to describe how adaptive management is considered. • Discussion added on how sensitive and vulnerable populations are considered in the human health risk assessment (HHRA). • Discussion added on large-bodied fish being protective of small-bodied fish based on 100% occupancy assumptions.
Métis Nation of Ontario Region 8 inquired whether harvesting of plant species, including the use of wood or Butternut tree nuts from OPG property, would be acceptable given the potential for plants to take up radionuclides or other contaminants from the environment.	OPG was supportive of the harvesting of plants or seeds/nuts from OPG lands provided they are not directly eaten. However, no seeds could be collected before removing the trees for re-introduction purpose as neither tree produced any seeds.

OPG's Indigenous Relations group will continue to coordinate engagement, which may impact the understanding of surrounding land use and receptor selection.

OPG endeavors to continue to work with Indigenous Nations and communities to develop more fulsome and ongoing engagement. OPG plans to share this ERA Addendum report with Indigenous nations and communities. It is acknowledged that as of the date of this report, this ERA Addendum does not benefit from being informed by an Indigenous Knowledge Study. As of June 2024, an Indigenous Knowledge Study is in the process of being scoped by representatives of the Williams Treaties First Nations (WTFN) with support provided by OPG. Information from this Indigenous Knowledge Study, if shared with OPG, could help apply an Indigenous lens to future risk assessments. It is also noted that the ERA is an iterative process and thus could be updated to incorporate Indigenous Knowledge if available in a future revision.

1.1.2 Summary of Previous Environmental Assessments, Environmental Risk Assessments, and Follow-up Monitoring Programs

Please refer to the 2020 ERA (Ecometrix, 2022a) for the summary of previous assessments and programs up to 2019.

1.2 Goals, Objectives, and Scope

The overall goals of this ERA Addendum are:

- To update existing conditions for the DN Site (2020 to 2022).
- To provide an interim update to the ERA in general accordance with the CSA N288.6:22 Standard (i.e., in the form of an ERA Addendum) prior to the next routine ERA update currently scheduled for submission in 2026.

- To provide focus for the environmental monitoring program on relevant chemicals and radionuclides (also known as contaminants of potential concern or COPCs), media, and ecological and human receptors.

The specific objectives of this ERA Addendum, consistent with CSA N288.6:22, are:

- To evaluate the risk to relevant human and ecological receptors resulting from exposure to contaminants and stressors related to the DN site and its activities with a focus on the years 2020 to 2022.
- To recommend potential further monitoring or assessment as needed based on the results of the ERA Addendum.

The scope of the ERA Addendum encompasses normal operations at DN (including the DNGS, the Darlington New Nuclear Project (DNNP) lands, the Nuclear Sustainability Services – Darlington Waste Management Facility (NSS-DWMF), the Tritium Removal Facility (TRF), and any other OPG activities within the DN property boundary) during the operations and refurbishment phases of the facility. It does not include decommissioning activities and does not address acute or high-level exposures resulting from accidents. The scope looks at the potential effects of releases from the DN facilities on the human and ecological environment, as well as physical stressors. The ERA Addendum focuses on the three-year period from 2020 to 2022 but incorporates other years of data when necessary.

OPG integrates adaptive management into its environmental management system. Specifically, adaptive management is fundamental to the environmental monitoring program (EMP) to ensure that the monitoring activities remain valid, and to enable OPG to appropriately identify and address any adverse findings or areas of risk. EMP program design reviews, self-assessments, and audits are regularly conducted to confirm effectiveness of environmental monitoring activities and to practice continual improvement. The ERA process is also a means for adaptive management as it is undertaken every 5 years and considers changes to site activities and environmental conditions to identify any areas where changes in mitigation or monitoring may be needed. Through the existing processes, if a risk to the environment is identified or predicted through the ERA, it can trigger changes to the EMP, supplementary studies, and/or mitigation measures, as required.

1.2.1 Spatial Boundaries

Spatial boundaries define the geographical extent(s) over which likely or potential environmental effects will be considered. The spatial boundaries have not changed since the 2020 ERA (Ecometrix, 2022a), and are as follows:

- The spatial scale for humans includes identified human receptors (potential critical groups) within about 10 km of the DN site, as shown in Figure 3-12 of the 2020 ERA (Ecometrix, 2022a). This study area also includes a portion of Lake Ontario abutting the property and used by those communities for activities such as recreation and community water supply and waste water discharge.

- The spatial scale for ecological receptors includes receptors on-site and within the immediate site boundary and the near-field receiving waters, known as the site study area (SSA) in past EAs. The SSA for the ecological risk assessment (EcoRA) is presented in Figure 4-1 of the 2020 ERA (Ecometrix, 2022a).

1.3 Periodic Review of the ERA

The 2020 DN ERA (Ecometrix, 2022a) was reviewed according to the recommendations in Clause 11 of CSA N288.6:22 for periodic review of the ERA. The purpose of the periodic review is to identify any new risks, changes to existing risks, or changes in risk assessment variables that need to be updated to reflect the new risk profile for the facility, considering various review elements. The periodic review findings and where the associated information can be found in this ERA Addendum are provided in **Table 1-2**.

Table 1-2: Periodic Review for DN ERA Addendum

Periodic Review Element	Findings from the 2020 to 2022 Period	Section/Table in the ERA Addendum
Changes to site ecology or surrounding land use	The 2021 bat acoustic monitoring (Beacon, 2021) identified four (4) endangered bat species at the DN site. This included the Eastern small-footed myotis, which was the first time this species was observed on the DN site. Some changes to species at risk federal or provincial statuses were noted, although these did not have an impact on the selected ecological receptors for the EcoRA. OPG's Indigenous Relations group continues to coordinate engagement with the WTFNs, which may inform the understanding of surrounding land use and receptor selection.	**Section 2.4** (Biodiversity data) **Section 1.1.1** (Indigenous engagement) **Section 4.1.1.1** (Considerations of Species at Risk)
Changes to the physical facility or facility processes	Changes identified to facility or facility processes include: • Changes to the physical features of the DN site resulting from the site preparation activities associated with the DNNP (largely site clearing and grading activities). • Molybdenum-99 (Mo-99) Isotope Irradiation System was	**Section 2.1** (Site History) and **Section 2.3** (Engineered Site Facilities)

Periodic Review Element	Findings from the 2020 to 2022 Period	Section/Table in the ERA Addendum
	commissioned in reactor unit 2 in the 2022 and 2023 period. Harvesting commenced in 2023. • The Yard Drainage area was expanded due to the extension/realignment of Holt Road. • A Demineralized Water Plant (DWP) is intended to replace the existing Water Treatment Plant (WTP) after commissioning (currently expected in 2024), which included expansion of the existing Yard Drainage to accommodate stormwater management at the DWP.	
New environmental monitoring data	Ongoing EMP monitoring occurred during the 2020 to 2023 monitoring period. Groundwater flow and quality is monitored under the groundwater monitoring program (GWMP). No changes have occurred that would affect the ERA Addendum. Some supplementary studies were conducted during this period: • In 2021, in support of DNNP, soil quality characterization was reported. • In 2021, in support of DNNP, an acoustic bat monitoring study was completed to more fully characterize bat species present on the site as well as specific areas where they may be roosting.	**Section 3.1.2** (Human health) **Section 4.1.3** (Ecological health)
Scientific advances	The Canadian Council of Ministers of the Environment (CCME) long-term water quality guidelines for the protection of aquatic life for manganese and zinc were updated in 2019 and 2018, respectively, as the result of new toxicology studies and new CCME assessments for these COPCs. The updated guidelines are lower (more stringent) than previously used guidelines and therefore, have potential	**Section 3.1.2** and **Section 3.3** (Human health) **Section 4.1.3** and **Section 4.3** (Ecological health)

Periodic Review Element	Findings from the 2020 to 2022 Period	Section/Table in the ERA Addendum
	to change existing risk implications. Updated Federal Environmental Quality Guidelines (FEQG) have also been posted in 2018 for hexavalent chromium, in 2019 for iron, in 2020 for lead and strontium, in 2021 for copper, and in 2022 for aluminum and selenium. The updated guidelines were used in the selection of COPCs for the EcoRA. In 2021, Health Canada (HC) and Environment and Climate Change Canada (ECCC) released updated Toxicity Reference Values (TRVs) for human health and wildlife receptors, respectively (HC, 2021a; ECCC, 2021a). These documents were considered during toxicity reference value (TRV) selection during the ERA update with a focus on new studies supporting the use of TRVs relevant to the COPCs for the HHRA and EcoRA.	
Changes in regulatory requirements	REGDOC 2.9.1, *Environmental Protection: Environmental Principles, Assessments and Protection Measures, Version 1.2* was published in September 2020. While REGDOC 2.9.1 is a CNSC regulatory document that outlines the CNSC's approach to conducting environmental assessments, it also provides requirements and guidance for conducting ERAs. The requirement is for a facility to conduct the ERA in accordance with CSA N288.6-12 (now N288.6:22). In 2020, Canadian Council of Ministers of the Environment (CCME) published an updated Ecological Risk Assessment Guidance Document (CCME, 2020). While not considered to be a regulatory requirement, this document is used as	**Section 3.0** (HHRA) and **Section 4.0** (EcoRA)

Periodic Review Element	Findings from the 2020 to 2022 Period	Section/Table in the ERA Addendum
	additional guidance to this ERA update, in addition to the CSA N288.6 standard.	

1.4 Recommendations from the 2020 ERA

Table 1-3 provides a summary of recommendations for the monitoring program from the 2020 DN ERA that were associated with uncertainties regarding interpretation of risk to human health or the environment (refer to Section 5.2.2 in the 2020 DN ERA (Ecometrix, 2022a)). The means by which the recommendations were addressed are described below.

Table 1-3: Recommendations from the 2020 Darlington Nuclear ERA

Type of Information	Recommendations Arising from the 2020 DN ERA	How the Recommendation was addressed
Human Health Risk Assessment		
Hydrazine in fish	Risks for hydrazine could not be ruled out for the Sport Fisher consuming fish from Lake Ontario near the DN site. A recommendation was made to complete a supplementary study sampling lake water for hydrazine but with a detection limit of 0.05 µg/L (compared to the detection limit relied on in the 2020 DN ERA of 0.1 µg/L). (Note that potential risks were only identified based on exposure to the maximum hydrazine concentration in the effluent; however, based on the UCLM, no risks were identified.)	The 2020 DN ERA identified a recommendation to collect hydrazine along and at the outlet of the DN diffuser at a lower detection limit of 0.05 µg/L. Since 2020, the understanding of what may be feasible with hydrazine has evolved. The ultra-low level detection limit is not achievable at commercial laboratories at this time. For the DN ERA Addendum, a refined water-to-fish bioconcentration factor (BCF) has been incorporated; see **Section 3.2.6.2.2**. Lake water sampling with a lower detection limit is not identified as a recommendation of this DN ERA Addendum.
Hydrazine in drinking water	Risks could not be ruled out for Oshawa/Courtice and Bowmanville Urban Residents as well as Campers due to hydrazine in drinking water.	Risks were re-assessed in the ERA Addendum to verify whether potential risks may still be present for these receptors

Type of Information	Recommendations Arising from the 2020 DN ERA	How the Recommendation was addressed
	Oshawa/Courtice Urban Residents and Campers obtained their drinking water from the Oshawa WSP, and Bowmanville Urban Residents from the Bowmanville WSP. (Note that potential risks were only identified based on exposure to the maximum hydrazine concentration in the effluent; however, based on the UCLM, no risks were identified.) No specific recommendation was included in the 2020 DN ERA; however, the uncertainties were raised in the 2020 DN ERA, and the uncertainties were addressed in the current DN ERA Addendum as described in the column to the right.	(Oshawa/Courtice and Bowmanville Urban Residents, Campers). Additionally, given that pre-treatment concentrations were assessed (i.e., water concentrations at the intake prior to water treatment), further information on the expected degradation of hydrazine due to water treatment was incorporated into the DN ERA Addendum (**Section 3.2.6.2.1**).
NO_2 in air	Nitrogen dioxide (NO_2) data from the air quality monitoring planned to be initiated at the DN site in 2021 should be used in the next ERA to refine the risk estimates for human and ecological receptors and provide a more realistic interpretation of risk.	One-hour and 24-hour NO_2 data were collected in 2022 and compared to relevant criteria (IEC, 2023). These data were assessed in **Section 3.1.2.1.3.2** in the ERA Addendum.
Ecological Risk Assessment		
Fish Impingement/ Entrainment	Impingement and entrainment studies have been carried out as required at DNGS prior to refurbishment and are considered appropriate for consideration in the DN ERA Addendum and future routine update to the DN ERA. Future impingement and entrainment studies will be conducted as per conditions of the Fisheries Act Authorization (FAA). Impingement studies were conducted between May 2010 and April 2011, which indicated that fish losses due to impingement were negligible.	Routine impingement monitoring is not required at DNGS. As a condition of the DFO Fisheries Act Authorization for the DNGS, OPG will be required to conduct a two-year fish impingement and entrainment monitoring study after Refurbishment is completed. The field portion of the impingement and entrainment study is to be conducted in 2027 and 2028 based on the current DN Authorization. This monitoring

Type of Information	Recommendations Arising from the 2020 DN ERA	How the Recommendation was addressed
	Studies of fish egg and larval entrainment at DN were conducted in 2004 (June – August), 2006 (March – September), and 2010 (April and July). A more recent entrainment study conducted between 2015 and 2016 determined the estimated annual entrainment to be higher than the 2004 and 2006 studies, but that overall fish losses were considered too low to significantly affect Lake Ontario fish populations. Overall, entrainment was considered to have a negligible effect on aquatic communities. The expectation is that impingement and entrainment studies would continue when feasible and as required by the FAA, and that new results should be considered in future risk assessments. Routine impingement monitoring is not currently required at DNGS. As a condition of the Department of Fisheries and Oceans Canada (DFO) Fisheries Act Authorization for the DNGS, OPG will be required to conduct fish impingement and entrainment monitoring studies after Refurbishment is completed. Refurbishment at DNGS is currently ongoing. The requirement to resume fish impingement and entrainment monitoring after Refurbishment is also documented in the DNGS Refurbishment Environmental Assessment (EA) Follow-Up Monitoring Program (FUMP) (OPG, 2013).	is also intended to address commitments made in the DNGS Refurbishment EA FUMP, noting that schedule implementation years have shifted to the years above.
Soil quality	Soil quality analysis of the yard waste and building materials storage area was undertaken and the data are summarized in **Appendix B.** It is recommended to use the results of the soil quality analysis to determine the next steps for	The soil quality analysis data have been incorporated into the soil quality dataset for Polygon E as shown in **Table A-20** in **Appendix A**.

Type of Information	Recommendations Arising from the 2020 DN ERA	How the Recommendation was addressed
	management of soil from the yard waste and building material storage area (identified as location DN6 and DN6A in Figure B-4, Appendix B, and zone F15 in *Review of the Darlington Nuclear Site Specific Survey* (OPG, 2018), so as to mitigate potential risks to ecological receptors.	

1.5 Organization of Report

The main sections of the ERA Addendum report, generally consistent with the suggested table of contents in CSA N288.6:22 (CSA, 2022), are as follows:

- **Section 0**: Site Description
- **Section 3.0**: Human Health Risk Assessment
- **Section 4.0**: Ecological Risk Assessment
- **Section 5.0**: Conclusions and Recommendations
- **Section 6.0**: Quality Assurance/Quality Control
- **Section 7.0**: References

This report has been prepared with similar headings to the 2020 DN ERA (Ecometrix, 2022a) to facilitate ease of review. Where no changes have been introduced since the 2020 ERA, this report refers to the relevant sections of the 2020 ERA where information can be found. Where viewing that information in this report would be helpful for a reviewer, it has been included, although in an abbreviated form.

2.0 Site History and Description

2.1 Site History

The DN site is located in the Province of Ontario, in the Regional Municipality of Durham, in the Municipality of Clarington, in the former township of Darlington, on the north shore of Lake Ontario at Raby Head. The DN site is about 5 km southwest of the community of Bowmanville and about 10 km east-southeast of the City of Oshawa. The site location and vicinity are shown in **Figure 2-1**. Furthermore, the site is located within the Gunshot Treaty lands of the Mississauga First Nations of Scugog Island, Curve Lake, Hiawatha and Alderville.

As described in the *Aboriginal Interests Technical Supporting Document* of the 2009 DNNP Environmental Impact Statement (EIS) (OPG, 2009), the discovery of archaeological resources and artifacts (e.g., “flakes”, the waste products of making stone tools) pertaining to Indigenous Peoples within the EIS Site Study Area (i.e., the DN site) suggest that hunting and gathering activities have historically occurred in the DN area, dating back thousands of years.

In the mid 1700s, the Indigenous Peoples in southeastern Ontario were compelled to cede their lands along the northern shore of Lake Ontario to the Crown. Three agreements and treaties with First Nations have historically related to the lands comprising the DN site: The Toronto Purchase Treaty (1787 and 1805) and The Gunshot Treaty (1787), which were ultimately replaced by the Williams Treaties (1923). To the present day, the DN site remains covered by the Williams Treaties (OPG, 2009).

OPG and its vendors recognize the importance of the 2018 Settlement between the seven members of the Williams Treaties First Nations (WTFN), the Province of Ontario and Canada. The Settlement (Government of Canada, 2018) pertains to the lands of the DN site and reaffirms the rights of WTFN citizens, which has fundamentally shifted how WTFN is engaged and consulted on site development.

The DN site was initially identified as a suitable location for electricity production by Ontario Hydro (the predecessor to OPG) in the late 1960s. In 1971, the Ontario government approved the land acquisition for the site and the local council approved the site for development as an energy production centre. Most of the land now occupied by the DN site was acquired by Ontario Hydro in the early 1970s for energy production purposes (SENES & MMM, 2009).

Ontario Hydro submitted a proposal for the Darlington Nuclear Generating Station to the Ontario government in 1976, and the construction licence for the project was approved by the Atomic Energy Control Board (the predecessor to the CNSC) in 1981 (SENES & MMM, 2009). The first operational unit of the DNGS (Unit 2) entered service in 1990; all four units were operational and in service by mid-1993.

2.2 Site Description

Today, the DN Site contains the following facilities (details of each can be found in Sections 2.1 and 2.2 in the 2020 ERA (Ecometrix, 2022a)):

- The DNGS is comprised of four CANada Deuterium Uranium (CANDU) reactor units. Units 2 and 3 have undergone recent refurbishment (completed in June 2020 and July 2023, respectively). Unit 1 and 4 refurbishments are underway and are expected to be completed in Q2 2025 and Q4 2026, respectively.
- TRF.
- NSS-DWMF, used for used fuel dry storage (UFDS) and dry storage container (DSC) processing.

The eastern portion of the DN Site has been allocated for the DNNP. The DNNP involves the construction and operation of up to four small modular reactors and the associated infrastructure. An Environmental Assessment (EA) was completed in accordance with the Canadian Environmental Assessment Act (CEAA). The DNNP lands will be developed as associated licensing and permitting achieved regulatory approval. In December 2021, OPG selected the small modular reactor (SMR) BWRX-300 for deployment at the DNNP site and started working with the vendor, GE Hitachi Nuclear Energy, to progress the design of the BWRX-300. A comprehensive review of the EIS for the deployment of up to four BWRX-300 SMR for the DNNP was undertaken by OPG to ensure that the results of the EIS remain valid (OPG, 2023a).

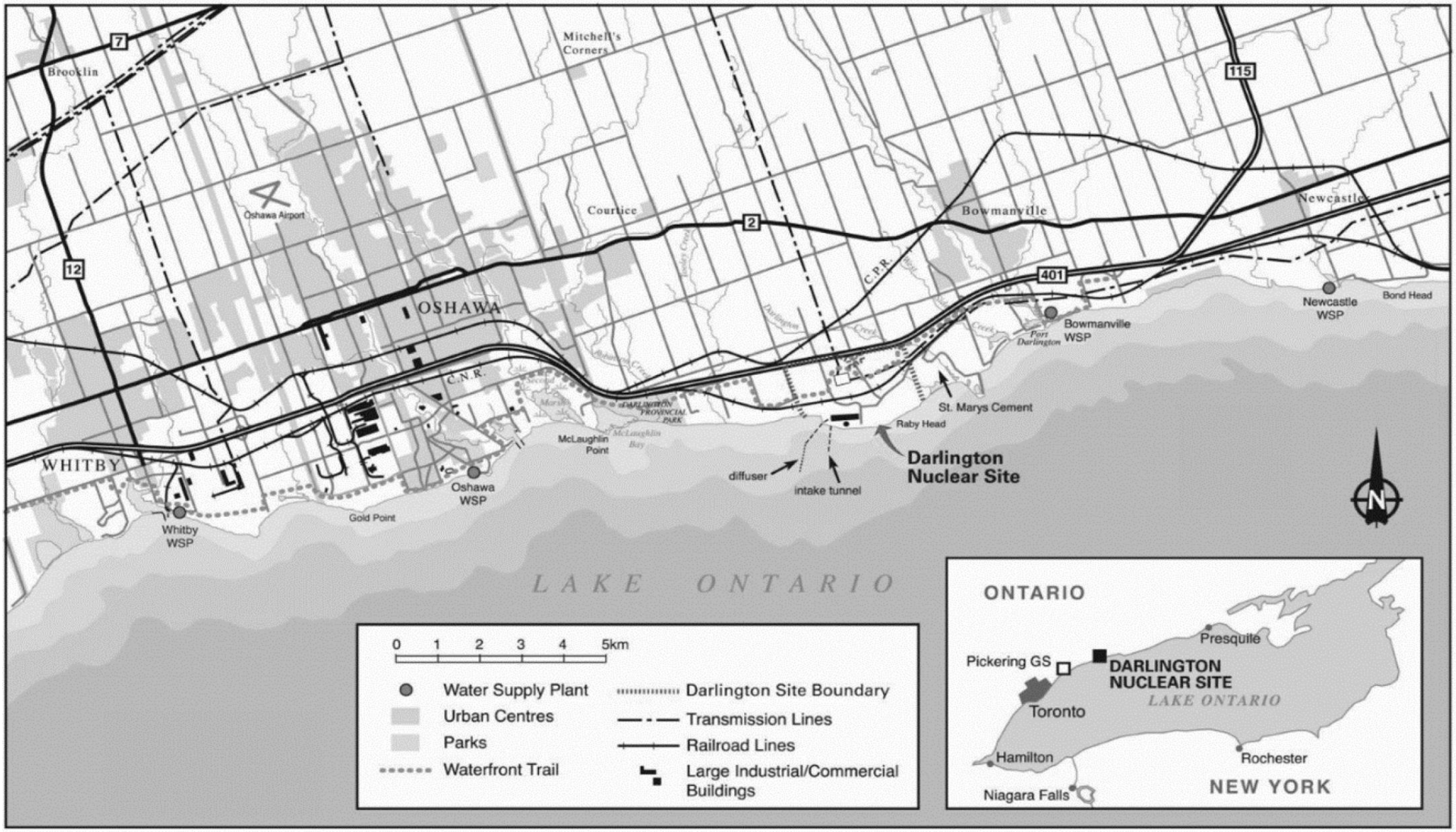

Figure 2-1: DN Site Location and Vicinity (OPG, 2022a)

2.3 Engineered Site Facilities

Detailed information regarding engineered site facilities can be found in Section 2.2 of the 2020 ERA (Ecometrix, 2022a). Some changes to the site layout and facilities (e.g., demolition and construction of various buildings, addition of a Molybdenum-99 / Target Delivery System into Unit 2 at DNGS) have occurred between 2020 and 2023 and brief descriptions of those changes are presented in the following subsections.

2.3.1 Changes to Site Layout

Changes to the DN site layout are presented in **Figure 2-2** below. Pertinent changes to site layout since the 2020 ERA up to and including to the end of 2023, include the following:

- Construction of the DWP.
- New parking lots and laydown areas, including a new upper Engineering Support and Services Building (ESSB) parking lot west of the lagoon, and new gravel areas west of Park Road to support laydown of construction materials.
- Site preparation activities associated with DNNP, which included the following changes to the site layout:
    - clearing and grubbing of land for the first SMR and the lands immediately north and south of 2nd Line;
    - grading at the first SMR area and nearby lands;
    - clearing of several storage areas within the DNNP site;
    - some parking lots were taken out of service to allow for DNNP site preparation activities;
    - construction of Phase 1 stormwater management facilities for the first SMR area, including outfall into Lake Ontario (excluded from **Figure 2-2**);
    - installation of new overhead and underground hydro lines (excluded from **Figure 2-2**); and,
    - construction of a Spoils Pile for the storage of excavated soils.
- The Western Storage Area has been constructed which includes an adjacent new gravel parking lot.
- Various road closures and re-alignments:
    - Holt Road is in the process of realignment and extension, which will include widening in certain sections;

- An east-west lane/haul road has been constructed to connect the Spoils Pile with access to Holt Road;
- A portion of 2nd Line (interface of 2nd Line and Hold Road) is closed to traffic and used for transport or staging heavy equipment for rail transfer; and,
- A portion of 3rd Line (immediately south of Building 363) was demolished and closed to accommodate the construction of a new UFDS building (UFDS #3).

Note that emissions associated with the site layout changes listed above, including fugitive dusts produced during land clearing and site preparation activities, are captured within the air monitoring programs undertaken at the Site on a routine basis (**Section 3.1.2.1**).

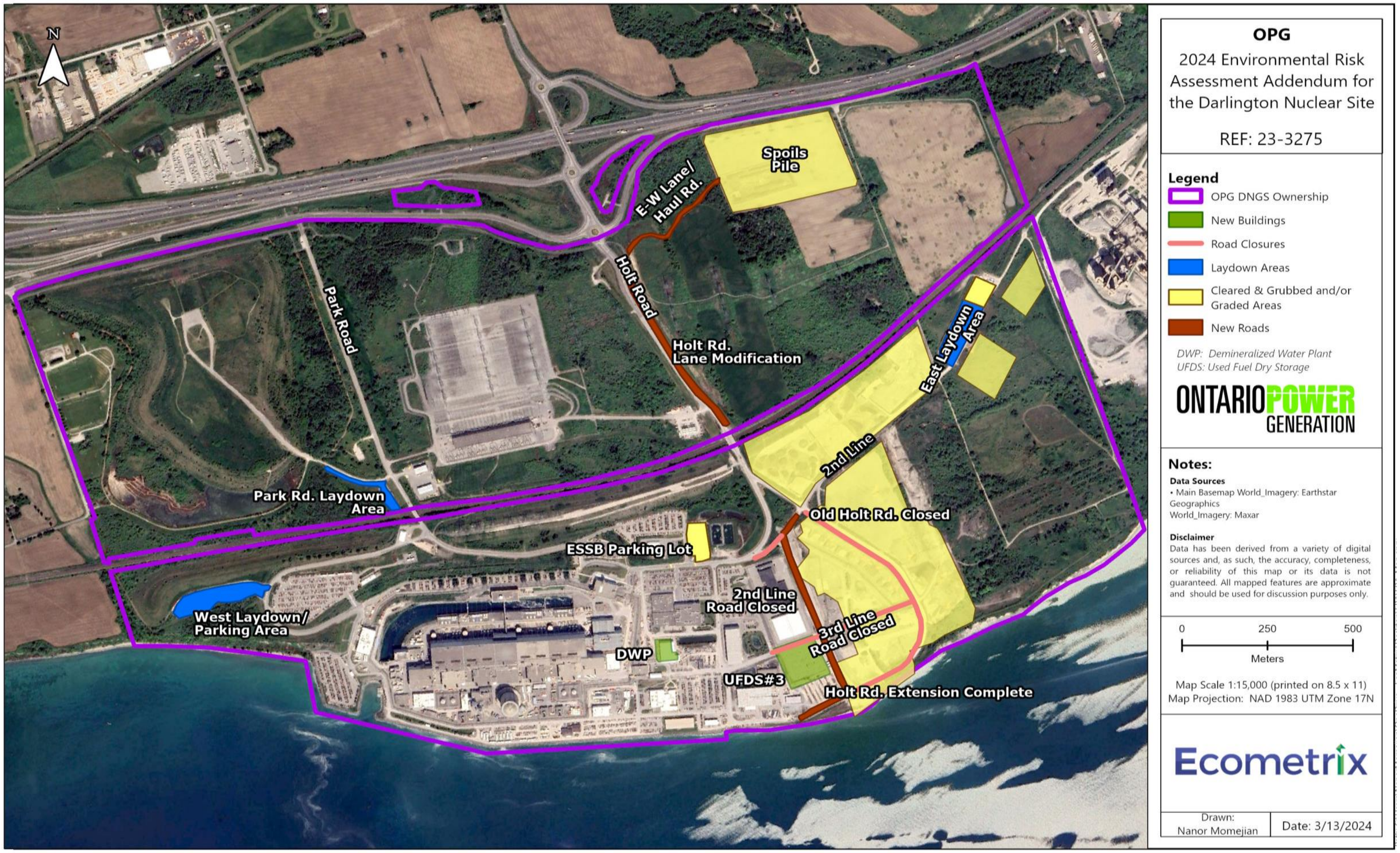

Figure 2-2: Changes to DN Site Layout

2.3.2 Molybdenum-99 / Target Delivery System

During 2022-2023, the Unit 2 Molybdenum-99/Target Delivery System (TDS) was commissioned. Monitoring of the releases from the TDS have been accomplished through the existing station effluent monitoring system and program that aligns with the requirements of CSA N288.5 standard, "Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills" (as outlined in N-STD-OP-0031, "Monitoring of Nuclear and Hazardous Substances in Effluents"). Releases from the TDS are largely expected to be represented by tritium during the process of seeding and harvesting targets, although there will be a small amount of particulates released from the zirconium sheath around the target capsule, with zirconium-95 as the dominant particulate. A HEPA filter will retain 99.97% of airborne particles (including with zirconium-95) before exhausting to the contaminated exhaust system. As such, particulate emissions are not evaluated further herein.

The contribution of releases from the TDS have been considered through the comparison of public dose estimates for the DN site as provided in the EMP reports for the years 2020, 2021, and 2022 (OPG, 2021c; OPG, 2023d). The 2022 DN site public dose was 0.6 µSv as represented by the Farm adult, which was unchanged from the 2021 and 2020 doses. The public dose of 0.6 µSv is less than 0.1% of the 1,000 µSv per year legal limit for a member of the public, and less than 0.1% of the estimated average background dose around the DN site from naturally occurring and man-made radiation of about 1,400 µSv per year. Therefore, the contribution of releases from the TDS to overall DN site emissions are negligible.

2.4 Description of the Natural and Physical Environment

2.4.1 Meteorology and Climate

Detailed information regarding meteorology and climate can be found in Section 2.3.1 of the 2020 ERA (Ecometrix, 2022a). No new climate data (temperature and precipitation) were available as of the writing of this report (December 2023) from the Canadian Climate Normals database (Government of Canada, 2023). It is noted that the website is currently in the process of reporting the Climate Normals for the period 1991-2020 for groups of stations and the data from the Oshawa and Bowmanville weather monitoring stations were not available at this time.

2.4.1.1 Wind

Wind data for the DN site meteorological station for the period 2017 to 2021 are presented as a wind rose in **Figure 2-3**. Data could not be collected from the DN meteorological tower for much of 2018 and 2019; therefore, data from the meteorological station at OPG's Pickering Nuclear Generating Station were used for those years consistent with the EMP reports. The prevailing winds blew from the north-west sector. The dominant wind direction was the northwest, followed by the west direction. The distribution of winds at the DN site is generally similar to that reported for the region based on wind patterns reported at Pearson International

Airport (2013 to 2019), where the wind direction is primarily from the north and west (see **Figure 2-4**).

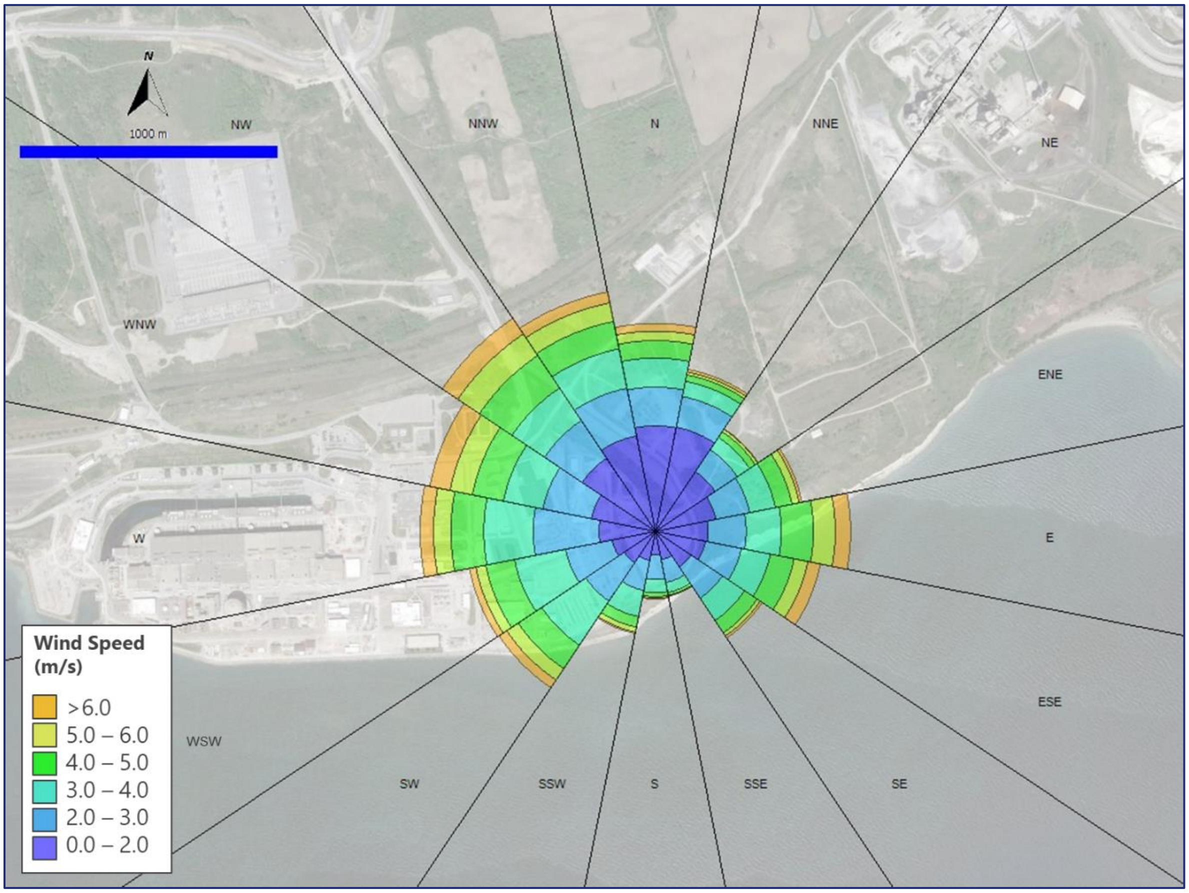

Figure 2-3: 2017-2021 Annual Average Windrose at 10-m Tower (2017, 2020-2021 DN, and 2018-2019 Pickering Nuclear)

Note: Direction is where wind blows from.

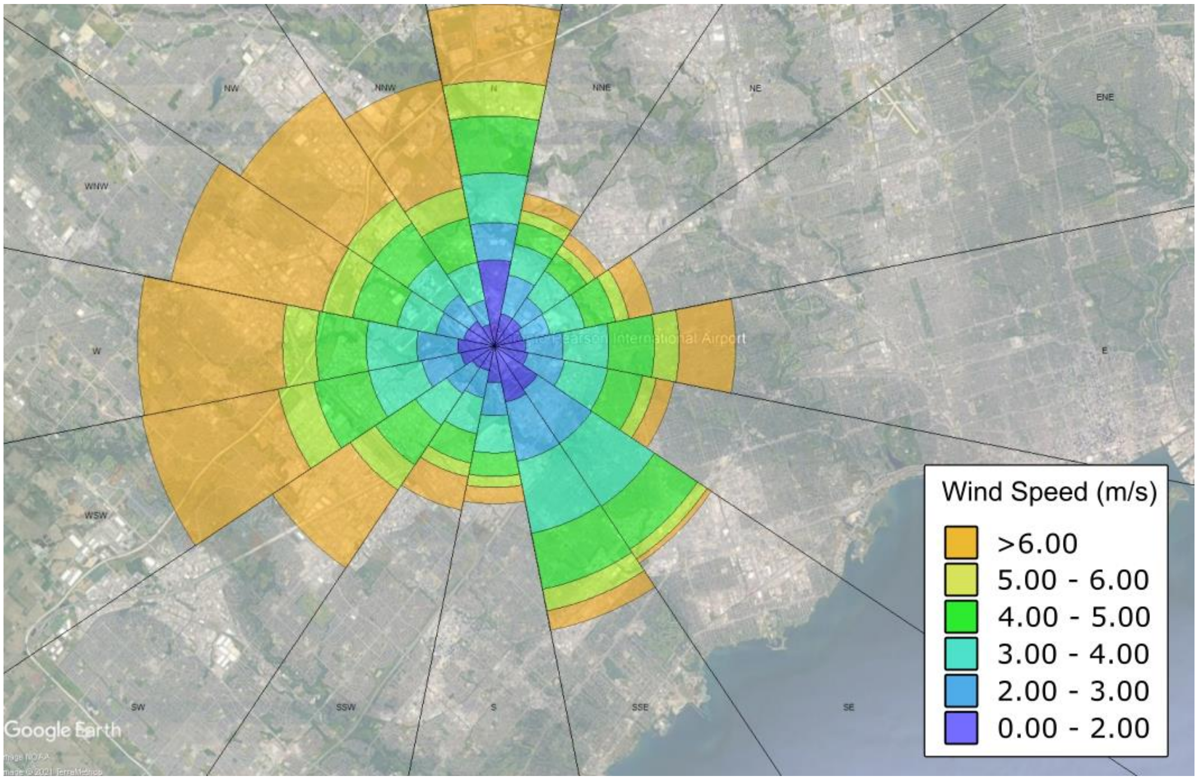

Figure 2-4: 2013 – 2019 Annual Average Windrose at 10-m Tower from Pearson International Airport

Note: Direction is where wind blows from.

2.4.2 Geology

Detailed information regarding geology, including bedrock, surficial geology and soil can be found in Section 2.3.2 of the 2020 ERA (Ecometrix, 2022a). No changes to bedrock or surficial geology have been reported from 2020 to 2022.

2.4.2.1 Soil

Detailed information regarding soil can be found in Section 2.3.2.3 of the 2020 ERA (Ecometrix, 2022a).

A soil characterization study was carried out in 2021 at the DNNP lands prior to the movement of soils for the purposes of regrading the DNNP lands; the soils have been moved to the DNNP northeast landfill area which is the current location of the Spoils Pile (as described in **Section 2.3.1**). The overburden materials within the DNNP lands were comprised of surficial fill that was underlain by native soils ranging from sandy silt, silty sand, clayey silt, silty clay, and gravel. These findings are in agreement with the soil types characterized for the remainder of the DN Site.

The soil type used in the IMPACT model is loam. This is consistent with the recommendation in CSA N288.1-20 to use a clay or loam soil type for Southern Ontario.

2.4.3 Hydrogeology

Detailed information regarding hydrogeology can be found in Section 2.3.3 of the 2020 ERA (Ecometrix, 2022a). No changes to hydrogeology have been reported in the 2020, 2021 and 2022 groundwater monitoring reports (OPG, 2021a, 2022b, 2023b). In brief, the predominant shallow groundwater flow patterns at the site remained unchanged between 2020 to 2022 from historical groundwater flow interpretations. Outside the protected area, groundwater generally flows from the north to the south, towards Lake Ontario. Inside the protected area and in the vicinity of the powerhouse, groundwater flows west and north towards the Forebay. Farther south of the powerhouse, groundwater flows towards Lake Ontario.

2.4.4 Hydrology

Detailed information regarding hydrology can be found in Section 2.3.4 of the 2020 ERA (Ecometrix, 2022a). The existing data on lake-wide circulation, lake water temperature, thermal information, and surface drainage are still relevant for the Site.

Therefore, no changes to the assessed water bodies nor hydrological connections in the IMPACT model were required for the ERA Addendum.

2.4.5 Vegetation Communities

Detailed information regarding vegetation communities can be found in Section 2.3.5 of the 2020 ERA (Ecometrix, 2022a). No incidental findings related to changes in vegetation communities were reported in the three-year biodiversity report (2019-2021) (Beacon, 2022) and the 2022 annual biodiversity report (Beacon, 2023). Some vegetation removal has occurred as part of site preparation activities (e.g., land clearing and grubbing) on the DNNP lands, though this is not expected to change the biodiversity of the overall vegetation community at the DN site as these areas of the DNNP lands were sparsely vegetated.

Therefore, no changes to the vegetation species assessed in the 2020 ERA were required.

2.4.6 Wildlife Habitat

Detailed information regarding wildlife habitat can be found in Section 2.3.6 of the 2020 ERA (Ecometrix, 2022a). Biodiversity monitoring at the DN site is carried out on an annual basis and is available for the period 2020 to 2022 (reporting for 2023 is not yet available). Updated biodiversity information is summarized below from the three-year biodiversity report (2019-2021) (Beacon, 2022) and the 2022 annual biodiversity report (Beacon, 2023).

2.4.6.1 Wildlife Habitat and Terrestrial Species

Overall, wildlife habitat and terrestrial species observations for the period 2020 to 2022 have not changed significantly since reported in the 2020 ERA (Ecometrix, 2022a). Updates to some statistics and individual species are noted below.

Birds

The DN site provides breeding habitat for many bird species as well as habitat for migrant songbirds. A total of 236 different species of birds have been observed at the DN site and almost all have occurred as migrants, even if they breed on the property (Beacon, 2023). The total annual number of confirmed and probable breeding bird species at the DN site since 1997 has varied between 53 and 73, and was 73 in 2022 (Beacon, 2023). The list of confirmed breeding birds for the DN site compiled for 2011 to 2022 is presented in **Table 2-1** for areas southwest and southeast of DN as well as within the DN Generating Station area itself.

Table 2-1: Breeding Bird Species Observed during 2011 to 2022 Biodiversity Surveys

Common Name	Scientific Name	Southwest	Station	Southeast
Green Heron	*Butorides virescens*			√
Black-crowned Night Heron	*Nycticorax nycticorax*	√		
Mute Swan	*Cygnus olor*	√	√	√
Double-breasted Cormorant	*Phalacrocorax auritus*		√	
Canada Goose	*Branta Canadensis*		√	√
Mallard	*Anas platyrynchos*	√	√	√
Gadwall	*Anas strepera*	√	√	√
American Kestrel	*Falco sparverius*	√	√	√
Red-tailed Hawk	*Buteo jamaicensis*	√		√
Killdeer	*Charadrius vociferous*	√	√	√
American Woodcock	*Scolopax minor*	√		√
Rock Pigeon	*Columbia livia*	√	√	√
Mourning Dove	*Zenaida macroura*	√	√	√
Chimney Swift	*Chaetura pelagica*	√		
Red-bellied Woodpecker	*Melanerpes carolinus*			√
Downy Woodpecker	*Picoides pubescens*	√		√
Hairy Woodpecker	*Dryobates villosus*			√
Northern Flicker	*Colaptes auratus*	√	√	√
Willow Flycatcher	*Empidonax traillii*	√	√	√
Alder Flycatcher	*Empidonaxalnorum*	√	√	√
Great Crested Flycatcher	*Myiarchus crinitus*	√	√	√
Least Flycatcher	*Empidonax minimus*	√		√
Eastern Kingbird	*Tyrannus tyrannus*	√	√	√
N. Rough-winged Swallow	*Stelgidopteryx serripennis*	√	√	√
Cliff Swallow	*Petrochelidon pyrrhonota*		√	
Tree Swallow	*Tachycineta bicolor*	√		√
Barn Swallow	*Hirundo rustica*	√	√	√

Common Name	Scientific Name	Southwest	Station	Southeast
Bank Swallow	*Riparia riparia*			√
Blue Jay	*Cyanocitta cristata*	√	√	√
American Crow	*Corvus brachyrhynchos*	√	√	√
Common Raven	*Corvus corax*	√		√
Black-capped Chickadee	*Poecile atricapillus*	√	√	√
Blue-gray Gnatcatcher	*Polioptila caerula*	√	√	√
House Wren	*Troglodytes aedon*	√	√	√
American Robin	*Turdus migratorius*	√	√	√
Wood Thrush	*Hylocichla mustelina*			√
Northern Mockingbird	*Mimus polyglottus*	√	√	√
Gray Catbird	*Dumetella carolinensis*	√	√	√
Brown Thrasher	*Toxostoma rufum*	√	√	√
Cedar Waxwing	*Bombycilla cedrorum*	√	√	√
European Starling	*Sturnus vulgaris*	√	√	√
Northern Cardinal	*Cardinalis cardinalis*	√	√	√
Warbling Vireo	*Vireo gilvus*	√	√	√
Red-eyed Vireo	*Vireo olivaceus*	√	√	√
Yellow Warbler	*Dendroica petechia*	√	√	√
Mourning Warbler	*Geothlypis philadelphia*			√
American Redstart	*Setophaga ruticilla*	√		√
Chestnut-sided Warbler	*Setophaga pensylvanica*			√
Common Yellowthroat	*Geothlyphis trichas*	√	√	√
Chipping Sparrow	*Spizella passerina*		√	
Field Sparrow	*Spizella pusilla*	√	√	√
Savannah Sparrow	*Passerculus sandwichensis*	√	√	√
Song Sparrow	*Melospiza melodia*	√	√	√
Clay-colored Sparrow	*Spizella pallida*			√
Swamp Sparrow	*Melospiza georgiana*		√	√
House Sparrow	*Passer domesticus*	√	√	√
Red-winged Blackbird	*Agelaius phoeniceus*	√	√	√
Eastern Meadowlark	*Sturnella magna*	√		√
Common Grackle	*Quiscalus quiscula*	√	√	√
Brown-headed Cowbird	*Molothrus ater*	√	√	√
Orchard Oriole	*Icterus spurius*	√	√	√
Baltimore Oriole	*Icterus galbula*	√	√	√
House Finch	*Haemorhous mexicanus*	√	√	√
American Goldfinch	*Spinus tristis*	√	√	√
Merlin	*Falco columbarius*			√
Turkey Vulture	*Cathartes aura*		√	√
Spotted Sandpiper	*Actitis macularius*	√	√	√
Black-billed Cuckoo	*Coccyzus erythropthalmus*	√		√
Belted Kingfisher	*Megaceryle alcyon*	√	√	√
Osprey	*Pandion haliaetus*			√
Wild Turkey	*Meleagris gallopavo*	√		√

Common Name	Scientific Name	Southwest	Station	Southeast
Ruby-throated Hummingbird	*Archilochus colubris*			√
Eastern Wood Peewee	*Contopus virens*	√		√
Red-breasted Nuthatch	*Sitta canadensis*	√		√
Indigo Bunting	*Passerina cyanea*			√
Bobolink	*Dolichonyx oryzivorus*	√		√
Rose-breasted Grosbeak	*Pheucticus ludovicianus*			√

Source: (Beacon, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019a, 2019b, 2022, 2023)
Check marks (√) indicate that at least one sighting of that species occurred in the general area noted.

The bluffs along the Lake Ontario shoreline provide nesting habitat for threatened Bank Swallows. The species also forages in various parts of the DN site. The lakeshore colonies have been surveyed for over ten years. In 2022 at the DN site, a total of 1,795 burrows were documented, which is similar to the average of 1,811 burrows over the past 16 years of monitoring (Beacon, 2023). All the burrows in 2022 were located in the eastern-most third of the shoreline of the DN site, as is typical. The number of burrows on the DN site has varied during the 2007 to 2022 period from 1,118 burrows to 2,617 burrows (Beacon, 2023). Based on the broader evaluation area extending from the site, since 2012 Bank Swallow burrows have decreased, 2020 being the lowest number of burrows recorded (Beacon, 2023).

<u>Mammals</u>

Thirty-seven mammal species have been inventoried at the DN site as a result of incidental observations during field investigations conducted for non-biological inventory purposes since 1997 (**Table 2-2**) (Beacon, 2023).

Table 2-2: Mammals Species List (1997-2022)

Common Name	*Scientific Name*
MAMMALS	
Virginia Opossum	*Didelphis virginiana*
Masked Shrew	*Sorex cinereus*
Smoky Shrew	*Sorex fumeus*
Pygmy Shrew	*Sorex hoyi*
Northern Short-tailed Shrew	*Blarina brevicauda*
Star-nosed Mole	*Condylura cristata*
Little Brown Myotis	*Myotis lucifugus*
Northern Myotis	*Myotis septentrionalis*
Small-footed Myotis	*Myotis leibii*
Silver-haired Bat	*Lasionycteris noctivagans*
Tri-coloured Bat	*Pipistrellus subflavus*
Big Brown Bat	*Eptesicus fuscus*
Eastern Red Bat	*Lasiurus borealis*
Hoary Bat	*Lasiurus cinereus*
Eastern Cottontail	*Sylvilagus floridanus*
European Hare	*Lepus europaeus*
Eastern Chipmunk	*Tamias striatus*
Woodchuck	*Marmota monax*
Grey Squirrel	*Sciurus carolinensis*
Red Squirrel	*Tamiasciurus hudsonicus*
Beaver	*Castor canadensis*
White-footed Mouse	*Peromyscus leucopus*
Deer Mouse	*Peromyscus maniculatus*
Meadow Vole	*Microtus pennsylvanicus*
Muskrat	*Ondatra zibethicus*
Norway Rat	*Rattus norvegicus*
Meadow Jumping Mouse	*Zapus hudsonius*
Woodland Jumping Mouse	*Napaeozapus insignis*
Eastern Coyote	*Canis latrans*
Red Fox	*Vulpes vulpes*
Black Bear	*Ursus americanus*
Raccoon	*Procyon lotor*
Short-tailed Weasel	*Mustela erminea*
Long-tailed Weasel	*Mustela frenata*
Mink	*Mustela vison*
Striped Skunk	*Mephitis mephitis*
White-tailed Deer	*Odocoileus virginianus*

Source: (Beacon, 2019b, 2022, 2023)

Amphibians and Reptiles

Eight species of amphibians and five species of reptiles have been inventoried for the DN site during the breeding season from 2008 to 2022 (**Table 2-3**) (Beacon, 2019b, 2023).

Table 2-3: Amphibian and Reptile Species List

Common Name	*Scientific Name*
REPTILES AND AMPHIBIANS	
American Toad	*Bufo americanus*
Eastern Gray Treefrog	*Hyla versicolor*
Western Chorus Frog	*Pseudacris triseriata*
Northern Leopard Frog	*Rana pipiens*
Green Frog	*Rana clamitans*
Wood Frog	*Rana sylvatica*
Midland Painted Turtle	*Chrysemys picta*
Common Snapping Turtle	*Chelydra serpentine*
Red-eared Slider	*Trachemys scripta*
Eastern Garter Snake	*Thamnophis sirtalis*
Spring Peeper	*Pseudacris crucifer*
DeKay’s Brownsnake	*Storeria dekayi*
Red-back Salamander	*Plethodon cinereus*

Source: (Beacon, 2019b, 2023)

Insects and other invertebrates

To date, 304 insect species (butterflies, dragonflies/damselflies, moths, and other insects) have been inventoried for the DN site (Beacon, 2019b, 2023). Moths represent the most diverse group (211 species), followed by dragonflies and damselflies (42 species), and butterflies (33 species). Other invertebrate groups that have been identified include tiger beetles (2 species), spiders (2 species), and other insects (14 species).

2.4.6.2 Terrestrial Animal Species at Risk

Two reptile species, eighteen breeding bird species, four mammals (bats), three insects, and one tree species at risk with a provincial ranking of endangered, threatened, or special concern were recorded at the DN site over the period from 2006 to 2022. One insect species (American Bumble Bee) is listed as special concern provincially and federally as of 2023. Eastern Small-Footed Myotis was identified for the first time on the DN site during bat acoustic monitoring in 2021 (Beacon, 2021). A list of the animal species that have a species at risk ranking of endangered, threatened, or special concern in Ontario and have been recorded at the DN site is provided in **Table 2-4**, along with their regional federal status ranking under Schedule 1 of the *Species at Risk Act* (SARA) and/or by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

Table 2-4: Wildlife Species at Risk Observed within the Vicinity of DN (2006-2022)

Scientific Name	Common Name	Federal Species at Risk Status(1)	Provincial Ranking(2)	Most Recent Year Observed
Amphibians and Reptiles				
Chelydra serpentina	Snapping Turtle	Special Concern	Special Concern	2020
Chrysemys picta marginata	Midland Painted Turtle	Special Concern[3]	No status	2022
Birds				
Ixobrychus exilis	Least Bittern	Threatened	Threatened	2022
Falco peregrinus	Peregrine Falcon	Special Concern	Special Concern	2022
Chlidonias niger	Black Tern	No status	Special Concern	2008
Asio flammeus	Short-eared Owl	Special Concern	Threatened	2018
Chordeiles minor	Common Nighthawk	Special Concern	Special Concern	2019
Chaetura pelagica	Chimney Swift	Threatened	Threatened	2021
Antrostomus vociferus	Eastern Whip-poor-will	Threatened	Threatened	2018
Contopus cooperi	Olive-sided Flycatcher	Special Concern	Special Concern	2019
Contopus virens	Eastern Wood Peewee	Special Concern	Special Concern	2022
Riparia riparia	Bank Swallow	Threatened	Threatened	2022
Hirundo rustica	Barn Swallow	Threatened	Special Concern	2022
Hylocichla mustelina	Wood Thrush	Threatened	Special Concern	2022
Cardellina canadensis	Canada Warbler	Threatened	Special Concern	2011
Icteria virens auricollis	Yellow-breasted Chat	Endangered	Endangered	2009
Dolichonyx oryzivorus	Bobolink	Threatened	Threatened	2022
Sturnella magna	Eastern Meadowlark	Threatened	Threatened	2022
Euphagus carolinus	Rusty Blackbird	Special Concern	Special Concern	2010
Mammals				
Myotis lucifugus	Little Brown Myotis (bat)	Endangered	Endangered	2022
Myotis septentrionalis	Northern Myotis (bat)	Endangered	Endangered	2021
Myotis leibii	Eastern Small-footed Myotis (bat)	No status	Endangered	2021
Pipistrellus subflavus	Tri-colored Bat	Endangered	Endangered	2022
Insects				
Denaus plexippus	Monarch (butterfly)	Endangered	Special Concern	2022
Bombus pensylvanicus	American Bumble Bee	Special Concern	Special Concern	2022
Bombus terricola	Yellow-banded Bumble Bee	Special Concern	Special Concern	2022

Scientific Name	Common Name	Federal Species at Risk Status(1)	Provincial Ranking(2)	Most Recent Year Observed
Plants				
Juglans cinerea	Butternut (tree)	Endangered	Endangered	2022

Notes:
The Provincial Species at Risk in Ontario List and Federal List of Wildlife Species at Risk (Schedule 1 of the SARA) are frequently revised.
(1) SARA Schedule 1 ranks species at risk as Extirpated, Endangered, Threatened Species, and Special Concern. Prohibitions of the Act do not apply to species of Special Concern.
(2) The provincial Endangered Species Act (ESA) (2007) came into effect on June 30, 2008, and it applies to species once they appear on the official list.
(3) Midland Painted Turtle was assessed as Special Concern by COSEWIC in 2018 but currently no Federal status or schedule
Sources: (Beacon, 2019a, 2019b, 2022, 2023)

Although there have been some observations of new Species at Risk, the selected receptors from the 2020 ERA are still relevant and representative. None of the newly observed Species at Risk introduce any new exposure pathways or exposure characteristics not already represented by the list of selected receptors from the 2020 ERA. As noted in the 2020 ERA, no bats were selected as valued ecosystem components (VECs) for the ecological risk assessment as the assessment of other terrestrial mammals is expected to be protective of this receptor group; this same assumption applies to the Eastern Small-footed Myotis, which would experience similar exposure characteristics and pathways as the other previously identified bat species. The American Bumble Bee and the Yellow-banded Bumble Bee are expected to be adequately represented by the Earthworm, as they are all terrestrial invertebrates. Both species of bumble bees and the Earthworm are assumed to be exposed to airborne contaminants via soil. As the Earthworm dwells underground and is more highly exposed to soil, using the Earthworm to represent the American Bumble Bee and the Yellow-banded Bumble Bee is considered conservative. No associated changes to the receptors assessed in the ERA Addendum were required.

2.4.7 Aquatic Communities

Detailed information regarding aquatic communities can be found in Section 2.3.7 of the 2020 ERA (Ecometrix, 2022a). The existing information on aquatic communities is still relevant for the Site.

Since the 2020 ERA, as part of the work to support the DNNP project, a channelized drainage feature which provides site drainage for Hydro One and OPG properties was assessed for fish habitat (Ecometrix, 2022b). The location of the ditch and drainage feature are shown on **Figure 2-5** below.

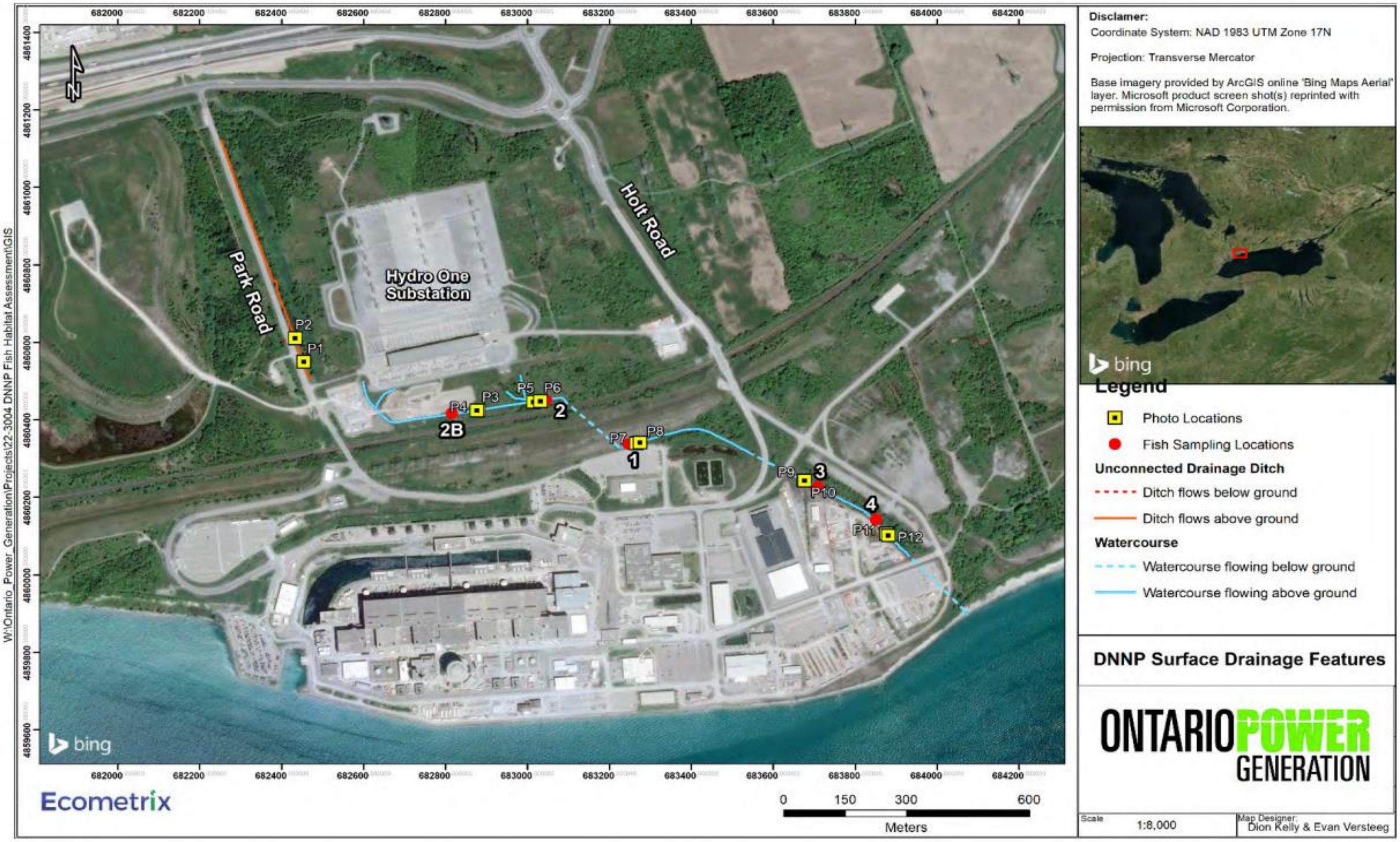

Figure 2-5: Fish Habitat Assessment of the Drainage Features

The fish habitat assessment was conducted using the principles of the Ontario Stream Assessment Protocol and included electrofishing. From the survey results, it was concluded that the channelized drainage feature does not support fish and there is no connectivity to fish bearing waters (i.e., Lake Ontario); thus, the drainage feature does not meet the definition of fish habitat under the *Fisheries Act*.

In May 2023, eDNA sampling was conducted in the drainage feature. Fish DNA was not present based on DNA barcoding.

Therefore, no new aquatic communities or aquatic community information has been incorporated into the ERA Addendum.

2.4.8 Human Land Use

Detailed information regarding human land use can be found in Section 2.3.8 of the 2020 ERA (Ecometrix, 2022a). The existing information on human land use is still relevant for the Site.

2.4.9 Population Distribution

The population distribution information remains unchanged from the 2020 ERA, as new census data is not available. Detailed information regarding population distribution use can be found in Section 2.3.9 of the 2020 ERA (Ecometrix, 2022a).

2.5 Uncertainties in Site Characterization

The DN Site is considered to be well-characterized. No residual uncertainties in the Site Characterization have been identified.

3.0 Human Health Risk Assessment (HHRA)

The human health risk assessment (HHRA) is a process that evaluates the potential for health risks to humans who may be exposed to chemical and radiological contaminants.

The HHRA consists of the following steps:

- Problem Formulation;
- Exposure Assessment;
- Toxicity Assessment; and
- Risk Characterization.

3.1 Problem Formulation

The problem formulation provides the objectives, goals, framework, and methodology for the risk assessment and consists of identifying the relevant components for the HHRA. These components include the identification of human receptors that may be potentially present in or around the DN Site; the identification of exposure pathways operating on or around the DN Site, based on the fate and transport of chemical and radiological contaminants in the environment; the identification of chemical, radiological, and other stressors; and a conceptual site model that illustrates all of these relationships.

During the problem formulation stage, decisions are made on which COPCs and receptors that should be focused on for further assessment in the HHRA. For this Addendum, the receptors and exposure pathways remain consistent with the 2020 ERA; however, the COPC screening is new, based on data collected since 2020.

3.1.1 Receptor Selection and Characterization

Consistent with the 2020 ERA, on-site workers, contractors, and visitors are protected through the Health and Safety Management System Program and the Radiation Protection Program and are not considered in the HHRA.

The receptors selected for the assessment and their characteristics remain unchanged from the 2020 ERA (Ecometrix, 2022a), as presented below.

- The **Oshawa/Courtice** potential critical group consists of urban residents in Oshawa and in the community of Courtice within the Municipality of Clarington located to the W and WNW of the site starting at about 6 km from the site. These residents obtain drinking water from the Oshawa WSP and grow a small percentage of their annual fruit and vegetable consumption in gardens.
- The **Bowmanville** potential critical group consists of urban residents located to the NE and NNE of the site at distances from 4 to 7 km from DN. These residents obtain drinking water from the Bowmanville WSP and grow a small percentage of their annual fruit and

vegetable consumption in gardens. They also purchase a small percentage of their annual meat, poultry, and egg consumption from local farms.

- The **West/East Beach** potential critical group consists of urban residents located to the ENE of the site at distances from 3.5 km to 7 km. These residents obtain their drinking water from both wells and the Bowmanville WSP and grow a small percentage of their annual fruit and vegetable consumption in gardens. They also purchase a small percentage of their annual poultry and egg consumption from local farms.
- The **Farm** potential critical group consists of agricultural farms (but not dairy farms) located in all landward wind sectors around the DN site at distances from 1.5 km to 10 km. The closest is in the WNW wind sector. Members of this group obtain their water supply mostly from wells and use it for drinking, bathing, irrigation, and watering livestock. They also obtain a large fraction of their annual fruit, vegetable, and animal product consumption from locally grown products.
- The **Dairy Farm** potential critical group consists of dairy farms located in all landward wind sectors around the DN site at distances from 3 km to over 10 km. The closest is in the N wind sector. Members of this group obtain their water supply from wells and use it for drinking, bathing, irrigation, and livestock watering. They also obtain a large fraction of their annual fruit, vegetable and animal product consumption, including fresh cow's milk, from locally grown products.
- The **Rural Resident** potential critical group consist of residents in rural areas in all landward wind sectors around the site at distances of about 2 km to 5 km. Members of this group obtain about half of their water supply from wells and half from the Bowmanville WSP, and use it for drinking, bathing, and irrigation. They obtain a moderate fraction of their annual fruits, vegetables, poultry, and eggs from locally grown products.
- The **Industrial/Commercial** potential critical group consist of adult workers whose work location is close to the nuclear site. The closest location for this group is the St. Mary's cement (SMC) plant about 1.8 km NE of the site; however, the most affected location due to updated meteorological data is the Courtice Water Pollution Control Plant about 2 km W of DN. Members of this group are typically at this location about 23% of the time. They consume water from the Bowmanville WSP.
- The **Sport Fisher** potential critical group is comprised of non-commercial individuals fishing near the DN site discharge, about 0.5 km S of the DN site. Members of this group were conservatively assumed to obtain their entire amount of fish for consumption from the vicinity of the DN site and spend 1% of their time at the discharge location where atmospheric exposure occurs.
- The **Camper** potential critical group consists of campers at the Darlington Provincial Park, located from 4 to 6 km W of the site at the lakeshore, and includes McLaughlin Bay, a shallow water body where some fishing takes place. The campers are assumed to be in the park no more than six months of the year. They consume drinking water from the Oshawa WSP, and purchase a small fraction of their annual fruits, vegetables, meat, poultry, and eggs from locally grown sources.

The HHRa and receptor selection does not directly address sensitive or vulnerable populations; however, sensitive or vulnerable human health groups are considered through the use of toxicity reference values (TRVs) in **Section 3.3.1** that incorporate uncertainty factors to account for sensitive individuals.

3.1.2 Selection of Chemical, Radiological, and Other Stressors

The DN facility emits certain chemicals and radionuclides to air and water in the normal course of operations. Measurements and modelled concentrations of chemical COPCs in air and water, from 2020 to the end of 2022, were screened against available screening benchmarks that are protective of human health to determine if any COPCs required further study in the context of human health risk assessment. The selection of COPCs in other environmental media is also discussed in the sections below. Contaminants were retained for evaluation of human health risks in this Addendum if they:

- Were a new COPC not previously identified in the 2020 ERA, or
- Were a COPC evaluated in the 2020 ERA and the maximum concentration in 2020 – 2022 was greater than that evaluated in the 2020 ERA.

The framework for the chemical COPC screening process used in the HHRA is consistent with the 2020 ERA, with updated guidelines applied where available. Generally, maximum observed or modelled concentrations were screened against the more conservative of federal or Ontario provincial guidelines. If there was no such guideline, guidelines from other jurisdictions, or the literature were considered and/or derived using federally and/or provincially accepted methods. For COPCs where these criteria were not available, conservative toxicity benchmarks (e.g., no effects levels) or upper limit of background concentrations were used as screening criteria. Maximum measured or modelled concentrations of parameters in air and surface water were compared to the selected screening criteria. Subsequent sections for each environmental medium provide hierarchical depictions outlining the specific guidelines considered in the screening process for that medium.

Since radionuclides are considered of public interest, relevant radionuclides are carried forward quantitatively in the HHRA, bypassing the screening assessment.

3.1.2.1 Selection of Chemical COPCs in Air

3.1.2.1.1 Emission Summary and Dispersion Modelling (ESDM) Reports

The ESDM Reports from 2020 to 2022 were consulted to aid in chemical COPC selection for air. The ESDM report presents the estimated atmospheric emissions of COPCs from the DN site (ORTECH, 2021, 2022a, 2022b). The impact of contaminant emissions was assessed within the ESDM reports by comparing point-of-impingement (POI) concentrations modeled from emission rates to POI exposure benchmarks listed in the Ministry of Environment, Conservation, and Parks (MECP) publication: *Air Contaminants Benchmarks (ACB) List: Standards, guidelines, and screening levels for assessing point of impingement concentrations of air contaminants* (the 'ACB list')

(MECP, 2023a). The ACB list encompasses the air standards set out in Ontario Regulation (O. Reg.) 419/05, as well as a broader list of additional benchmarks further intended to aid facilities in preparing ESDM reports. Modelled POI concentrations were compared to respective MECP POI benchmarks with corresponding averaging periods, typically 24-hour or annual averages.

3.1.2.1.2 DNNP Air Quality Monitoring Data

In November 2021, OPG initiated an air quality study in support of the DNNP, with the goal of re-establishing existing air quality conditions at the DN site prior to the start of DNNP site preparation and construction activities (IEC, 2023). The study monitors priority air contaminants including particulate matter (PM_{10}, $PM_{2.5}$, total suspended particulates [TSP]), pollutant gases (Nitrogen dioxide, NO_2; Sulphur dioxide, SO_2), volatile organic compounds (VOCs), and benzo(a)pyrene (BAP; a surrogate for total polycyclic aromatic hydrocarbons [PAHs]). Air quality data are presented for two monitoring locations situated on the western and eastern boundaries of the DNNP site (OPG West and OPG East) as shown in **Figure 3-1**.

3.1.2.1.3 HHRA Air Screening

3.1.2.1.3.1 ESDM Report Screening

The maximum predicted POI concentrations for each of the modelled parameters in Table 1 of the ESDM reports were compared to selected health-based screening benchmarks. Selection of health-based screening criteria followed the hierarchy depicted in **Figure 3-2**. Preferred primary guidelines consisted of the most conservative of the MECP ACBs (MECP, 2023a), and the Canadian Council of Ministers of the Environment (CCME) Canadian Ambient Air Quality Standards (CAAQS) (CCME, 2019). CAAQS are only available for four parameters. Secondary guidelines consisted of the MECP ambient air quality criteria (MECP, 2023b), while tertiary guidelines were the Texas Commission on Environmental Quality Effects Screening Levels (TCEQ, 2023).

Figure 3-1: Location of OPG East and OPG West Air Quality Monitoring Stations (IEC, 2023)

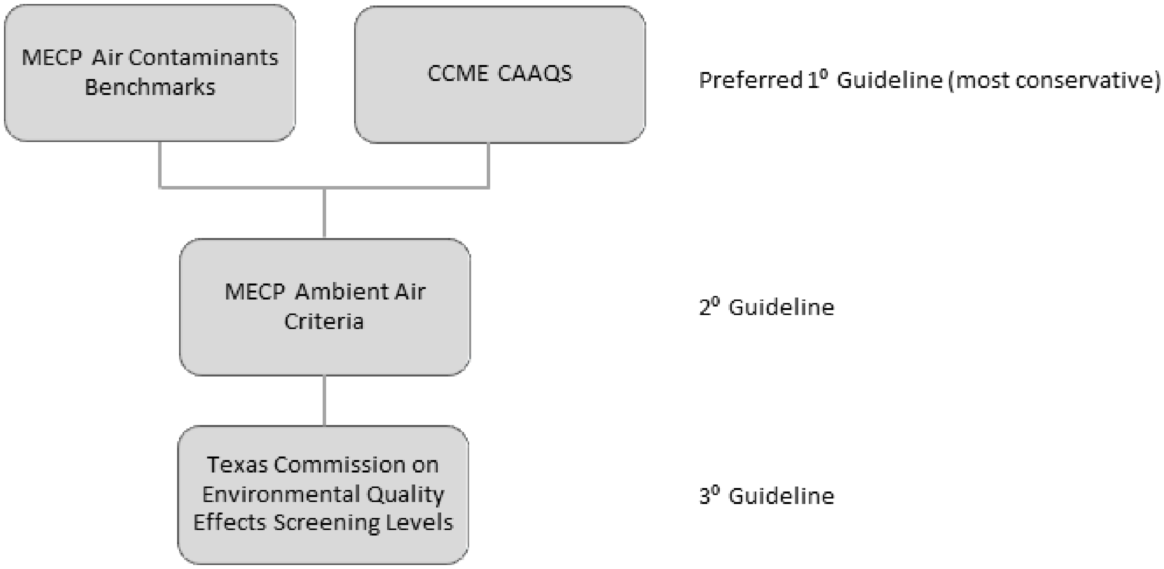

Figure 3-2: Hierarchy of Screening Criteria for HHRA Chemical COPCs in Air

The HHRA screening of chemical COPCs based on maximum predicted POI concentrations is shown in **Table A-1** in **Appendix A**. Modelled POI concentrations were directly compared to guidelines with the same averaging periods (e.g., 24-hour or annual) or were adjusted to meet the timeframes of the relevant screening criteria. With the exception of nitrogen oxides (NOx), no other modelled concentrations exceeded selected screening criteria from 2020 to 2022. Maximum POI concentrations of NOx in 2020, 2021, and 2022 exceeded the 1-hour CCME CAAQS (205 µg/m^3 > 113 µg/m^3). The maximum POI 1-hour concentration from 2020 – 2022 (205 µg/m^3) was the same as the maximum POI concentration from 2016 – 2020 (205 µg/m^3). Thus, this concentration of NOx was evaluated in the 2020 ERA and does not need to be repeated.

The POI concentrations calculated for the DN site tend to be conservative as they consider the worst-case operating conditions resulting in the highest POI concentrations for each air pollutant (and relevant averaging period) that the DN site is capable of producing. For example, the maximum POI concentration for NOx was calculated to be 205 µg/m^3, whereas the monitoring data from the DNNP air quality monitoring (see next section) measured the concentration of NO_2 (comparable to NOx) to be 127 µg/m^3. Its important to note, as described in the next section, that the concentration of NO_2 measured in the DNNP air study likely captured other sources of NO_2 external to the DN site, further suggesting that the POI concentrations are likely to be a conservative overestimate of DN air emissions.

3.1.2.1.3.2 DNNP Air Quality Monitoring Screening

Monitored air quality data were also compared against selected HHRA screening criteria (**Figure 3-2**) in **Table A-2** in **Appendix A**. Monitored air quality data are mostly presented as 24-hour averages. In addition to 24-hour averages, PM_{10}, $PM_{2.5}$, NO_2, and SO_2 are presented as 1-hour averages, and four parameters (methylene chloride, 1,2-dichloroethane, tetrachloroethylene, and benzene) are presented as annual averages. The exceedances are discussed below.

Out of 90 samples (East and West stations), there were 9 exceedances of the 24-hour ambient air quality criteria (AAQC) value for TSP. The exceedances were all at the East station, which is located close to St. Mary's Cement (SMC). Exceedances were likely due to factors such as the degree of truck traffic at SMC, the predominant wind direction, and whether there was precipitation or frozen ground that would suppress dust generation from SMC roads. Each TSP exceedance coincided with a PM_{10} exceedance at one or both stations.

For $PM_{2.5}$, there were 3 exceedances at the East station and 1 exceedance at the West station of the 24-hour AAQC from November 2021 to November 2022. The $PM_{2.5}$ concentrations were similar at the East and West stations, with short term peaks occurring more often at the East station during the late spring and early summer months.

For PM_{10}, there were 57 exceedances at the East station and 16 exceedances at the West station of the 24-hour AAQC from November 2021 to November 2022. The PM_{10} concentrations at the West station were largely stable with some short-term peaks, while the concentrations at the East station tended to peak more frequently and over a much larger concentration range compared to the West station. This pattern is similar to TSP and is expected to be due to the SMC facility operations and associated truck traffic on unpaved roads. All of the PM_{10} exceedances at the West station coincided (in time) with the exceedances at the East station. Seasonally, the number of exceedances were lower in the winter months where frozen ground and/or snow-covered / wet ground would suppress the re-suspension of dust.

SO_2 concentrations did not vary greatly between the two monitoring stations, though there were more short-term spikes in concentration at the West station. There were no exceedances of the 24-hour SO_2 criteria at either station; however, there was one exceedance of the 1-hr AAQC at the East station, and 21 at the West station. Most of the exceedances at the West station (15 out of 21) occurred when winds were from the east. As there were no corresponding exceedances at the East station, this indicates that the SO_2 emissions may have originated from OPG property (i.e., Holt Road) or possibly from plume dispersion from the Durham-York Energy Centre (DYEC) tall stack. Other exceedances occurred when winds were from the west, north, and north-west suggesting that other local sources may at times be contributing to higher short-term concentrations of SO_2 (i.e., Highway 401, Highway 418, SMC, DYEC, etc.).

For BAP, there were 25 samples at the East station and 22 samples at the West station that exceeded the 24-hour AAQC from November 2021 to November 2022. The BAP concentrations at the OPG stations were generally within the same range as the concentrations measured at the DYEC stations. This suggests sources of BAP that are external to the Site as mentioned above for particulate.

For NO_2, there were 3 samples at the East station that exceeded the 1-hour NO_2 CCME CAAQS from May 2022 to August 2022. The hourly NO_2 concentrations did not vary greatly between the two monitoring stations, with the exception of a 3-week period where concentrations at the East station were consistently above those at the West station. These elevated NO_2 concentrations at the East station may have been attributed to overlapping activities associated with the nearby Ministry of Transportation Trailer and Staging and Black and McDonald Bulk Storage projects, which are close to the East Station. At the East station, the 98th percentile of the daily maximum 1-hour average concentrations was 45 ppb, while the CCME CAAQS is 60 ppb. There were no samples with exceedances of the 1-hour NO_2 CCME CAAQS at the West station. There were no samples with exceedances of the 24-hour NO_2 CCME CAAQS at either station.

Though these parameters exceed their respective air quality screening criteria, they are not retained as air COPCs with respect to human health. Under the influence of changing wind directions and meteorological conditions, the DNNP air quality monitoring program is likely to capture sources of pollution external to the DN site from local and regional industry and traffic, including from the nearby SMC, DYEC, Canadian National and Canadian Pacific railways, and Highway 401.

Based on these results, there were no COPCs that were retained in air.

3.1.2.2 Selection of Chemical COPCs in Surface Water

The surface water screening is based on measurements of chemical COPCs in lake water, condensing cooling water (CCW) discharges, and stormwater discharges. In 2020 – 2022, there were no new measurements for lake water or stormwater discharges. Therefore, the 2016 – 2020 data for lake water and stormwater discharge was re-screened against updated guidelines. New data were available for CCW Effluent for 2020 – 2022.

3.1.2.2.1 Lake Water Sampling

Surface water sampling was conducted quarterly (spring, summer, early fall, and early winter) in 2019 (Ecometrix, 2022c). The results of this sampling program were used as the basis for the screening of COPCs in Lake Ontario.

Selection of surface water screening criteria followed the hierarchy depicted in **Figure 3-3**. Maximum measured concentrations were compared to the following criteria, in order of preference:

- The more conservative of:
    - Health Canada (HC) Canadian Drinking Water Quality Guidelines (CDWG) (HC, 2022); or,
    - Ontario Drinking Water Standards (ODWS) for Potable Ground Water (MECP, 2011) and the related GW1 Component Values in Ontario Regulation 153/04;
- Guidelines available from other jurisdictions (e.g., British Columbia Ministry of Environment (BC MOE) Source Drinking Water Quality Guidelines (BC MOE, 2020); United States Environmental Protection Agency (US EPA) Regional Screening Levels (RSLs) for resident tap water - target hazard quotients (THQ) of 0.2) (US EPA, 2023a);
- Modified toxicity values available from other sources (e.g., World Health Organization (WHO) (WHO, 2011); US EPA Integrated Risk Information System (IRIS) (US EPA, 2023b);

HC (HC, 2022)), or background typically found in drinking water (Agency for Toxic Substances and Disease Registry (ATSDR) (ATSDR, 2023);

- 95th percentile background concentrations (based on 2019 data from sampling station SW2 at Cobourg).

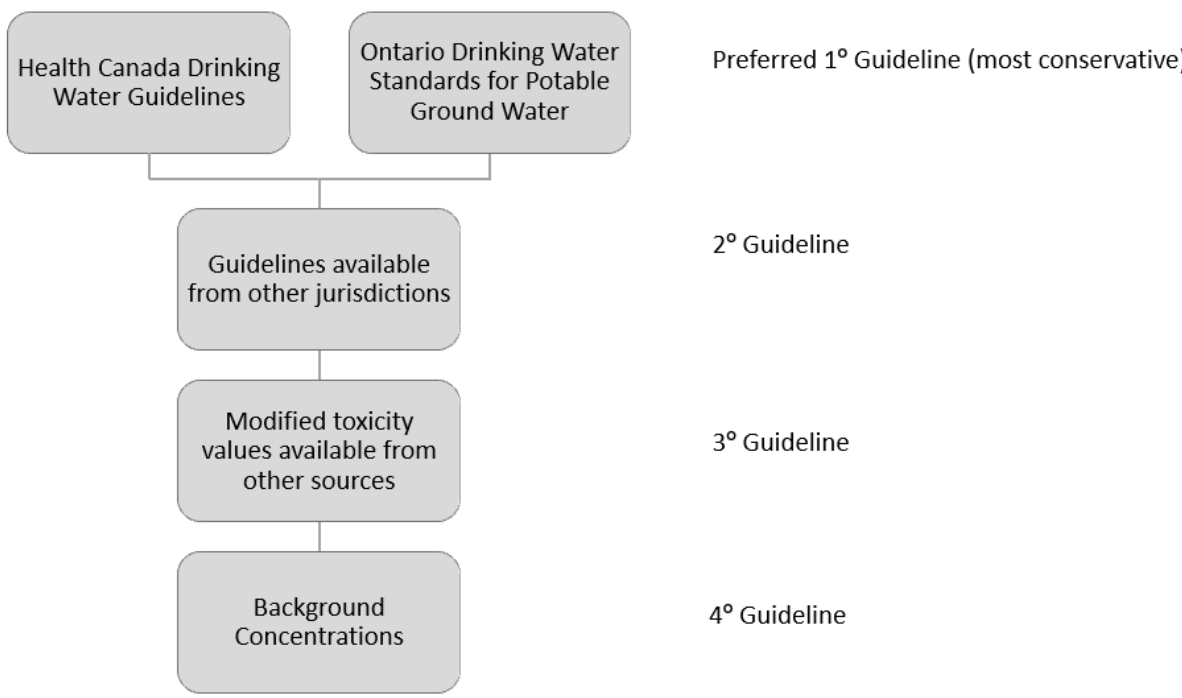

Figure 3-3: Hierarchy of Screening Criteria for HHRA Chemical COPCs in Surface Water

Selections of human health screening criteria are shown in **Table A-3** in Error! Reference source not found.. The results of this screening can be found in **Table A-4** in Error! Reference source not found..

As shown in **Table A-4**, the estimated *Escherichia coli*, fecal coliform, and total coliform bacteria concentrations in Lake Ontario were detectable at 2000, 2000, and 2100 CFU/100mL, respectively, which does not meet the HHRA screening criteria that stipulates these microbial parameters must not be detectable. However, *E. coli*, fecal coliform, and total coliform bacteria are naturally-occurring in the environment and not considered to be hazardous. Furthermore, these microbes are not specifically associated with nuclear facilities and are not released as part of normal DN operations. As such, *E. coli*, fecal coliform, and total coliform bacteria have not been considered as COPCs for human health.

The list of COPCs with concentrations that exceed screening criteria is unchanged from the 2020 ERA. As there was no new concentration data, and no new COPCs based on updated guidelines, there were no COPCs retained in lake water for assessment of human health risks in this Addendum.

3.1.2.2.2 Liquid Effluent Sampling

Clause 0.2.2 and 7.2.5.2 of Canadian Standards Association (CSA) N288.6 discuss screening of liquid effluents, highlighting the relationship of effluent monitoring programs to environmental risk assessment and the screening process. Information from 2020 to 2022 on the concentration of COPCs discharged in liquid effluents into the environment was available from DN Environmental Compliance Approval (ECA) reports. This information was assessed to aid in COPC selection to ensure that the lake water chemical COPC selection was complete.

Waterborne effluent from DN discharged to the CCW duct is diluted through the diffuser as it is released to the lake. Concentrations of COPCs measured in the CCW represent concentrations prior to release to Lake Ontario via the diffuser. Effluent quality results were therefore converted to estimated concentrations in the mixing zone using a dilution factor of 7 at the diffuser (OPG, 2022c).

3.1.2.2.2.1 Monitoring for ECA Requirements

As part of the ECA requirements, the effluent from the CCW is sampled and analyzed for compliance with effluent limits for unionized ammonia, hydrazine, morpholine, pH, and TRC (OPG, 2021b, 2022d, 2023c). For each of these chemicals, the maximum concentration in the mixing zone was estimated based on the maximum measured concentration in the CCW and a dilution factor of 7 at the diffuser (OPG, 2022c). Estimated mixing zone concentrations from 2020 to 2022 were screened against the same screening criteria as the lake water samples.

Hydrazine does not have a HC drinking water guideline nor an ODWS. However, the US EPA estimated that a hydrazine concentration of 0.00001 mg/L corresponds to a cancer risk level of one in one million (1×10^{-6}) (EC and HC, 2011; US EPA, 1988), based on a drinking water intake rate of 2 L/day and no exposure amortization. As shown in **Table A-5** in **Appendix A**, the estimated maximum effluent concentration of hydrazine exceeds the drinking water value of 0.00001 mg/L. Additionally, the maximum concentration of hydrazine estimated in the mixing zone is 0.0011 mg/L, compared to the human health screening level of 0.00001 mg/L. The maximum hydrazine concentration from 2020-2022 of 0.0011 mg/L was greater than the maximum concentration of 0.0009 mg/L from the 2020 ERA. As such, hydrazine from CCW effluent was retained for further assessment of human health risks in this Addendum.

3.1.2.2.2.2 Effluent Characterization

Liquid effluent sampling and analysis were performed in 2016 to provide data for the characterization of non-radiological parameters. OPG is aware that CANDU Owners Group (COG) has carried out a one-time monitoring event of the DNGS effluent streams in 2018; however, given this was a one-time event and the 2016 effluent characterization program was much more comprehensive, the DN ERA Addendum continues to rely on the 2016 effluent characterization.

The 2016 program was part of a follow-up monitoring program from the 2011 Refurbishment and Continued Operation (RCO) EA (OPG, 2013) which included broad spectrum characterization of DN liquid effluents to confirm EA predictions of no residual adverse effects on surface water.

Under the program, five effluent streams were characterized through weekly sampling and chemical analysis for metals, glycols, morpholine, TRC, petroleum hydrocarbons (PHCs), phosphorus and nitrate, alkyl ethoxylates, alkylphenol ethoxylates, and linear alkylbenzene sulphonates (LAS). These streams included radioactive liquid waste (RLW), inactive drainage (IAD; building effluent treatment facility lagoon), boiler blowdown (BB), water treatment plant (WTP), and the condenser cooling water (CCW).

As identified in the 2020 ERA, and still the case based on updated guidelines, no exceedances of screening criteria in the initial mixing zone are expected for the 2016 CCW effluent parameters, as shown in **Table A-6a** and **Table A-6b** in **Appendix A**. As such, no COPCs were carried forward for human health risk assessment in this Addendum.

3.1.2.2.3 Stormwater Sampling

The Stormwater Management System, or Yard Drainage System, collects storm runoff from the entire DN site and discharges to Lake Ontario either directly through the storm sewer drainage system or through drainage swales/creeks via culverts which eventually discharge to the lake. There has been no new stormwater sampling subsequent to the 2020 ERA. The stormwater screening from the 2020 ERA was repeated based on the same data, but with updated human health screening criteria, where available.

Consistent with the 2020 DN ERA, nearshore Lake Ontario concentrations were modelled based on the release and subsequent dilution of stormwater effluent into the lake. The estimated Lake Ontario concentrations were screened against the same human health screening criteria used in the lake water screening. As shown in **Table A-7** in **Appendix A** , the estimated *E. coli*, fecal coliform, and total coliform bacteria concentrations in Lake Ontario exceeded the HHRA screening criteria that stipulates these microbial parameters must be non-detectable. However, *E. coli*, fecal coliform, and total coliform bacteria are naturally occurring in the environment. Furthermore, they are not specifically associated with and are not released by normal operations at the DN site. As such, *E. coli*, fecal coliform, and total coliform bacteria have not been considered as COPCs for human health.

None of the remaining stormwater constituents had estimated Lake Ontario concentrations exceeding the selected human health screening criteria. There was no new stormwater data, and there were no new COPCs identified based on updated guidelines. As such, no further assessment of human health risks related to stormwater were carried out in this Addendum.

3.1.2.3 Selection of Chemical COPCs in Soil

As identified in the 2020 ERA for the human health risk assessment, potential risks from soil were determined to be of little concern. On-site workers, contractors, and visitors are potentially exposed to on-site soil; however, these exposures are considered and controlled through OPG's Environment Health and Safety Managed System Program. Human exposure to contaminants in off-site soil is unlikely, since the results of the air screening show acceptable concentrations for contaminants that could deposit on soil.

Overall, exposure from soil was not carried forward for further analysis in this Addendum.

3.1.2.4 Selection of Chemical COPCs in Groundwater

The DN site has a groundwater protection program (GWPP) and groundwater monitoring program (GWMP) compliant with CSA (2017) N288.7-15 Standard "Groundwater protection programs at Class I nuclear facilities and uranium mines and mills". The GWPP is a comprehensive document that defines groundwater protection goals for the DN site based on site-specific hydrogeological conditions and groundwater end uses that are presented in a conceptual site model (CSM). A systematic planning process is used to design a GWMP that collects the information required to meet each of the GWPP objectives. Groundwater monitoring and reporting follows the design provided in the GWMP.

In the CSM, structures, systems, and components (SSCs) were identified in order to identify high priority SSCs: those which act as potential sources of chemicals to groundwater. Chemicals associated with the SSCs were screened as COPCs for monitoring in the GWMP on the basis of recent groundwater concentrations of those chemicals at the DN site.

OPG executes an annual groundwater monitoring program to understand the groundwater quality beneath the DN site. Based on the results of this program, groundwater on the DN site was found to generally flow toward Lake Ontario or the Forebay. In 2020 to 2022, the groundwater monitoring program included sampling groundwater monitoring wells for tritium, and certain locations for selected hazardous substances, such as PHCs and benzene, toluene, ethylbenzene, and xylenes (BTEX). Analytical results were compared to the MECP Table 3 Standard: "Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act" for 2011, Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition. This comparison was conducted for assessment purposes only, because the Standards are used as a best management practice in this case.

Concentrations of benzene, PHC F2, and PHC F3 in groundwater in the vicinity or downgradient of the Emergency Power Generators, Standby Generators (SGs), and the Construction Boilerhouse have been detected greater than the MECP Table 3 Site Condition Standards. The exceedances of the MECP Standards are limited and are due to naturally occurring hydrocarbons in the petroliferous calcareous shale rather than site operations. Additionally, there are no groundwater supply wells downgradient of potential source areas on-site. As water on the DN site is not used for human consumption, the only on-site pathway for human exposure to groundwater would be from ingestion of water from Lake Ontario after dilution of the groundwater in the lake. Concentrations of potential chemical stressors in off-site drinking water wells are not influenced by DN. As a result, the groundwater pathway is not carried forward for further inclusion in this Addendum.

3.1.2.5 Selection of Chemical COPCs in Lake Sediment

As in the 2020 DN ERA, no direct human health exposure pathways exist between potential chemical COPCs in sediments and the selected human receptors, so no screening of chemicals in sediment for potential human health effects is required. Bioaccumulation of chemicals in fish is likely to be primarily driven by water exposures for the fish, since sediments in areas where human receptors catch fish, such as Lake Ontario in the vicinity of DN, are transient. Lake Ontario in the vicinity of DN is not a depositional environment, as characterized in COG (2013a). As such, the lake water screening is considered sufficient to identify COPCs for human health from fish ingestion.

Overall, exposure from sediment was not carried forward for further analysis in this Addendum.

3.1.2.6 Selection of Radionuclide COPCs

In the 2020 ERA, radiological emissions and effluent releases were identified, along with the sources and patterns over time. Radiological COPCs in air, surface water, soil, groundwater, and sediment were identified. In this Addendum, the radiological dose to the critical receptor for the year 2020, 2021, and 2022 are reported (**Table 3-6**). Supporting information in terms of COPC emissions and how doses were calculated, are specified in the Environmental Monitoring Reports (OPG, 2021c, 2022b, 2023d). Further information regarding radiological COPC screening and radiological dose calculations can be found in the 2020 ERA (Ecometrix, 2022a).

Radionuclide COPCs selected are consistent with those identified as part of the derived release limit (DRL) calculations for the DN Site. Separate medium-specific DRLs were calculated for each radionuclide released to air and to water, but some of these radionuclides were grouped to allow easier screening.

The airborne effluent groups that were used for DN are as follows:

- Elemental tritium (HT),
- Tritium oxide (HTO) as water vapour,
- Noble gas mixtures (noble gases),
- Radioiodine mixed fission products (Imfp),
- Carbon-14 (C-14) as $^{14}CO_2$
- Mixed beta-gamma emitting radionuclides (particulate), and
- Mixed alpha emitting radionuclides (gross alpha).

The liquid effluent release groups that were used for DN are:

- HTO as water,
- Mixed beta-gamma emitting radionuclides (gross beta-gamma),
- C-14 as dissolved carbonate/bicarbonate, and
- Mixed alpha emitting radionuclides (gross alpha).

The limiting radionuclides (i.e., the radionuclide with the most restrictive DRL) for particulates in air and for gross beta-gamma in water were used to represent all radionuclides in each grouping. For particulates in air, Carbon-60 was identified as the limiting radionuclide and for gross beta-gamma in water, Cesium-134 was identified as the limiting radionuclide.

Waste management operations at DN are undertaken in three locations within the DN site, including in two Fueling Facilities Auxiliary Areas (FFAAs; East and West) and the NSS-DWMF. Radiological emissions and effluent releases from the NSS-DWMF were reviewed in the 2020 ERA (Ecometrix, 2022), and the data indicated that the contribution of the NSS-DWMF to dose identified human receptors was negligible. The emissions data available from 2020 to 2022 for the NSS-DWMF and Retube Waste Storage Building (RWSB) perimeter (as reported quarterly in OPG 2020a, 2020b, 2020c, 2021e, 2021f, 2021g, 2021h, 2022e, 2022f, 2022g, 2022h) were reviewed. The average NSS-DWMF fence perimeter air kerma rate from 2016 to 2019 was 0.08 µGy/h, and the average from 2020 to 2022 was 0.086 µGy/h. In 2017, OPG started to transfer retube waste containers loaded with Darlington Storage Overpack from the DNGS to the RWSB as part of the Darlington Refurbishment Project. The perimeter dose rate at the RWSB was monitored from 2017 to 2019, with an average air kerma rate at 0.06 µGy/h. The average RWSB perimeter air kerma rate was 0.067 µGy/h for the period 2020 to 2022. All dose rates are below the dose target rate of 0.5 µGy/h at the NSS-DWMF perimeter fence line.

The emissions data available from 2020 to 2022 for the NSS-DWMF and RWSB perimeter were not markedly different from those assessed in the 2020 ERA; therefore, the conclusion that the doses were negligible in the previous ERA continues to be valid. As such, the dose contribution from the NSS-DWMF was not discussed further in the 2020 ERA and is not retained for evaluation in this Addendum.

3.1.2.7 Selection of Other Stressors

Noise is the only physical stressor mentioned in N288.6:22 as a potential human stressor and is the only physical stressor associated with DN that is of potential concern to humans.

3.1.2.7.1 Noise

The noise environment in the vicinity of DN site is typical of an urban setting and is influenced by several noise sources including DN Generating Station, traffic on Highway 401 and local roads, the Canadian National (CN) rail line, and local industry (e.g., SMC plant and DYEC).

The noise monitoring locations for humans, also known as Point(s) of Reception, located in the vicinity of OPG DN are in an area best described as Class 1 as per MECP publication *"Environmental Noise Guideline, Stationary and Transportation Sources – Approval and Planning"* (NPC 300) (MECP, 2013). This designation is based on the presence of Highway 401 and its consistent contribution to background sound levels in the area. The energy equivalent sound levels for stationary sources in Class 1 areas (L_{eq}) are summarized in **Table 3-1** and used to assess compliance of a facility in accordance with NPC 300.

Table 3-1: Sound Level Limits for Class 1 Areas (MECP, 2013)

Time Period	Class 1 MECP Energy Equivalent Sound Level Limit in A-Weighted Decibels (dBA)
Daytime (07:00 – 19:00)	50
Evening (19:00 – 23:00)	47
Night-time (23:00 – 07:00)	45

2022 acoustic assessment results in support of DNNP are provided in the following two reports:

- Darlington New Nuclear Project (DNNP) Baseline Noise Monitoring – Spring 2022 (OPG, 2022e); and,
- Darlington New Nuclear Project (DNNP) Baseline Noise Monitoring – Fall Report 2022 (OPG, 2023e).

Following an assessment of the 2018/2019 noise monitoring program, the 2020 ERA concluded (see Section 3.1.2.10.1, Ecometrix 2022a) that noise emissions from the DN site are indistinguishable from other, more dominant sources of noise (e.g., Highway 401, other local traffic, and industry). As a result, noise was not considered a physical stressor in the previous human health risk assessment (Ecometrix, 2022a). Noise measurements from the 2018/2019 study (as presented in the 2020 ERA) are again presented here as a comparison to updated noise measurements from the more recent Spring and Fall 2022 studies.

During Spring of 2022, noise monitoring was conducted to update existing noise level measurements at the locations of selected receptors that are closest to the DNNP footprint. The equivalent noise level, including LAeq[1] and LAs90[2], were monitored per the methodology described from the methodology report (OPG, 2021d). The Spring 2022 monitoring was conducted continuously for a week between April 27, 2022, to May 4, 2022.

Acoustic monitoring continued in Fall 2022 following the same methodology as the Spring 2022 program. Points of Reception (POR) for the Fall 2022 program remained consistent with Spring 2022. Noise monitoring in the Fall occurred at the end of November 2022.

The noise receptors were selected to be representative of sensitive PORs in all directions around the DNNP site (**Figure 3-4**). Between the 2018/2019 and the 2022 monitoring events, one additional POR (POR4, also referred to as R20) was added to the monitoring program; this receptor was previously included in noise modelling assessments from the 2009 DNNP EIS (SENES & MMM, 2009). In total, four PORs were identified as sensitive receptors nearest to the DNNP site and were considered in the Noise Monitoring Program (OPG, 2022e) to be representative of sound levels to the west, northwest, north, and east of the DNNP site.

Acoustic monitoring data from Spring and Fall 2022 and a comparison with results from the 2018/2019 acoustic monitoring program are presented in **Table 3-2**. Results of the Spring and Fall 2022 monitoring determined that DNGS is not audible above other noise sources at the receptor locations. Noise impacts at all four PORs in close proximity to the DNNP are mainly

[1] LAeq: A-weighted equivalent continuous sound level, in A-weighted decibels (dBA)
[2] LAs90: the 90th-percentile of the statistical noise level distribution, or the noise level that is exceeded for 90% of the measurement time

attributed to traffic from Highway 401. Partial influence was also noted from local traffic volume and operation of the DNGS, St. Mary's Cement and the Durham York Energy Centre. These findings are consistent with those determined in the 2018/2019 monitoring program.

Table 3-2: Fall and Spring 2022 and 2018/2019 Acoustic Monitoring Results

Location	Minimum Sound Measurement			Maximum Sound Measurement		
	2018/2019 (Leq)	Spring 2022 (LAeq)	Fall 2022 (LAeq)	2018/2019 (Leq)	Spring 2022 (LAeq)	Fall 2022 (LAeq)
POR1 (R15)	46.6	42.3	44.3	62.2	67.1	62.2
POR2 (R19)	51.6	59.9	55.2	69.9	75.8	71.1
POR3 (R23)	46.2	48.7	55.1	62.3	69.4	70.2
POR4 (R20)	57.8 [1]	56.3	58.2	70.4 [1]	72.3	76.4

Notes:
[1] Not measured in 2018/2019; values presented are referenced from Appendix E of the 2009 Atmospheric Environment Existing Environmental Conditions Technical Support Document New Nuclear – Darlington Environmental Assessment (SENES, 2009a)
Leq: the equivalent continuous sound level (in decibels, dB)
LAeq: the A-weighted equivalent continuous sound level (in A-weighted decibels, dBA)
POR: Point of Reception
R: Receptor

Given that noise from the DN site was not distinguishable at offsite receptor monitoring locations in both the 2018/2019 and Spring/Fall 2022 acoustic assessments and given the large contribution of noise at these receptors from roads (particularly Highway 401) and other local industry, noise was not carried forward as a physical stressor for further assessment in the HHRA.

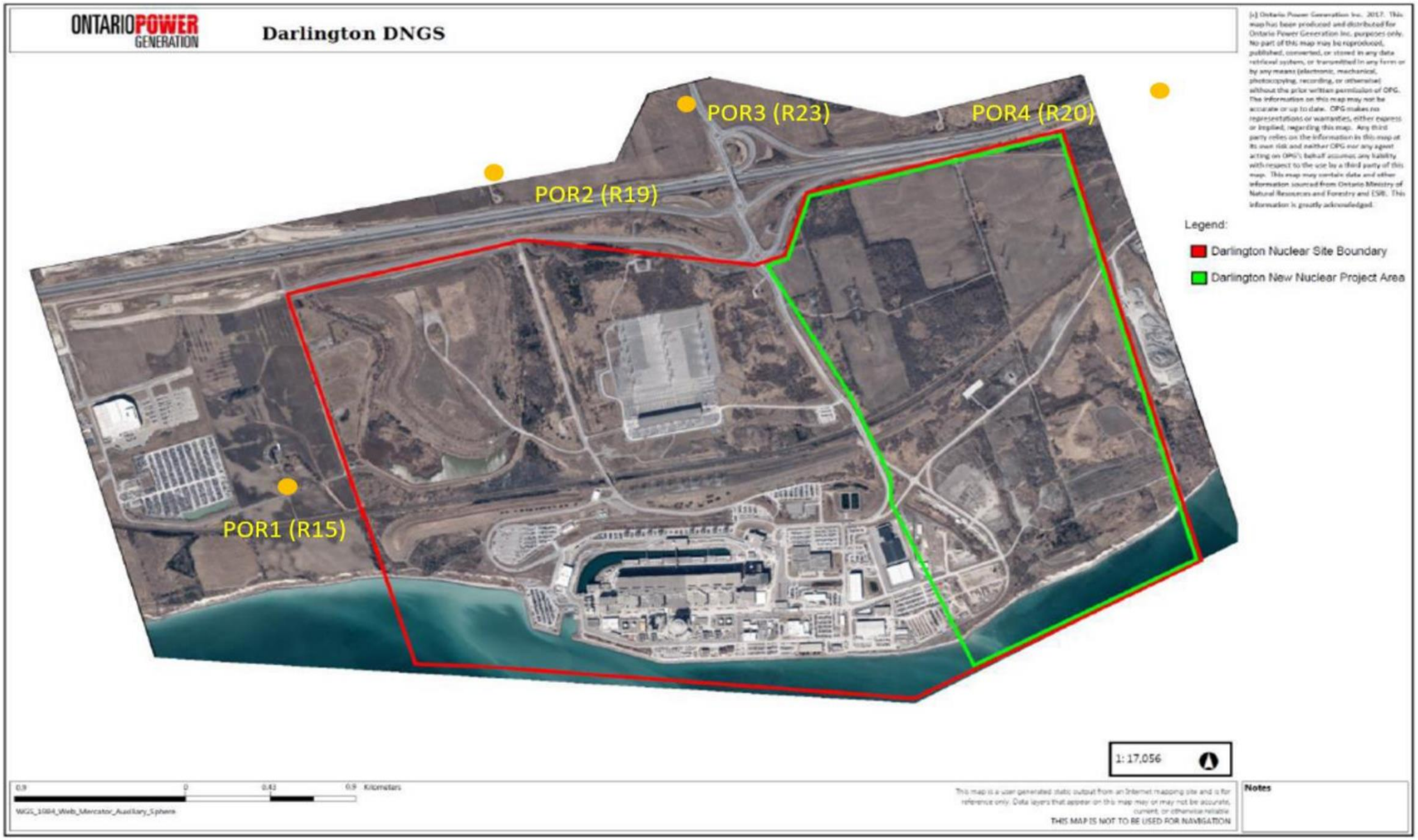

Figure 3-4: Location of Points of Reception (POR1-4)

3.1.2.8 Summary of COPC Selection

For this addendum, human health risks are only calculated if, compared to the 2020 ERA, there is a new COPC or there is a COPC with a higher maximum concentration based on the 2020 – 2022 data. The only chemical COPC retained for evaluation of human health risks is hydrazine in surface water. Radionuclides were evaluated based on the total public dose to the critical receptor. **Table 3-3** summarizes the COPCs that were carried forward to the exposure assessment in this Addendum.

Table 3-3: Summary of COPCs Selected for the HHRA

Category	Radiological COPC	Chemical COPC
Air	C-14, Co-60, HT, HTO, noble gases, Imfp	None
Surface water	C-14, Cs-134, HTO	Hydrazine
Soil	C-14, Co-60, Cs-134, HTO, I-131	None
Groundwater	HTO, I-131	None
Sediment (beach sand)	C-14, Cs-134, HTO	None
Physical Stressors	None	

3.1.3 Selection of Exposure Pathways

Based on the chemical COPC retained for quantitative evaluation in the HHRA (hydrazine in surface water), the relevant exposure pathways evaluated are ingestion of water and ingestion of fish. Dermal (skin) contact with water was not retained as a pathway given exposure via this pathway is low relative to ingestion. The relevant receptors are those that may utilize water from the Bowmanville or Oshawa Water Supply Plants (WSPs), specifically the Oshawa/Courtice Urban Resident, Bowmanville Urban Resident, West/Each Beach Urban Resident, Rural Resident, Industrial/Commercial Worker, and the Camper. Also relevant are those that may consume fish from Lake Ontario, including the Farm, Dairy Farm, Rural Resident, Sport Fisher, and Camper receptors.

Exposure pathways for radionuclides are unchanged from the 2020 ERA (Ecometrix, 2022a).

3.1.4 Human Health Conceptual Model

The conceptual model illustrates how receptors are exposed to COPCs. It represents the relationship between the source and receptors by identifying the source of contaminants, receptor locations and the exposure pathways to be considered in the assessment for each receptor. Exposure pathways represent the various routes by which radionuclides and/or chemicals may enter the body of the receptor, or (for radionuclides) how they may exert effects from outside the body.

The complete conceptual model for DN is provided in the 2020 ERA (Ecometrix, 2022a), which includes radionuclide and chemical COPCs. For this Addendum, the only chemical COPC identified was hydrazine from the CCW effluent. As such, human health risks from this are evaluated for water ingestion and fish ingestion, which are the relevant surface water exposure pathways for CCW effluent. The human health risks assessed for radionuclides include all relevant pathways consistent with the 2020 ERA conceptual model and are evaluated based on the total dose to the critical receptor.

3.1.5 Uncertainties in the Problem Formulation

The uncertainties in the Problem Formulation remain as identified in the 2020 ERA (Ecometrix, 2022a). No new uncertainties were identified based on the new data and guidelines that were evaluated.

3.2 Exposure Assessment

The exposure assessment describes the exposure scenarios (locations, receptors), the methods used in estimating exposure concentrations and doses at the receptor locations, and the results of the exposure and dose calculations for each human receptor.

3.2.1 Exposure Locations

An exposure location is the place where the receptor comes into contact with a COPC. For both the radiological and chemical exposure assessments, the relevant human receptors are the potential critical groups defined by the EMP, as discussed in **Section 3.1**. A map of the receptor locations is provided in the 2020 ERA (Ecometrix, 2022a) and the EMP (OPG, 2023d) reports.

3.2.2 Exposure Duration and Frequency

The assumptions made for exposure duration and frequency are presented in **Section 0**.

3.2.3 Exposure and Dose Calculations

3.2.3.1 Radiological Dose Calculations

Radiological dose calculations follow the equations presented in N288.1:20 (CSA, 2020), which are not reproduced in this report.

3.2.3.2 Chemical Dose Calculations

The ingestion doses from exposure to hydrazine in drinking water and fish were calculated according to the equations presented in N288.6:22 (CSA, 2022).

3.2.4 Exposure Factors

3.2.4.1 Radiological Exposure Factors

For the radiological dose calculations, the exposure factors (e.g., intake rates, occupancy, and shielding factors, etc.) are generally those used in CSA N288.1:20. The intake rates for ingestion and inhalation are generally the central or mean intake rates provided in CSA N288.1:20 and the COG Derived Release Limits Guidance (COG, 2013b). The radiological exposure factors are provided in the 2020 ERA and not reproduced herein.

3.2.4.2 Non-Radiological Exposure Factors

Based on the results of the screening, the human exposure assessment was performed for the drinking water and fish ingestion pathways for hydrazine.

For non-radiological dose calculations, exposure factors are generally those from HC Preliminary Quantitative Risk Assessment (PQRA) guidance (HC, 2021b), as recommended by Clause 6.3.5 of CSA N288.6:22. **Table 3-4** summarizes the exposure factors used in the non-radiological dose calculations.

For surface water, each receptor was assumed to obtain a portion of their drinking water and/or fish from near the DN site. The assumed fractions of the total drinking water obtained from local WSPs and total fish obtained near DN site were based on the results of the site-specific survey (OPG, 2018). These fractions are tabulated in **Table 3-5**.

3.2.5 Dispersion Models

OPG uses IMPACT™ version 5.5.2 (IMPACT) to calculate its annual public radiological doses using a mixture of environmental monitoring data and emissions data. IMPACT represents the method of dose calculation presented in CSA N288.1:20. Where environmental monitoring data were lacking, the concentration of radionuclides in air was determined from the sector-averaged Gaussian plume atmospheric dispersion model in IMPACT, based on the release rates from DN. The 2020 ERA (Ecometrix, 2022a) shows a summary of which radionuclides and pathways were modelled and where measured data were used.

Table 3-4: Human Exposure Factors for Non-Radiological Dose Calculations

Parameter	Units	Urban Resident		Farm		Rural Resident		Industrial/ Commercial Worker	Sport Fisher		Camper		Reference
		Toddler	Adult	Toddler	Adult	Toddler	Adult	Adult	Toddler	Adult	Toddler	Adult	
Drinking Water Intake Rate	L/d	0.6	1.5	0.6	1.5	0.6	1.5	1.5	N/A	N/A	0.6	1.5	(HC, 2010)
Fish Ingestion Rate	kg/d	0.056	0.111	0.056	0.111	0.056	0.111	N/A	0.056	0.111	0.056	0.111	(HC, 2004)
Days per Week Exposed /7 days per week (D2)	d/ d	1	1	1	1	1	1	1	N/A	N/A	1	1	(OPG, 2021i)
Weeks per Year Exposed /52 weeks per year (D3)	wk/wk	1	1	1	1	1	1	0.23	N/A	N/A	0.5	0.5	(OPG, 2021i)
Years Exposed (D4)	years	N/A	30	N/A	30	N/A	30	30	N/A	30	N/A	30	(HC, 2004)
Days per year with consumption of fish	d/a	365	365	365	365	365	365	N/A	365	365	365	365	(OPG, 2021i)
Body Weight	kg	16.5	70.7	16.5	70.7	16.5	70.7	70.7	16.5	70.7	16.5	70.7	(HC, 2010)
Life Expectancy	years	N/A	70	N/A	70	N/A	70	70	N/A	70	N/A	70	(HC, 2010)
$RAF_{GIThydrazine}$	unitless	1	1	1	1	1	1	1	1	1	1	1	conservative assumption

RAF_{GIT} = Relative absorption factor for the gastrointestinal tract for hydrazine.

Table 3-5: Assumed Fractions of Drinking Water from WSPs and Fish from DN Outfall (OPG, 2021i)

Media	Urban Resident Oshawa/Courtice	Urban Resident Bowmanville	Urban Resident West/East Beach	Farm	Dairy Farm	Rural Resident	Industrial/ Commercial Worker	Sport Fisher	Camper
Water	0.834	0.785	0.142	0.05	0	0.158	1	0	1
Fish	0.1136	0.0061	0.1183	0.0518	0.0103	0.035	0	1	0.5

3.2.6 Exposure Point Concentrations and Doses

3.2.6.1 Exposure Point Concentrations and Doses for Radiological COPCs

For the radiological exposure assessment, exposure point concentrations are either based on measured data from the annual EMP or modelled from emissions data, as described in the 2020 EMP Report (OPG, 2021c). Additionally, when measurement averages or other calculations are performed, they are calculated using actual results obtained even if they are below the critical level (OPG, 2021c). As mentioned above, OPG uses IMPACT™ version 5.5.2 (IMPACT) to calculate its annual public doses using a mixture of environmental monitoring data and emissions data. **Table 3-6** presents a summary of the annual doses to the three most exposed critical groups from 2020 to 2022. These doses were calculated using annual average measured and modelled concentrations in environmental media. It is noted that these doses incorporate any emissions from the Molybdenum-99 (Mo-99)/TDS, which has been operational since 2023.

The annual average dose to the three most exposed critical groups during the three-year period of interest (2020 to 2022) ranged from 0.1 to 0.6 µSv. From 2020 to 2022, the most exposed critical groups were the dairy farm, farm, and rural residents. The dominant pathways and radionuclides that contribute significantly to the total dose are inhalation and ingestion of HTO in air and in water, plants, and animal products; external exposure to noble gases; and ingestion of C-14 in plants and animal products.

The dose to the most exposed critical groups over the 2020 to 2022 time period remained relatively consistent, and the doses have remained largely unchanged for the past ten years (OPG, 2023d).

Table 3-6: Summary of Doses to Most Exposed Critical Groups from 2020 to 2022

Year	Age Class	Radiological Dose (µSv/a)		
		Dairy Farm	Farm	Rural Resident
2020	Adult	0.2	0.4	0.3
	Child	0.2	0.4	0.2
	Infant	0.2	0.3	0.1
2021	Adult	0.2	0.6	0.3
	Child	0.1	0.6	0.3
	Infant	0.1	0.4	0.2
2022	Adult	0.2	0.6	0.3
	Child	0.3	0.5	0.2
	Infant	0.4	0.4	0.2

Sources: (OPG, 2021c, 2023f, 2023d)

3.2.6.2 Exposure Point Concentrations and Doses for Chemical COPCs

The exposure point concentrations are based on the screening conducted during problem formulation. For hydrazine, data were screened based on CCW data from the ECA from 2020 to

2022 (hydrazine). The overall maximum and mean concentration from the ECA were used for the exposure assessment. The dose to receptors due to ingestion of fish exposed to hydrazine assumes a continuous release.

3.2.6.2.1 Exposure Point Concentrations in and Doses from Surface Water

Maximum and mean measured concentrations in CCW effluent were diluted using the estimated dilution factors from OPG (2022c) in order to estimate exposure point concentrations for hydrazine, as follows:

- A dilution factor of 7 was applied to measured CCW effluent to estimate a concentration in Lake Ontario at the Outfall;
- A dilution factor of 34.7 was applied to the CCW effluent to estimate a concentration at the Bowmanville WSP; and,
- A dilution factor of 35.6 was applied to the CCW effluent to estimate a concentration at the Oshawa WSP.

The WSP dilution factors were calculated using the CSA N288.1:20 aquatic dispersion model (CSA, 2020), which is an approved method of estimating dilution factors. Additional model parameter values used in the calculations are provided in the 2020 ERA.

At a pH of 8 (representative of the typical pH observed in Lake Ontario near DN), the chemical half-life of hydrazine ranges from 0.6 to 1.31 days (EC and HC, 2011). Considering dilution along the flowpath from DN to the WSPs, and using the longer half-life for hydrazine, calculations of exposure point concentrations are carried out accounting for dilution and decay, starting from CCW concentrations of hydrazine at the discharge point (**Table 3-7**). Considering the dilution along the flowpath in Lake Ontario, the hydrazine concentration estimated at the WSPs would range from 0.003 to 0.013 µg/L at the Bowmanville and Oshawa WSPs (**Table 3-8**). The hydrazine concentration at the Oshawa WSP is slightly greater than the hydrazine drinking water benchmark of 0.01 µg/L (US EPA, 2023b).

The conditions within the Bowmanville and Oshawa WSPs during water treatment favour the degradation of hydrazine. The water treatment process involves chlorinating the process water at several distinct points through the addition of sodium hypochlorite, which is an alkaline substance expected to raise the pH at those steps. pH is then adjusted through the addition of sulfuric acid (Durham Region, 2022a, 2022b). Hydrazine degradation is highly influenced by pH; alkaline conditions favour its degradation (Choudhary and Hansen, 1998). Additionally, degradation of hydrazine occurs through oxidation in the presence of oxygen; the reaction tends to be catalyzed (i.e., sped up) in the presence of certain compounds like Copper (II) and phosphate ions, which are likely to be present in some amount in drinking water. Hydrazine degradation is also favoured in the presence of organic matter, which also is likely to be present in drinking water. Hydrazine was found to decrease by more than 90% when added to chlorinated, filtered county water after 1 day (Choudhary and Hansen, 1998). As such, it was considered reasonable to assume that 90% of the starting concentration of hydrazine at the

Bowmanville and Oshawa WSP intakes would be degraded upon use by off-site members of the public.

The maximum and mean exposure point concentrations for hydrazine are presented in **Table 3-8** using CCW data. The mean exposure point concentrations are more representative of concentrations at WSPs than the maximum concentrations because mean concentrations reflect expected exposure over the long-term. Based on these exposure point concentrations, and using the equations presented in **Section 3.2.3.2** and the receptor characteristics presented in **Section 3.2.4.2**, surface water doses were estimated for each receptor. These doses are presented in **Table 3-9** for hydrazine.

Table 3-7: Summary of Exposure Point Concentrations of Hydrazine in Surface Water

COPC	Lake Water (mg/L)		Effluent (ECA) (mg/L)		Dilution Factors[b]			
	Maximum Concentration	UCLM Concentration	Maximum Concentration	Mean[a] Concentration	Outfall	Beach	Bowmanville WSP	Oshawa WSP
Hydrazine (CCW)	-	-	0.0076	0.0019	7	10.9	34.7	35.6

Notes:
[a] Hydrazine concentrations from the CCW are based on mean concentrations, since raw data to calculate UCLM concentrations were not available.
[b] Dilution factors are described in Section 3.2.6.2.1.

Table 3-8: Maximum and Mean Exposure Point Concentrations for Hydrazine in Surface Water

COPC	Estimated Point of Exposure Concentrations (mg/L)							
	Outfall		Beach		Bowmanville WSP		Oshawa WSP	
	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean
Hydrazine (CCW) decayed $t_{1/2}$ = 1.3 days	1.09E-03	2.70E-04	6.17E-04	1.53E-04	1.32E-05	3.29E-06	1.21E-05	3.01E-06

Table 3-9: Summary of Estimated Doses Due to Ingestion of Maximum and Mean Hydrazine Concentrations in Surface Water

Receptor Group		Dose (mg/kg/d)	
		Hydrazine (CCW) decayed t½ = 1.3 days	
		Max	Mean
Urban Resident Oshawa/Courtice	Toddler	-	-
	Adult	9.19E-08	2.29E-08
Urban Resident Bowmanville	Toddler	-	-
	Adult	9.44E-08	2.35E-08
Urban Resident West/East Beach	Toddler	-	-
	Adult	1.71E-08	4.25E-09
Farm	Toddler	-	-
	Adult	6.01E-09	1.50E-09
Rural Resident	Toddler	-	-
	Adult	1.90E-08	4.73E-09
Industrial / Commercial Worker	Adult	2.77E-08	6.88E-09
Camper	Toddler	-	-
	Adult	5.51E-08	1.37E-08

3.2.6.2.2 Exposure Point Concentrations in and Doses from Fish

Hydrazine is released into the atmosphere through boiler steam releases and venting; given that hydrazine tends to degrade rapidly in the atmospheric environment, atmospheric releases are typically negligible as a contribution to aquatic exposures (EC, 2013). Hydrazine is also discharged into the aquatic environment through BB and flushing to the intake forebay. Furthermore, hydrazine is added to the feedwater for oxygen removal. For this assessment, it was conservatively assumed that hydrazine is released to the aquatic environment on an on-going basis.

The Camper, Sport Fisher, and West-East Beach resident are assumed to ingest local fish, based on site specific surveys that have been carried out (OPG, 2022c). Since several human receptors are potentially exposed to chemical COPCs through fish ingestion, the fish tissue concentrations for hydrazine were estimated using a bioconcentration factor (BCF), which has been updated based upon a detailed review of the available literature on quantitative structure-activity relationship (QSAR). The European Commission (European Commission, 2003) provides guidance on estimating uptake from water to fish for a range of log K_{ow} values; for log K_{ow} = 1, a log BCF of 0.15 L/kg (or BCF = 1.4 L/kg) is recommended based upon Veith et al. (Veith et al., 1979). As this value is well-supported and recommended by a leading authority on risk assessment guidance, it was selected for use in the DN ERA Addendum. It is noted that this selected value is lower than the value previously used of 3.2 L/kg (Meylan et al., 1999) by approximately 50% (thus reducing the estimated exposure doses). The use of the lower BCF is also considered to be more representative of the expected uptake and retention into tissues considering that hydrazine is released intermittently rather than steadily; therefore, there is opportunity for tissue clearance in fish in between scheduled releases of hydrazine from the outfall. A summary of exposure point concentrations of hydrazine in fish is presented in **Table 3-10**.

The resulting estimated exposure point concentrations for fish are presented in **Table 3-11**. Based on these exposure point concentrations, and using the equations presented in **Section 3.2.3.2** and the receptor characteristics presented in **Section 3.2.4.2**, fish ingestion doses were estimated for each receptor. These doses are presented in **Table 3-12**. Dose calculations are provided based on maximum and mean concentrations of hydrazine measured in the CCW.

Table 3-10: Summary of Exposure Point Concentrations of Hydrazine in Fish

COPC	Estimated Water Concentrations Estimated at Outfall (mg/L)		Bioconcentration Factor (BCF) (L/kg)	Estimated Fish Concentrations Estimated at Outfall (mg/kg)	
	Maximum Concentration	Mean Concentration		Maximum Concentration	Mean Concentration
Hydrazine (CCW) decayed t½ = 1.3 days	1.09E-03	2.70E-04	1.4	1.5E-03	3.8E-04

Table 3-11: Maximum and UCLM Concentration of Hydrazine in Fish

COPC	Estimated Water Concentrations Estimated at Beach (mg/L)		Bioconcentration Factor (BCF) (L/kg)	Estimated Fish Concentrations Estimated at Beach (mg/kg)	
	Maximum Concentration	UCLM[a] Concentration		Maximum Concentration	UCLM[a] Concentration
Hydrazine (CCW) decayed t½ = 1.3 days	6.17E-04	1.53E-04	1.4	8.71E-04	2.17E-04

Notes:
[a] Hydrazine concentrations from the CCW are based on mean water concentrations, since raw data to calculate UCLM concentrations were not available.

Table 3-12: Summary of Estimated Doses Due to Ingestion of Maximum and Mean Hydrazine Concentrations in Fish

Receptor Group		Dose (mg/kg/d)	
		Hydrazine (CCW) decayed t½ = 1.3 days	
		Max	**Mean**
Urban Resident West/East Beach	Toddler	-	-
	Adult	1.22E-07	3.04E-08
Sport Fisher	Toddler	-	-
	Adult	1.03E-06	2.57E-07
Camper	Toddler	-	-
	Adult	2.93E-07	7.29E-08

3.2.7 Uncertainties in the Exposure Assessment

The uncertainties in the exposure assessment remain unchanged from the 2020 ERA (Ecometrix, 2022a). There continues to be uncertainty with the approach to select and derive a water-to-fish BCF for hydrazine given that the BCF is based upon QSAR equations rather than chemical-specific uptake data. No new sources of uncertainty were introduced with the data from 2020 to 2022 that was used in the exposure assessment (**Appendix A**).

3.3 Toxicity Assessment

3.3.1 Toxicological Reference Values (TRVs)

A toxicity reference value (TRV) is a toxicological index, associating specific health effects with a level of exposure to a chemical. TRVs may include slope factors and unit risks for carcinogens, and reference doses (RfD), tolerable daily intakes (TDI), or acceptable daily intakes for non-carcinogens. TRVs are used in the risk characterization to determine Incremental Lifetime Cancer Risks (ILCRs) and Hazard Quotients (HQs), as discussed in **Section 3.4.1.2**.

Hydrazine is classified by the International Agency for Research on Cancer (IARC) as a Group 1A carcinogen and the US EPA as a Group B2 carcinogen (probable human carcinogen), and by the European Commission as Category 2 for carcinogenicity (should be regarded as if it is carcinogenic to man). Studies showed tumor induction in mice, rats and hamsters following administration of hydrazine via inhalation (1.3 and/or 6.5 mg/m^3) and in mice treated orally (1.87 mg/kg bw/day) (EC and HC, 2011). The US EPA (1991) has derived an oral slope factor of 3.0 $(mg/kg\text{-}day)^{-1}$ for human ingestion of hydrazine based on a 1970 study by Biancifiori on liver cancer in mice exposed to hydrazine sulphate orally.

3.3.2 Radiation Dose Limits and Targets

The public dose limit for radiation protection is 1 mSv/a, as described in the Radiation Protection Regulations under the *Nuclear Safety and Control Act*. This limit is defined as an incremental dose to background. It is set at a fraction of natural background exposure to radiation. Public doses arising from licensed facilities are compared to the public dose limit and higher doses are considered unacceptable.

3.3.3 Uncertainties in the Toxicity Assessment

The uncertainties in the toxicity assessment remain unchanged from the 2020 ERA (Ecometrix, 2022a). The same TRV for hydrazine was adopted, and the same public dose limit was used.

3.4 Risk Characterization

3.4.1 Risk Estimation

3.4.1.1 Risk Estimation for Radiological COPCs

For radionuclides, the total doses presented in **Table 3-6** are compared to the public dose limit of 1 mSv/a, as discussed in **Section 3.3.2** above.

3.4.1.2 Risk Estimation for Chemical COPCs

To characterize potential risks due to chemical COPCs quantitatively, the results of the exposure and toxicity assessments were used to estimate ILCRs for each receptor. For carcinogenic substances such as hydrazine, the estimated oral exposure was multiplied by a slope factor, to derive a conservative estimate of the potential ILCR, as follows:

$$\text{ILCR} = \text{Estimated Oral Exposure} \times \text{Cancer Slope Factor}$$

The estimated ILCRs were compared to a target cancer risk of 1 in 1,000,000 or 10^{-6}, as recommended by Clause 6.5.2.4 in CSA N288.6:22. This level is consistent with the acceptable risk level used by the Ontario MECP (MECP, 2011) and the US EPA (2005). At this risk level, health impacts are considered to be negligible. Other agencies, such as HC use a target cancer risk of 1 in 100,000 or 10^{-5}. However, a range of cancer risk levels between 1 in 10,000 and 1 in 1,000,000 may be considered acceptable (HC, 2021a).

Summaries of the ILCRs for surface water ingestion are presented in **Table 3-13**, and those for fish ingestion are presented in **Table 3-14**.

Table 3-13: Summary of Estimated Risk Due to Ingestion of Maximum and Mean Hydrazine Concentrations in Surface Water

Receptor Group		Incremental Lifetime Cancer Risks (ILCR) (unitless)	
		Hydrazine (CCW) decayed t½ = 1.3 days	
		Max	Mean
Urban Resident Oshawa/Courtice	Toddler	-	-
	Adult	3E-07	7E-08
Urban Resident Bowmanville	Toddler	-	-
	Adult	3E-07	7E-08
Urban Resident West/East Beach	Toddler	-	-
	Adult	5E-08	1E-08
Farm	Toddler	-	-
	Adult	2E-08	4E-09
Rural Resident	Toddler	-	-
	Adult	6E-08	1E-08
Industrial / Commercial Worker	Adult	8E-08	2E-08
Camper	Toddler	-	-
	Adult	2E-07	4E-08

Table 3-14: Summary of Estimated Risk Due to Ingestion of Maximum and Mean Hydrazine Concentrations in Fish

Receptor Group		Incremental Lifetime Cancer Risks (ILCR) Hydrazine (CCW) decayed t½ = 1.3 days	
		Max	Mean
Urban Resident West/East Beach	Toddler	-	-
	Adult	4E-07	9E-08
Sport Fisher	Toddler	-	-
	Adult	**3E-06**	8E-07
Camper	Toddler	-	-
	Adult	9E-07	2E-07

Notes:
Grey shading and bold font indicates when the risk exceeds the associated target value. Cancer Risk > 1E-06.

3.4.2 Discussion of Chemical and Radiation Effects

Discussion regarding health indicators in the Durham Region was provided in the 2020 ERA (Ecometrix, 2022a). One additional study since the 2020 ERA is discussed herein. Population health assessments have been conducted by the Durham Region (DRHD, 2023), who focused on analysis by Health Neighbourhood and presented a broad range of health data. DNGS falls within the Darlington (C6) Clarington Health Neighbourhood. The C6 Health Neighbourhood follows the boundaries of the old county of Darlington, excluding the town areas of Courtice and Bowmanville. It extends from Lake Ontario in the south to the Scugog border in the north. The west side is along the City of Oshawa and the eastern boundary is Regional Road 42 (Darlington-Clarke Townline Road). **Figure 3-5** below shows the boundary of the C6 Health Neighbourhood (outlined in blue) and the approximate location of the DN site relative to the rest of the Durham Region. For the year 2016, compared to the Durham Region, residents in this Health Neighbourhood have similar or lower rates for health indicators such as asthma, diabetes, lung disease, and cardiovascular disease. The population residing in Health Neighbourhood C6 are generally found to be doing similar or better in terms of health compared to the rest of Durham Region (DRHD, 2023).

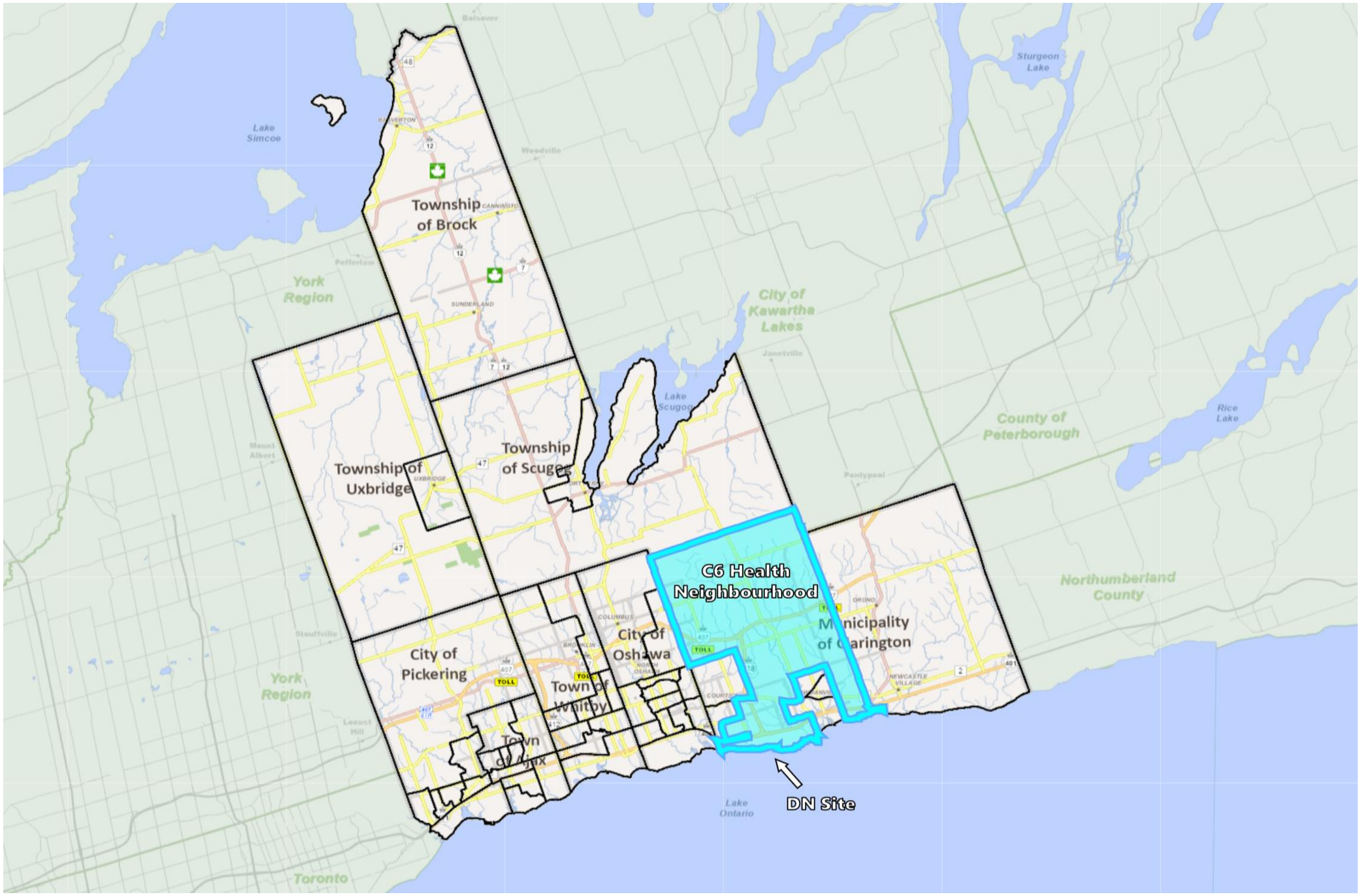

Figure 3-5: Health Neighbourhoods in Durham Region (DRHD, 2023)

3.4.2.1 Likelihood of Effects

3.4.2.1.1 Likelihood of Effects from Radiological COPCs

The 2020-2022 public dose estimates for the critical groups are at most approximately 0.06% of the regulatory public dose limit of 1 mSv/a, and at most approximately 0.04% of the dose from background radiation (1.4 mSv/a) in the vicinity of DN. In the 2020 ERA, dose estimates were 0.08% of the public dose limit and 0.06% of background. Since the critical group receives the highest dose from DN, demonstration that they are protected implies that other receptor groups near DN are also protected.

Facility releases are considered to be adequately controlled, and further optimization of DN operations is not required. Nevertheless, the ALARA (as low as reasonably achievable) principle is applied at DN to keep emissions as low as reasonably possible.

Since the dose estimates are a small fraction of the public dose limit and natural background exposure, no discernable health effects are anticipated due to exposure of potential groups to radiological releases from DN.

3.4.2.1.2 Likelihood of Effects from Chemical COPCs

Surface Water – Ingestion

The estimated ILCRs for hydrazine for surface water ingestion based on mean and maximum hydrazine concentrations in the CCW were below the one in one million cancer risk level for all human receptors. Given that ILCRs for all of the receptors, based on mean and maximum hydrazine concentrations measured in the CCW, are below one in a million, adverse effects to humans due to hydrazine originating from DN through surface water ingestion are not expected. Risks are lower than in the 2020 ERA (Ecometrix, 2022a). Although the CCW concentrations were greater compared to the 2020 ERA, a 90% decay factor for hydrazine at the WSPs was applied in this assessment.

Surface Water – Fish Ingestion

The resulting estimated ILCRs did not exceed one in one million for any human receptor due to exposure to mean concentrations of hydrazine in fish.

While exposure to maximum concentrations of hydrazine in fish resulted in ILCRs greater than one in one million for the Sport Fisher, the maximum is not considered representative of long-term exposure, and results should be interpreted based on the mean. The Sport Fisher was conservatively assumed to eat all of the fish portion of their annual diet from Lake Ontario fish caught at DN. Realistically, a fisher would likely visit and harvest fish from various locations throughout the year including those unaffected by DN emissions. It is also likely that a portion of a fisher's annual diet could consist of fish that is purchased rather than locally caught. As such, adverse effects on humans due to hydrazine originating from DN through fish ingestion are not expected. Risks for fish ingestion are lower than those presented in the 2020 ERA

(Ecometrix, 2022a); while there was an increase in mean and maximum hydrazine concentrations in the CCW, an updated water-to-fish bioconcentration factor was adopted for the Addendum which resulted in a net reduction in exposure and risk.

As discussed in **Table 1-**, a recommendation from the 2020 ERA was to analyze Lake Ontario surface water samples for hydrazine with a lower detection limit (Ecometrix, 2022a). Given that the expected risks due to water and fish ingestion are negligible, no further recommendation on sampling is required. OPG will explore the availability of hydrazine analysis at a lower detection limit if future monitoring programs are identified.

3.4.3 Uncertainties in the Risk Characterization

Uncertainties in the characterization of risk remain as presented in the 2020 ERA (Ecometrix, 2022a). No new sources of uncertainty were introduced based on the data / information evaluated in this Addendum.

4.0 Ecological Risk Assessment (EcoRA)

The EcoRA is a process that evaluates the potential for adverse effects and risks to ecological receptors (plants, animals, etc.) that may be exposed to chemical and radiological contaminants.

Similar to the HHRA, the EcoRA consists of the following steps:

- Problem Formulation;
- Exposure Assessment;
- Toxicity Assessment; and
- Risk Characterization.

4.1 Problem Formulation

The Problem Formulation defines the problem to be addressed in the EcoRA and the framework and general methodology by which the EcoRA will address the defined problem (FCSAP, 2012). During the problem formulation stage, decisions are made on which COPCs and receptors should be further evaluated in the EcoRA. For this Addendum, the focus is on any new contaminants or contaminants with higher maximum concentrations than in the 2020 ERA, for which ecological health risks will be evaluated.

The EcoRA focuses on the DN site and surrounding area, as shown in **Figure 4-1**. The assessment has been divided into polygons, generally consistent with past EcoRAs. The assessment also looks at nearshore Lake Ontario, generally in the area surrounding the outfall from the DN diffuser.

Figure 4-1: Area of Assessment for Ecological Risk Assessment

4.1.1 Receptor Selection and Characterization

The receptors remain unchanged from the 2020 ERA (Ecometrix, 2022a). The ecological receptors were selected based on the criteria for receptor selection identified in N288.6:22. Species were selected to represent each major plant and animal group, reflecting the main ecological exposure pathways, feeding habits, and habitats at or around the site. The criteria for selection began with the previous rationale outlined in the 2020 ERA and was supplemented with recently completed site studies (e.g., biodiversity reports) and recent regulatory information (e.g., Species at Risk status). Species that were ecologically similar to other species and could be represented by another species were not included in the assessment to reduce redundancy in the exposure calculations. Some receptors are considered as a general category or species, such as benthic invertebrates. This is common practice in EcoRAs to assess the benthic community as a single receptor rather than individual benthic invertebrate species since it is not feasible or practical to assess individual species. However, conservative toxicity benchmarks are used that are protective of the majority of species.

Table 4-1 shows the ecological receptors chosen for assessment and the assessment models used in estimating their COPC exposure, dose, and risk. These organisms are selected because they are known to exist on the site and are representative of major taxonomic groups or exposure pathways, or have a special importance or value. For the full list of species considered in the EcoRA and the rationale for the selection of Representative Species, please refer to Table 4-1 in the 2020 ERA (Ecometrix, 2022a). The 2020 ERA also includes the full list of species observed on-site and identifies which selected ecological receptor represents the observed species.

Small-bodied forage fish are not identified as a specific ecological receptor; however, all fish assessed in the EcoRA are assumed to spend 100% of their time in the vicinity of DN, near the diffuser. Therefore, the results for large-bodied fish would be applicable for small-bodied fish.

Table 4-1: Summary of Ecological Receptors and their Assessment Models used in the EcoRA

Receptor Category	Assessment Model	Major Plant or Animal Group	Representative Species
Fish	Bottom Feeding Fish	Benthopelagic forage fish	Northern Redbelly Dace
		Benthic forage fish	Round Whitefish
		Benthic forage fish	White Sucker
		Benthic predator fish	American Eel
	Pelagic Fish	Pelagic forage fish	Alewife
		Pelagic predator fish	Lake Trout
Reptiles and Amphibians	Bottom Feeding Fish	Reptile	Turtles
		Amphibian	Frogs
Aquatic Plants	Aquatic Plant	Aquatic Plants	Aquatic Plants

Receptor Category	Assessment Model	Major Plant or Animal Group	Representative Species
Aquatic Invertebrates	Benthic Invertebrate	Benthic Invertebrates	Benthic Invertebrates
Riparian Birds	Bufflehead	Diving bird - omnivore	Bufflehead
	Mallard	Dabbling bird – omnivore	Mallard
	Green Heron	Piscivore	Green Heron
Riparian Mammals	Muskrat	Herbivore	Muskrat
Terrestrial Invertebrates	Soil Invertebrate	Soil dwelling detrivore	Earthworm
Terrestrial Birds	American Robin	Ground feeding insectivore	American Robin
	Bank Swallow	Aerial insectivore	Bank Swallow
	Song Sparrow	Omnivore	Song Sparrow
	Yellow Warbler	Insectivore	Yellow Warbler
Terrestrial Plants	Terrestrial Plant	Grass	Grass
	Terrestrial Plant	Deciduous tree	Sugar Maple
Terrestrial Mammals	Eastern Cottontail	Mammalian herbivore	Eastern Cottontail
	Meadow Vole	Mammalian herbivore	Meadow Vole
	White-tailed Deer	Mammalian herbivore	White-tailed Deer
	Common Shrew	Mammalian insectivore	Common Shrew
	Raccoon	Mammalian omnivore	Raccoon
	Red Fox	Mammalian carnivore	Red Fox
	Short-tailed Weasel	Mammalian carnivore	Short-tailed Weasel

4.1.1.1 Consideration of Species at Risk

The list of identified Species at Risk from the 2020 ERA (Ecometrix, 2022a) was updated based on new data from 2020 to 2022 and is reported on in **Section 2.4.6.2**. A number of threatened and endangered species were identified within the DN Site Study Area during the 2020 to 2022 time period. If a species is listed as Endangered (i.e., a species that is facing imminent extirpation or extinction) or Threatened (i.e., a species that is likely to become an endangered species without protective action) by either COSEWIC, SARA, or Species at Risk in Ontario (SARO), this species is included in **Table 4-2**. There are both general and species-specific prohibitions outlined by SARA that apply to species designated as either Endangered or Threatened. However, as the general prohibitions under SARA do not apply to species of Special Concern, and CSA N288.6 identifies a population level risk assessment as appropriate for species of Special Concern, the status of “Special Concern” is not listed in **Table 4-2**.

Exposure models for specific assessment of these species are typically lacking due to gaps in the eco-toxicological literature. Species at Risk can be assessed by reference to representative species for the EcoRA (**Table 4-1**). The ecological receptors (or their representative species) are selected with consideration for receptor characteristics (body weight, food ingestion rates, dietary habits) that are representative (i.e., expected to result in estimated doses that would be similar to other members of the group). Therefore, the estimated doses for the representative ecological receptor are expected to be similar to the doses for the individual species within that group. Detailed justifications for selections of each of the representative species, based on habitat, diet, and ecological niche considerations, are presented below.

Table 4-2: Representative Species for Identified Species at Risk (2020 – 2022)

Common Name (*Scientific Name*)	Category	Representative Species	Last Observed in Biodiversity Studies
Birds			
Bank Swallow (*Riparia riparia*)	Terrestrial Birds – Aerial Insectivore	Bank Swallow (*Riparia riparia*)	2022
Barn Swallow (*Hirundo rustica*)	Terrestrial Birds – Aerial Insectivore	Bank Swallow (*Riparia riparia*)	2022
Bobolink (*Dolichinyx oryzivorus*)	Terrestrial Birds – Ground-feeding Omnivore	American Robin (*Turdus migratorius*)	2022
Canada Warbler (*Cardellina canadensis*)	Terrestrial Birds – Aerial Insectivore	Bank Swallow (*Riparia riparia*)	2019
Chimney Swift (*Chaetura pelagica*)	Terrestrial Birds – Aerial Insectivore	Bank Swallow (*Riparia riparia*)	2022
Eastern Meadowlark (*Strunella magna*)	Terrestrial Birds – Ground-feeding Omnivore	American Robin (*Turdus migratorius*)	2022
Wood Thrush (*Hylocichla mustelina*)	Terrestrial Birds – Ground-feeding Omnivore	American Robin (*Turdus migratorius*)	2022
Least Bittern (*Ixobrychus exilis*)	Terrestrial Birds – Ground-feeding Omnivore	American Robin (*Turdus migratorius*)	2022
Mammals			
Little Brown Myotis (*Myotis lucifugus*)	Terrestrial Mammals	Common Shrew (*Sorex cinereus*)	2022
Terrestrial Invertebrates			
Monarch (*Danaus plexippus*)	Terrestrial Invertebrates	Earthworm (*Lumbricus*)	2022
Plants			
Butternut Tree (*Juglans cinerea*)	Terrestrial Plants	Sugar Maple (*Acer saccharum*)	2022
Fish			

Common Name (*Scientific Name*)	Category	Representative Species	Last Observed in Biodiversity Studies
American Eel (*Anguilla rostrata*)	Bottom Feeding Fish	American Eel (*Anguilla rostrata*)	2019 (sighting) 2022 (impingement – see Table 4-3)

Notes

1. For birds, only species possibly breeding on-Site are included. Olive-Sided Flycatcher is not identified as a species that is breeding on-site (Beacon, 2019c), therefore is not included in this table. Loggerhead Shrike and Red Knot (*Rufa* subspecies) are also not included as only one incidental sighting of each species has occurred (Beacon, 2022, 2023). The Eastern Whip-poor-will and Common Nighthawk observations were considered to be migrants and not remaining on-site (Beacon, 2022, 2023). The Yellow-breasted Chat has not been observed on the site since 2009 and there is no evidence that it is breeding on-site (Beacon, 2022, 2023) and is, therefore, not included in this table. The Chimney swift and Least bittern have conservatively been retained as a Species at Risk as they are considered "possible" breeders on the DN site (Beacon, 2022).
2. For bat species, only species roosting on-site are included. During 2020 to 2022, one new Species at Risk, the Eastern small-footed myotis, was identified during passive monitoring of the DNNP. However, results suggest this species was not roosting on the DN site (Beacon, 2022), and has not been retained as a Species at Risk for the EcoRA.
3. The federal and provincial status of a Species at Risk may change over time. The status of these species was last verified on November 24, 2023.
4. Species with Special Concern Status are not included in this table, as the general prohibitions under SARA do not apply to species of Special Concern, and CSA N288.6 does not specify this status as ecologically significant.

Eight (8) bird species, one (1) mammal species, one (1) plant species, one (1) terrestrial invertebrate, and one (1) fish species were identified as threatened or endangered at the DN site. All species, excluding the Canada Warbler were sighted between 2020 and 2022. Though not specifically identified between 2020 and 2022, the Canada Warbler was retained as Species at Risk as it was previously identified in the 2020 ERA.

The status of some species has changed since the 2020 ERA. In 2021, the Barn Swallow and Canada Warbler were newly designated "Special Concern" by COSEWIC and SARO, both previously listed as "Threatened" (Canada Warbler was re-assessed by COSEWIC in 2020). The Bobolink was also newly designated "Special Concern" by COSEWIC (previously designated as "Threatened") in 2022. The Monarch, a milkweed butterfly, was assessed and designated as "Special Concern" under SARO in 2020 and was designated as "Endangered" under SARA in late 2023. Overall, these changes in status do not affect the inclusion of these species as Species at Risk for the EcoRA. The Monarch is a migrating species that covers long distances between Ontario and Florida or central Mexico annually through four generations. In Ontario, Monarch caterpillars feed on milkweed plants and are confined to meadows and open areas with food sources. Adult butterflies are found in diverse habitats and, as a breeding species, are found in large numbers throughout the DN site. Monarch butterflies were observed annually between 2020 and 2022 (Beacon, 2023). Potential risk to Monarchs is expected to be adequately assessed by the Earthworm, as they are both terrestrial invertebrates. Both Earthworms and Monarch caterpillars are exposed to airborne emissions via soil. Earthworms dwell underground and receive more soil exposure. Therefore, using Earthworms to represent Monarch caterpillars is considered conservative.

Butternut is a medium-sized tree, belonging to the walnut family, which can reach up to 30 m in height. In Ontario, Butternut usually grows alone or in small groups in deciduous forests, in sunny openings, and near forest edges. It prefers moist, well-drained soil and is often found along streams, or on well-drained gravel sites. Two Butternut trees are located in the southeast area of the DN site, on DNNP lands. In 2019, a Butternut Health Assessment was conducted and one of the Butternut trees was assessed as non-retainable (Beacon, 2023). Potential risk to this species is expected to be adequately assessed by reference to other terrestrial plant species such as the Sugar Maple, as they receive similar exposure to airborne emissions via soil.

Bank Swallow and Barn Swallow are aerial insectivores and feed over open areas such as fields, meadows, watercourses, and waterbodies. Bank swallows nest colonially in small to large colonies where there are natural or artificial soft soil banks, such as natural river and lake bluffs, in which they create nesting burrows. The lakeshore Bank Swallow colonies at the DN site during the 2020 to 2022 period were estimated to have between 1,118 and 1,795 burrows, the majority of which were found along the eastern-most third of the shoreline of the DN site (Beacon, 2022, 2023). Bank Swallow was retained as an ecological receptor in this Addendum.

Barn Swallows, in Ontario, typically nest in small openings in man-made buildings, such as barns. Barn Swallows are annual breeders at the Site, all around the existing station. Over the 2020 to 2022 period, 43 to 98 active nests were observed in and around the buildings on the site (Beacon, 2022, 2023). Barn Swallows are typically observed foraging over lawns, open field areas, wetlands and along the lakeshore at the DN Site. Several of the buildings on the DN site may provide a suitable habitat for birds. The Bank Swallow is considered a suitable representative species for the Barn Swallow, and the assessment of ecological risks for the Bank Swallow in this Addendum is expected to be adequate for protection of the Barn Swallow, considering their similar diet and other characteristics.

The Chimney Swift is a relatively small bird that feeds almost exclusive on flying insects, consuming flies, beetles, and moths while in flight. They tend to nest in caves and hollow trees, and in urbanized areas can be found nesting in buildings and man-made structures, including chimneys. The Chimney Swift was recorded in all years between 2020 and 2022. Though not seen breeding on the DN site since 2009, the species is considered a possible breeder (Beacon, 2022) and has conservatively been retained as a Species at Risk for this Addendum. The Bank Swallow is considered a suitable representative species for the Chimney Swift, considering their similar diet and other characteristics.

The Canada Warbler eats insects such as spiders that have been gleaned off of foliage. The Canada Warbler is a regular migrant species. The last observation of this species at the DN site was 2019 (Beacon, 2023). The Bank Swallow is also considered a suitable representative species for the Canada Warbler considering the similar diet and physical characteristics.

Bobolink and Eastern Meadowlark are omnivores which typically forage on or near the ground for insects, seeds, and berries. The Bobolink typically breeds in large agricultural grasslands or fields such as hayfields and other fields with tall, lush forb vegetation. It is a regular breeder at the DN site. After an absence of Bobolink in 2016, numbers have fluctuated between one and three pairs; two pairs were recorded in 2022 (Beacon, 2023). Eastern Meadowlark also breeds in grasslands and prairie, as well as pastures and hay fields. The Eastern Meadowlark builds its nest on the ground, covered with a roof woven from grasses. The species is an annual breeder at the DN site, though like the Bobolink, sightings have declined in recent years (Beacon, 2023). Potential risk to these species is expected to be adequately assessed by reference to other avian omnivores such as the American Robin, as they are all ground feeding birds and receive similar atmospheric exposure through food and soil.

Wood Thrush are omnivores, which typically forage on invertebrates and fruits. They prefer woodlands and are not typically found at DN. However, in June 2021, Wood Thrush were heard from the Treefrog Swamp and the East Hedge transect, though it is not clear whether these recordings were of the same individual (Beacon, 2022). Another pair was heard from the Big Hedge transect in 2022 (Beacon, 2023). American Robin is also considered a suitable representative for Wood Thrush, as they are both ground feeding insectivores, and are exposed to similar atmospheric exposure through food and soil.

Little Brown Myotis is an aerial insectivore. Like other bats, they forage during the night and roost in trees or buildings during the day. Little Brown Myotis will often select attics, abandoned buildings and barns for summer colonies to raise their young. It was recorded near the DN site in all years between 2020 and 2022, and likely has roosting habitat on site (Beacon, 2023). Potential risk to Little Brown Myotis is expected to be adequately assessed by reference to other mammalian insectivores such as the Common Shrew considering their similar diet. Common Shrew has more soil exposure compared to Little Brown Myotis; therefore, it is a conservative representative species.

The American Eel is carnivorous, feeding on a variety of fishes and invertebrates. The American Eel is catadromous, utilizing a variety of marine and freshwater habitats over the course of its life history. It spawns in the Sargasso Sea, and during its migrations to and from spawning areas, it occurs in continental and oceanic habitats. In fresh water, its preferred habitat is in lakes and rivers including all waters to a depth of least a 10 m. The American Eel has been retained in this Addendum as an ecological receptor from the 2020 ERA as it has been periodically impinged in since 2020.

4.1.1.2 Receptor Characterization

Receptor characterization remains unchanged from the 2020 ERA (Ecometrix, 2022a). The 2020 ERA provided the habitat and feeding habits of the selected receptor species in Appendix C of the 2020 ERA.

4.1.2 Assessment and Measurement Endpoints

The assessment and measurement endpoints remain unchanged from the 2020 ERA. The 2020 ERA provided the assessment endpoints, measurement endpoints and lines of evidence in Table 4-4.

4.1.3 Selection of Chemical, Radiological, and Other Stressors

The same monitoring data sources previously screened for the HHRA (**Section 3.1.2**) were screened for the EcoRA using the more conservative of available federal and provincial guidelines and objectives protective of ecological health as screening criteria. If there was no such guideline or objective, screening criteria were obtained from available scientific literature, and/or derived using federally and/or provincially accepted methods. For COPCs where these criteria were not available, conservative toxicity benchmarks (e.g., no effects levels) or upper limit of background concentrations were used as screening criteria. Maximum measured concentrations of parameters in air, surface water, soil, and sediment were compared to the selected screening criteria. Contaminants were retained for evaluation of ecological health risks in this Addendum if they:

- Were a new COPC not previously identified in the 2020 ERA, or
- Were a COPC evaluated in the 2020 ERA and the maximum concentration in 2020 – 2022 was greater than that evaluated in the 2020 ERA (Ecometrix, 2022a).

The framework for the chemical COPC screening process used in the EcoRA is consistent with the 2020 ERA (Ecometrix, 2022a), with updated guidelines applied where available.

4.1.3.1 Selection of Chemical COPCs in Air

As per clause 7.3.4.2.5 in N288.6:22, inhalation exposures to biota are usually minor compared to the soil and food ingestion pathways, and can be ignored for most substances, except for substances that do not partition to soil (CSA, 2022). These substances may include gases such as NOx, SO_2, hydrazine, and morpholine, of which air concentrations dominate the exposure pathway to terrestrial biota. For completeness, all chemicals modelled in the 2020-2022 ESDM reports (ORTECH, 2021, 2022a, 2022b) were screened against relevant ecological screening criteria (**Figure 4-2** and **Appendix A**, **Table A-8**). However, chemicals that do not partition to soil were considered for COPC selection for air. Furthermore, measured air quality data (IEC, 2023) collected from the DNNP air quality study (as described in **Section 3.1.2.1.2**) was also screened against the same ecological air quality screening criteria (**Table A-9**, **Appendix A**).

The modelled POI concentrations provided in the ESDM reports were typically 24-hour, or annual averages. These modelled POI concentrations were directly compared to selected screening criteria, as described below, with the same averaging periods (e.g., 24-hour, or annual), or were adjusted to meet the timeframes of the relevant screening criteria using the suggested conversion method provided by MECP (MOECC, 2017). It should be noted that POI conversion is minimized in this screening process to avoid uncertainty introduced by converting POI concentrations to different averaging periods.

The MECP AAQC was used as the preferred screening level as AAQCs are developed to be protective of health and the environment (MECP, 2023b). Where AAQCs were not available, the Effects Screening Levels (ESLs) from the Texas Commission on Environmental Quality (TCEQ, 2023) were used. ESLs are based on data for health effects, odour, and effects on vegetation and can, therefore, be applied as ecological screening levels. There are no MECP AAQC or TCEQ ESL values for hydrazine and morpholine. For these two COPCs, MECP ACBs (MECP, 2023a) are available and were utilized.

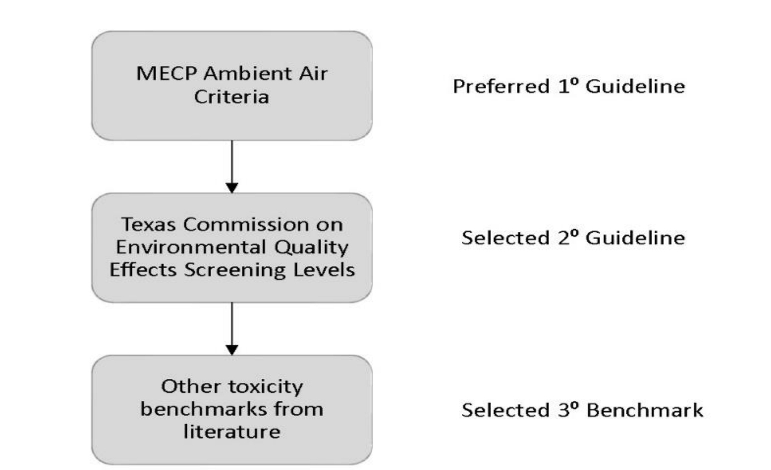

Figure 4-2: Hierarchy of Screening Criteria for Chemical COPCs in Air

Based on the POI concentration screening presented in **Table A-8** in **Appendix A**, for chemicals released to air, there were no COPCs identified for ecological effects. When considering the screening of measured DNNP air quality data in **Table A-9**, 24-hour air quality criteria were exceeded for $PM_{2.5}$, PM_{10}, TSP, and BAP, a surrogate for total PAHs. The 1-hour air quality criteria for SO_2 and the annual air quality criteria for benzene were also exceeded. Out of these exceedances, BAP is the only parameter that would be expected to partition to soil and is not considered further in this report, given that contaminants that partition to soil are negligible from an atmospheric perspective (as per clause 7.3.4.2.5 in N288.6:22).

Although $PM_{2.5}$, PM_{10}, and TSP exceed their respective air quality screening criteria, they are not retained as air COPCs with respect to ecological health. As per CSA N288.6:22, "For particulate substances released to air and accumulating over time in the soil, the steady-state soil concentration is usually high enough that the soil and food components of dose are dominant." Also, as described in **Section 3.1.2.1.3.2**, changing wind directions and differing meteorological conditions make the DNNP air quality monitoring program likely to capture sources of pollution external to the DN site from local and regional industry and traffic, thus potentially overestimating the DN site's contribution to local air quality conditions. Furthermore, many ecological receptors are mobile and are expected to move around or leave the DN site over the course of their lifetime, further reducing the likelihood that these receptors would be exposed to harmful levels of air pollution for extended periods of time.

While SO_2 exceeded its 1-hour MECP AAQC (MECP, 2023b), it did not exceed its 24-hour MECP ACB (MECP, 2023a). Generally, 24-hour air quality criteria are more protective of long-term, chronic exposures to air pollutants compared with 1-hour air quality criteria (MECP, 2023b). Both mobile and immobile receptors (e.g., vegetation) are not expected to be at risk of adverse effects from SO_2 via long-term, chronic exposure. Thus, SO_2 is not retained as an air COPC for the EcoRA.

Benzene exceeded its annual MECP AAQC; however, the maximum concentration of benzene (annual averaging period) was measured to be 0.5 $\mu g/m^3$, approximately half the average concentration reported in rural areas (1.2 $\mu g/m^3$) and approximately 64,000-times lower than the effects threshold of 32 mg/m^3, where immunological changes were noted in laboratory rats experiencing chronic exposure to benzene (EC and HC, 1993). Furthermore, many ecological receptors such as plants and invertebrates are able to metabolize and excrete benzene as it is not considered to bioaccumulate in tissues and does not tend to concentrate to harmful levels in foodstuffs (CCME, 2004; EC and HC, 1993). Therefore, benzene is considered to be minimally toxic to terrestrial biota via the inhalation pathway and is not retained as an air COPC for the EcoRA.

Therefore, the exposure from air was not evaluated further for ecological receptors in this Addendum.

4.1.3.2 Selection of Chemical COPCs in Surface Water

The surface water screening is based primarily on measurements of constituents in Lake Ontario water, as well as Coot's Pond and Treefrog Pond water. In addition, concentrations of chemical parameters in the CCW discharges from 2020 to 2022 and concentrations of chemical parameters in stormwater discharges to Lake Ontario in 2019 (**Section 4.1.3.2.3**) were screened to ensure that the list of chemical COPCs was complete. COPCs for surface water were only retained in this Addendum if it was a new COPC not evaluated in the 2020 ERA or if the concentration was greater than that evaluated in the 2020 ERA (Ecometrix, 2022a).

For each parameter, its maximum concentration in surface water was screened against its screening criterion, which was selected following the process illustrated in **Figure 4-3**, and detailed below.

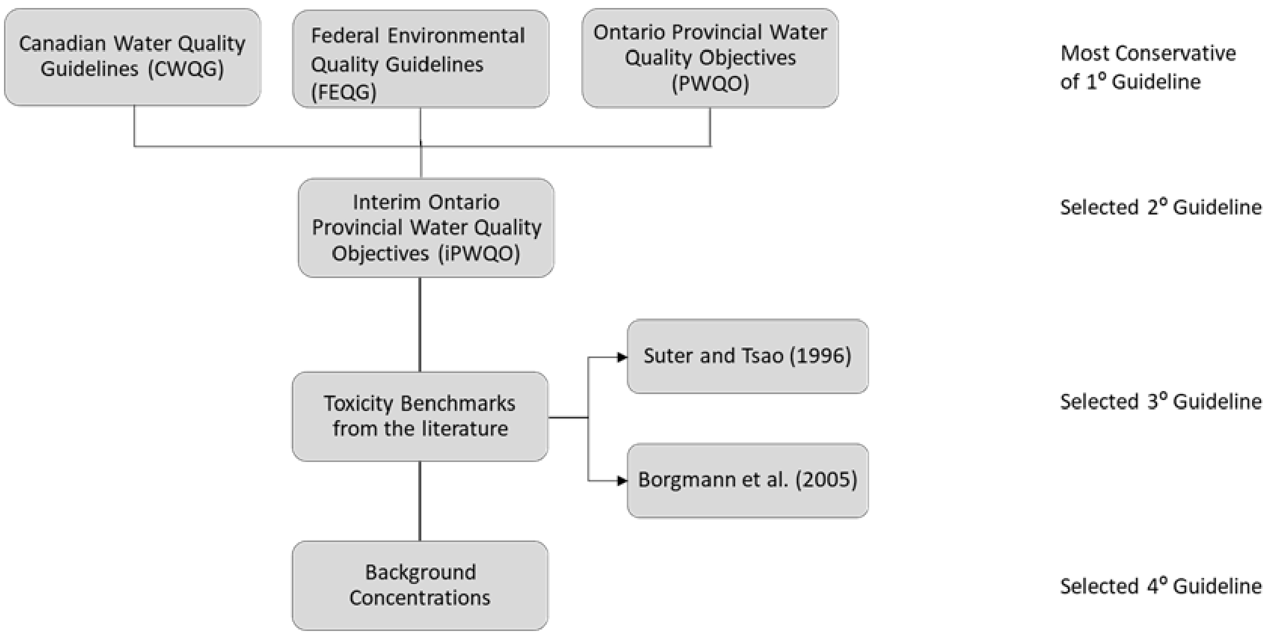

Figure 4-3: Selection of Screening Criteria for Chemical COPCs in Surface Water

The most restrictive federal or provincial guideline for surface water quality, including the CCME water quality guidelines for the protection of freshwater aquatic life (the Canadian Water Quality Guidelines, CWQG) (CCME, 2010a), the federal environmental quality guidelines (FEQG) (ECCC, 2021b), the provincial water quality objective (PWQO), or the interim PWQO (iPWQO) (MOEE, 1994) were selected as the screening criteria for most surface water parameters (**Appendix A, Table A-10**). In cases where no toxicity benchmarks were available from selected literature (e.g., Suter & Tsao (1996), Borgmann et al. (2005)), the maximum concentrations were compared to the 95th percentile of background concentrations in Lake Ontario (Ecometrix, 2022c).

4.1.3.2.1 Lake Water Sampling

Surface water sampling was conducted quarterly (spring, summer, early fall, and early winter) in 2019 (Ecometrix, 2022c). The results of this sampling program were used as the basis for the screening of COPCs in Lake Ontario. No new data was collected since the 2020 ERA (Ecometrix, 2022a). The screening of lake water concentrations is provided in **Table A-11** in **Appendix A**, with updated guidelines as available.

Based on updated guidelines, the list of COPCs with concentrations that exceed screening criteria remains the same as for the 2020 ERA (Ecometrix, 2022a). As such, there were no COPCs retained in lake water for assessment of ecological health risks in this Addendum.

4.1.3.2.2 Liquid Effluent Sampling

As in the HHRA, information from 2020 to 2022 on the concentrations of COPCs in liquid effluents was available and was assessed to aid in COPC selection to ensure that the lake water chemical COPC selection was complete. As in the HHRA, the final discharge released from the CCW duct was evaluated. Effluent released from the CCW duct is diluted in Lake Ontario through the diffuser. Thus, the initial mixing zone in Lake Ontario represents a maximum potential exposure for ecological receptors. Effluent quality results were converted to estimated concentrations in the mixing zone using a dilution factor of 7 at the diffuser (OPG, 2022c); estimated mixing zone concentrations were considered in the screening.

4.1.3.2.2.1 Monitoring for ECA Requirements

As part of the ECA requirements, the effluent from the CCW was sampled and analyzed for compliance with effluent limits for unionized ammonia, hydrazine, morpholine, pH, and total residual chlorine (TRC) (OPG, 2021b, 2022d, 2023c). For each of these chemicals, the maximum concentration in the mixing zone was estimated based on the maximum measured concentration in the CCW and a dilution factor of 7 at the diffuser. Estimated mixing zone concentrations from 2020 to 2022 were screened against the same screening criteria as the lake water samples.

The maximum mixing zone concentrations for hydrazine, morpholine, and TRC were all below their selected screening criteria.

Based on the screening of the available 2020 – 2022 data (**Table A-12**, **Appendix A**), there were no COPCs identified in CCW effluent and thus further evaluation of ecological risks related to CCW effluent was not carried out in this Addendum.

4.1.3.2.2.2 2016 Effluent Characterization Study

Liquid effluent sampling and analysis were performed in 2016 to provide data for the characterization of non-radiological parameters. No additional data have been collected since 2016.

As identified in the 2020 ERA (Ecometrix, 2022a), and still the case based on updated guidelines, no exceedances of screening criteria in the initial mixing zone are expected for the 2016 CCW effluent parameters, as shown in **Table A-13a** and **A-13b** in **Appendix A**. As such, no COPCs were carried forward for further assessment of ecological health risks in this Addendum.

4.1.3.2.3 Stormwater Sampling

The Stormwater Management System, or Yard Drainage System, collects storm runoff from the entire DN site and discharges to Lake Ontario, either directly through the storm sewer drainage system or through drainage swales/creeks via culverts, which eventually discharge to the lake. There has been no new stormwater sampling subsequent to the 2020 ERA (Ecometrix, 2022a). The stormwater screening from the 2020 ERA was repeated based on the same data, but with updated ecological screening criteria, where available.

Consistent with the 2020 ERA (Ecometrix, 2022a), nearshore Lake Ontario concentrations were modelled based on the release of stormwater effluent into the lake. The estimated Lake Ontario concentrations were then screened against the same ecological screening benchmarks used in the lake water screening. The results are presented in **Table A-14** in **Appendix A**.

The list of COPCs with concentrations that exceeded screening criteria was the same as for the 2020 ERA (Ecometrix, 2022a). As there were no new concentration data, and no new COPCs based on updated guidelines, there were no COPCs retained for assessment of ecological health risks in this Addendum.

4.1.3.2.4 Pond Water Sampling

Pond water sampling was conducted in 2019 from Coot's Pond and Treefrog Pond (Ecometrix, 2022c). These ponds are not exposed to liquid effluent from DN, but Coot's Pond is exposed to stormwater runoff from the construction landfill. The ponds are also expected to be exposed to chemical contaminants in air, which could be deposited in surface water after release to the atmosphere from DN. No new data were collected since the 2020 ERA (Ecometrix, 2022a). Results of the pond water screening are presented in **Table A-15** in **Appendix A**.

The list of COPCs with concentrations which exceed screening criteria is the same as for the 2020 ERA (Ecometrix, 2022a). As there was no new concentration data, and no new COPCs based on updated guidelines, there were no COPCs retained for assessment of ecological health risks in this Addendum.

4.1.3.3 Selection of Chemical COPCs in Sediment

Sediment sampling in Lake Ontario was conducted in 2018 at the Darlington Harbour area and near-shore locations immediately west of the Darlington Harbour. In 2019, sediment sampling occurred at the Lake Ontario near-shore and off-shore locations (including the St. Mary's future embayment and proposed infill area), and at Coot's Pond and Treefrog Pond to support DNNP site preparation licence renewal. The 2018 to 2019 sediment data were screened against relevant screening criteria. The screening criteria were selected following the hierarchy illustrated in **Figure 4-4**. All regulatory and toxicity benchmarks consulted are listed in **Appendix A**, **Table A-16**. No new sediment data was available since the 2020 ERA (Ecometrix, 2022a).

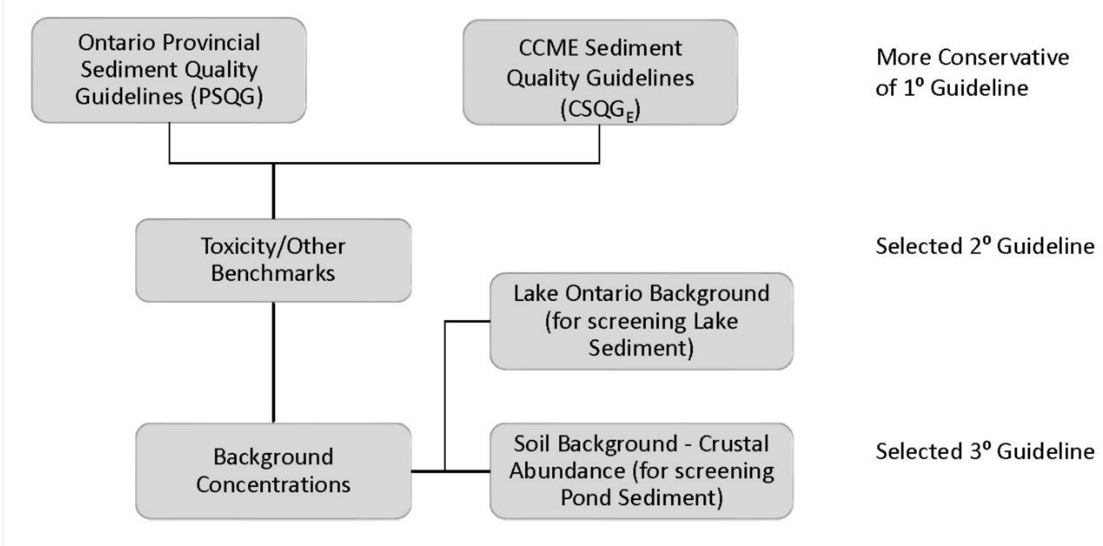

Figure 4-4: Selection of Screening Criteria for COPCs in Sediment

In particular, maximum measured concentrations of sediment parameters were compared against the more conservative values of Ontario Provincial Sediment Quality Guidelines (PSQG, (MOE, 2008)), and the CCME Sediment Quality Guidelines for the Protection of Aquatic Life (CSQG, (CCME, 2001)). If regulatory criteria were not available, values from toxicity studies and other literature were used, as detailed in **Appendix A**, **Table A-16**. If there were no reported toxicity values for a certain parameter analyzed in Lake Ontario, the 95th percentile of background concentrations in Lake Ontario sediment (SENES, 2009b) were used as the screening criteria for this parameter. These background values were not used to screen sediment chemicals in Coot's Pond and Treefrog Pond as the background values are not representative of pond background concentrations. The upper end of the ranges of crustal abundance for the United States from Dragun and Chiasson (1991) were consulted to screen the pond sediment COPCs, if no toxicity-based benchmark was available.

4.1.3.3.1 Lake Ontario Sediment Sampling

Within the study area in Lake Ontario, the substrate is predominantly gravel and cobble on top of glacial till or bedrock, except in the St. Mary's boat slip. Any finer material, mostly sand, is patchy, thin and transient. Lake Ontario in the vicinity of DN is not a depositional environment, as characterized in COG (COG, 2013a). As such, any chemical parameters in sediments in Lake Ontario due to DN's influence are likely to be due to liquid effluents, and screening of Lake Ontario water and liquid effluents for COPCs are expected to be protective of aquatic life. However, to be complete, the sediment monitoring data were screened as an additional line of evidence for the selection of COPCs.

The screening results for Lake Ontario sediment are presented in **Appendix A**, **Table A-17**. The list of COPCs with concentrations that exceed screening criteria is the same as for the 2020 ERA (Ecometrix, 2022a). As there were no new concentration data, and no new COPCs based on updated guidelines, there were no COPCs retained for assessment of ecological health risks in this Addendum.

4.1.3.3.2 Pond Sediment Sampling

The on-site ponds, including Coot's Pond and Treefrog Pond, are depositional environments. However, other than stormwater runoff, these ponds do not receive liquid effluents from DN, so the only potential transport pathway for COPCs from DN to these ponds is through airborne deposition of air emissions from DN.

The results of the pond sediment screening are presented in **Table A-18** in **Appendix A**. The list of COPCs with concentrations that exceed screening criteria is the same as for the 2020 ERA (Ecometrix, 2022a). As there were no new concentration data, and no new COPCs based on updated guidelines, there were no COPCs retained for assessment of ecological health risks in this Addendum.

4.1.3.4 Selection of Chemical COPCs in Soil

Soil sampling was conducted at the DN in 2019. The 2019 soil sampling program is described in more detail in the 2020 ERA (Ecometrix, 2022c).

In 2021, a soil characterization program was initiated for the DNNP to meet objectives relating to EA commitments and licensing (soil quality data is summarized in Appendix B). The program involved the drilling of 56 boreholes and the analysis of soil samples for a suite of contaminants, including VOCs, PHCs, PAHs, polychlorinated biphenyls (PCBs), metals, and other regulated parameters. The locations of the 2021 soil samples correspond with Polygon E (**Figure 4-1**).

Consistent with the methodology outlined in the CCME's *Ecological Risk Assessment Guidance Document* (CCME, 2020), only soils less than 1.5 metres below ground surface (mbgs) were screened for soil COPCs. This is considered the default depth for the analysis of ecological direct contact to surface soil contaminants, and is also consistent with the Canada-wide standard for PHCs in soil (ECCC, 2022). Soils in the top 1.5 mbgs are considered "surface soils" for the purpose of assessing soil exposure to ecological receptors, including those that live just below the ground surface in underground burrows, nests, and dens. There are no ecological receptors assessed in this Addendum that are expected to contact soils deeper than 1.5 mbgs.

Screening criteria were selected following the process illustrated in **Figure 4-5**.

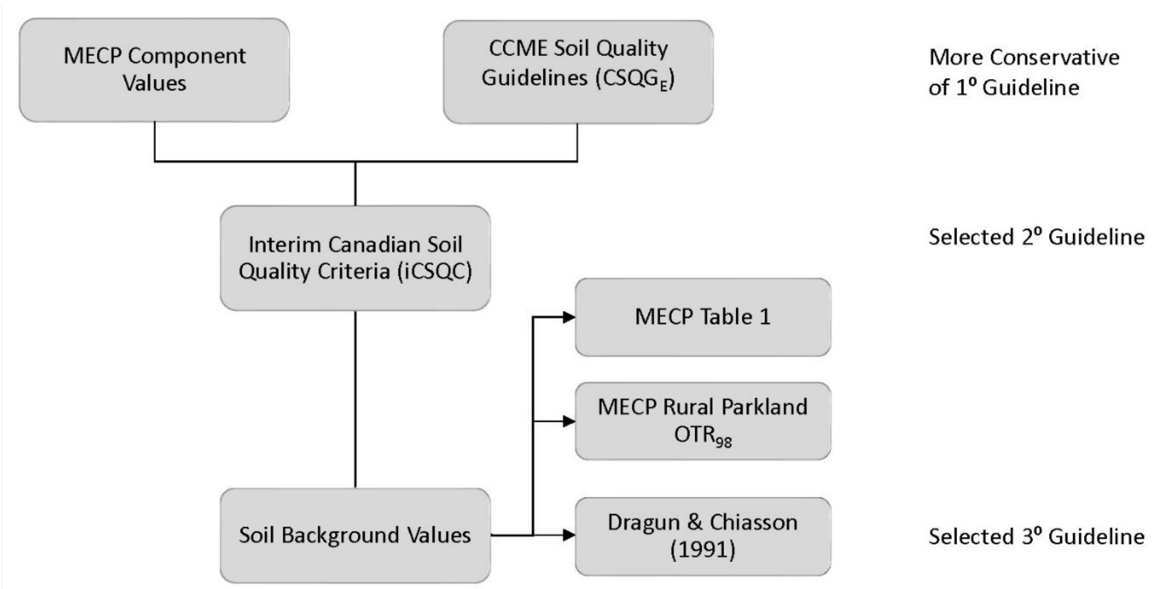

Figure 4-5: Selection of Screening Criteria for Chemical COPCs in Soil

In particular, maximum measured concentrations of soil COPCs were compared against two MECP component values (MECP, 2011), one based on protection of Plants and Soil Organisms (PSO), and the other based on protection of Birds and Mammals (BM). The residential/parkland component values were selected considering these benchmarks are protective of ecological receptors observed at the site. From a federal perspective, CCME Soil Quality Guidelines for Environmental Health (SQG$_E$) were consulted, as were Interim Canadian Soil Quality Criteria (ICSQC; (CCME, 1991)), if an SQG$_E$ was not available. Agricultural SQG$_E$ values were used because these guidelines account for bird and mammal ingestion of plants. The more conservative of these provincial and federal screening criteria were selected for the protection of plants, soil organisms, mammals, and birds. The only exception was for selected PAHs, including benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene, fluorene, indeno(1,2,3-c,d)pyrene, phenanthrene, and pyrene, as there were insufficient soil contact data, and the CCME SQG$_E$ was based on the 1991 interim soil quality criteria (CCME, 2010b). For these parameters, the Ontario provincial component values were adopted, if available, prior to the CCME SQG$_{E,}$ as the Ontario provincial values are considered more recent.

If none of the provincial or federal criteria, guidelines, or component values were available, background concentrations of analyzed chemicals in soil were used. The MECP Table 1 Site Condition Standards under Ontario Regulation 153/04 are derived from the Ontario Typical Range (OTR$_{98}$) values for the land use and are considered representative of upper limits of typical province-wide background concentrations in soils that are not contaminated by point sources (MECP, 2011). If MECP Table 1 values were not available, MECP's Ontario Typical Range (OTR$_{98}$) concentrations (for rural parkland) were used instead. If background values from Ontario were not available, the upper end of the ranges of crustal abundance for the United States from Dragun and Chiasson (1991) were used to represent the background soil concentrations.

Of the screening criteria derived in this way, the benchmark for vanadium was given more detailed scrutiny because of its use by MECP in deriving a Site Condition Standard under Ontario Regulation (O.Reg.) 153/04. MECP derived a vanadium soil protection value for mammals and birds of 18 mg/kg, with the American Woodcock as the most sensitive receptor (MECP, 2011). This concentration was less than the OTR_{98} concentration for vanadium of 86 mg/kg in rural parkland. In setting their Site Condition Standard, MECP chose the Ontario background concentration for vanadium over the mammal and bird soil protection value. A similar approach was used here, in that the Ontario background concentration for vanadium was selected as a more appropriate screening benchmark for birds and mammals. This approach is also consistent with the guidance in N288.6:22 (CSA, 2022), in that screening benchmarks should not be set below an upper limit of background.

Similarly, the CCME Soil Quality Guideline (SQG) values, for benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene and pyrene, which were based on the 1991 interim soil quality criteria, were lower than the Ontario background soil concentrations (MECP Table 1). For these three compounds, the soil background values were selected as the screening criteria instead of the CCME values. The selected screening criteria are presented in **Table A-19** in **Appendix A**.

As shown in **Table A-20** in **Appendix A**, compared to the 2020 ERA (Ecometrix, 2022a), the following COPCs exceeded screening values:

- Sodium Adsorption Ratio
- PHC F1, PHC F2, PHC F3
- 2-methylnaphthalene

Of the COPCs that were already identified in the 2020 ERA (Ecometrix, 2022a), there are no new maximum concentrations based on the new soil data.

For 2-methylnaphthalene, MECP component values and CCME soil quality guidelines are not available, and the MECP Table 1 values were used for screening. However, the MECP Table 1 values are based on background conditions, and not toxicological benchmarks. The US EPA has developed Ecological Soil Screening Levels (Eco-SSLs) that are “concentrations of contaminants in soil that are protective of ecological receptors that commonly come into contact with and/or consume biota that live in or on soil” (US EPA, 2007). For PAHs, Eco-SSLs are provided for low molecular weight compounds composed of fewer than four rings and high molecular weight compounds. 2-methylnaphthalene is a low molecular weight PAH. There was sufficient toxicological information for low molecular weight PAHs to derive an Eco-SSL for soil invertebrates (29 mg/kg) and mammals (100 mg/kg). There was insufficient toxicological information to derive Eco-SSLs for plants or avian species. For avian species, a no observed adverse effect level (NOAEL) of 5620 mg/kg was determined based on dietary exposure. For plants, the effect levels ranged from 30 to >1000 mg/kg. The maximum 2-methylnaphthalene concentration of 0.62 mg/kg was below the Eco-SSLs, was nearly 10,000 times lower than the avian NOAEL, and 50 times lower than the plant effect levels. As such, risks to ecological receptors from soil concentrations of 2-methylnaphthalene are expected to be negligible. 2-methylnaphthalene was not retained for further quantitative assessment in this Addendum.

The soil COPCs retained for evaluation in this Addendum are Sodium Adsorption Ratio, PHC F1, PHC F2, and PHC F3.

4.1.3.5 Selection of Chemical COPCs in Groundwater

OPG executes an annual groundwater monitoring program to understand the groundwater flow and quality beneath the DN site. Based on the results of this program, groundwater on the DN site was found to generally flow toward Lake Ontario or the Forebay. From 2020 to 2022, the groundwater monitoring program included sampling groundwater monitoring wells for tritium, and certain locations for select hazardous substances, such as PHCs and BTEX.

As there is no on-site exposure of ecological receptors to groundwater, the only pathway for ecological receptors to be exposed to groundwater would be at the shoreline of Lake Ontario after dilution of the groundwater in the near shore lake. As discussed in **Section 3.1.2.4**, there is a GWPP for the DN site that evaluates groundwater concentrations against relevant criteria. As for human health, although COPCs are identified in the GWMP, the exceedances of MECP Standards are limited, not related to site activities, and not relevant to ecological health. As such, groundwater COPCs are not retained for further evaluation in this Addendum.

4.1.3.6 Selection of Radiological COPCs

The radiological COPCs that were selected to evaluate radiological dose remain unchanged from the 2020 ERA. The selection of radiological COPCs is detailed in **Sections 4.1.4.6** (Air and Water), **4.1.4.7** (Soil), **4.1.4.8** (Groundwater), and **4.1.4.9** (Sediment) of the 2020 ERA (Ecometrix, 2022a).

Radionuclide COPCs selected are consistent with those identified as part of the DRL calculations for the DN Site (see **Section 3.1.2.6**).

4.1.3.7 Selection of Other Stressors

4.1.3.7.1 Noise

As discussed in **Section 3.1.2.7.1**, the noise environment in the vicinity of DN site is typical of an urban setting and is influenced by several noise sources including the DNGS, traffic on Highway 401 and local roads, the CN rail line, and the SMC plant. Beacon Environmental noted that bird and wildlife communities at DN would likely be adjusted to the high level of noise in the vicinity of the Station (Beacon, 2009, 2011), and observed that none of the planned activities, for which the respective EAs were being conducted, were likely to increase noise to beyond levels tolerable by breeding birds from the literature. In 2018/2019, the noise at the DN vicinity was monitored again, and the results were similar to previous studies (OPG, 2022e). As described in **Section 3.1.2.7.1**, the recent Spring and Fall 2022 noise assessments (OPG, 2022e, 2023e) found similar conclusions to the 2018/2019 and past noise assessments. As indicated by the recent noise monitoring programs, noise levels at the DN site have remained consistent over time, further supporting the notion that local birds and wildlife would be accustomed to current noise levels. As such, noise has not been considered a stressor in the EcoRA.

4.1.3.7.2 Thermal Stressors, Entrainment, Impingement

Thermal stressors, entrainment and impingement were not re-evaluated in this Addendum as new data was not available. In the 2020 ERA, effects from thermal stressors were identified as negligible.

As a condition of the Department of Fisheries and Oceans Canada (DFO) Fisheries Act Authorization for the DNGS, OPG will be required to conduct fish impingement and entrainment monitoring studies after Refurbishment is completed. Refurbishment at DNGS is currently ongoing. Fish losses due to impingement at DN were considered negligible in the 2020 ERA (Ecometrix, 2022a), when considering the Lake Ontario populations of the impinged organisms. As discussed in the 2020 ERA, losses from fish entrainment were considered too low to measurably affect Lake Ontario fish populations.

4.1.3.7.3 Bird Strikes and Wildlife Collisions

OPG tracks wildlife fatalities and injuries through an informal reporting process. For the period from 2020 to 2022, the fatalities and injuries reported through this method, not including predation deaths, are summarized in **Table 4-3**. The 2016 to 2019 fatality and injury list was reported in the 2020 ERA (Ecometrix, 2022a). The 2020 to 2022 wildlife list documented a similar number of incidents compared to the 2016 to 2019 list. Due to the small number of affected wildlife, bird strikes, and other types of physical wildlife incidents are not expected to affect populations of birds and mammals at the DN Site. Wildlife fatalities and injuries are not discussed further in this Addendum.

Table 4-3: Summary of Reported Wildlife Injuries/Fatalities at DN (2020 to 2022)

Year	Type	Number	Species	Cause
2020	Fatality	1	bird (unknown species)	Trapped / entangled under canopy
	Fatality	1	American Eel	Impingement
	Likely a fatality	1	Sparrow	Trapped in equipment
	Potentially distressed but not injured	1	bird (unknown species)	Trapped in equipment
	Injured	1	deer (unknown species)	Vehicle hit
2021	Fatality	1	Mouse (unknown species)	Unknown
	Fatality	5	American Eel	Impingement
	Fatality	1	Seagull	Entangled on fence
2022	Potentially distressed but not injured	6	bird / gull (unknown species)	Trapped in equipment
	Fatality	1	Unknown (likely mammal)	Unknown
	Fatality	1	Goose	Vehicle hit
	Fatality	4	American Eel	Impingement
	Fatality	1	Fox (species unknown)	Unknown

4.1.3.8 Summary of COPC Selection

For this addendum, ecological risks were only calculated if, compared to the 2020 ERA (Ecometrix, 2022a), there was a new COPC or a COPC with a higher maximum concentration based on the 2020 – 2022 data. Based on these criteria, the only chemical COPCs retained for evaluation of ecological risks are Sodium Adsorption Ratio (SAR), PHC F1, PHC F2, and PHC F3 in soil. Radionuclides will be evaluated based on the total dose due to all combined exposure pathways and all COPCs to each receptor. **Table 4-4** summarizes the radiological COPCs that were carried forward to the exposure assessment in this Addendum.

Table 4-4: Summary of COPCs Selected for the EcoRA

Category	Radiological COPC	Chemical COPC
Air	C-14, Co-60, HT, HTO, noble gases, Imfp	None
Surface water	C-14, Cs-134, HTO	None
Soil	C-14, Co-60, Cs-134, HTO, I-131	SAR, PHC F1, PHC F2, PHC F3
Groundwater	HTO, I-131	None
Sediment	C-14, Cs-134, HTO	None
Physical Stressors	None	

4.1.4 Selection of Exposure Pathways

There were new non-radiological COPCs identified in soil for polygon E: SAR, PHC F1, PHC F2, and PHC F3. There were no COPCs retained for evaluation in other media, as there were no new COPCs and COPC concentrations were not greater than in the 2020 ERA (Ecometrix, 2022a).

The relevant exposure pathway for the identified soil COPCs is direct contact with soil by plants and soil invertebrates. The SAR parameter is relevant to osmotic effects in soil organisms, which refers to an altered ability for soil organisms to take up nutrients from the soil. Thus, the SAR parameter only affects soil organisms and is not evaluated for terrestrial vertebrates. As described by CCME (2008), PHCs are "readily metabolized by vertebrates, modified into a more readily excretable form, and thus do not tend to accumulate in tissues". As such, risks to mammals and birds based on SAR and PHC exposure are considered negligible and not evaluated herein.

All radionuclides retained in the 2020 ERA (Ecometrix, 2022a) were also retained for the Addendum. As such, the same exposure pathways that were evaluated in the 2020 ERA for exposure to radiological COPCs are relevant for this ERA Addendum. These pathways are detailed in **Table 4-5** below.

Table 4-5: Complete Exposure Pathways for All Selected Ecological Receptors

Category	Ecological Receptor	Location	Exposure Pathway	Environmental Media
Bottom Feeding Fish	Northern Redbelly Dace	Coot's Pond (AB)	Direct Contact	In Water On Sediment
	Round Whitefish	Lake Ontario	Direct Contact	In Water On Sediment
	White Sucker		Direct Contact	In Water On Sediment
	American Eel		Direct Contact	In Water On Sediment
Pelagic Fish	Alewife	Lake Ontario	Direct Contact	In Water
	Lake Trout		Direct Contact	In Water
Reptiles and Amphibians	Turtle	Coot's Pond (AB), Treefrog/Dragonfly/ Polliwog Pond (D)	Direct Contact	In Water On Sediment
	Frog		Direct Contact	In Water On Sediment
Aquatic Plants	Aquatic Plant	Coot's Pond (AB), Treefrog/ Dragonfly/ Polliwog Pond (D)	Direct Contact	In Water
Benthic Invertebrates	Benthic Invertebrate	Lake Ontario, Coot's Pond (AB)	Direct Contact	In Water In Sediment
Riparian Birds	Bufflehead	Lake Ontario	Direct Contact	On Sediment
			Ingestion	Water Sediment Benthic Invertebrates
		Coot's Pond (AB)	Direct Contact	On Sediment
			Ingestion	Water Sediment Aquatic Plants Benthic Invertebrates
	Mallard	Lake Ontario	Direct Contact	On Sediment
			Ingestion	Water Sediment Benthic Invertebrates
		Coot's Pond (AB)	Direct Contact	On Sediment
			Ingestion	Water Sediment Aquatic Plants Benthic Invertebrates
	Green Heron	Coot's Pond (AB)	Direct Contact	On Sediment
			Ingestion	Water Sediment

Category	Ecological Receptor	Location	Exposure Pathway	Environmental Media
				Bottom-Feeding Fish (Northern Redbelly Dace)
Riparian Mammals	Muskrat	Coot's Pond (AB)	Direct Contact	On Sediment
			Ingestion	Water Sediment Aquatic Plants
Terrestrial Invertebrates	Earthworm	AB, C, D, E	Direct Contact	In Soil
Terrestrial Birds	American Robin	AB, C, D, E	Direct Contact	On Soil
			Ingestion	Water Soil Earthworms Fruit
	Bank Swallow	AB, E	Direct Contact	On Soil
			Ingestion	Water Soil Caterpillars
	Song Sparrow	AB, C, D, E	Direct Contact	On Soil
			Ingestion	Water Soil Fruit Caterpillars
	Yellow Warbler	AB, C, D, E	Direct Contact	On Soil
			Ingestion	Water Soil Fruit Caterpillars
Terrestrial Plants	Grasses	AB, C, D, E	Direct Contact	On Soil
	Sugar Maple	D, E	Direct Contact	On Soil
Terrestrial Mammals	Eastern Cottontail	AB, C, D, E	Direct Contact	On Soil
			Ingestion	Water Soil Grasses
	Meadow Vole	AB, C, D, E	Direct Contact	On Soil
			Ingestion	Water Soil Grasses
	White-tailed Deer	AB, C	Direct Contact	On Soil
			Ingestion	Water

Category	Ecological Receptor	Location	Exposure Pathway	Environmental Media
				Soil Grasses
		D, E	Direct Contact	On Soil
			Ingestion	Water Soil Grasses Sugar Maple trees
	Common Shrew	AB, C, D, E	Direct Contact	On Soil
			Ingestion	Water Soil Caterpillars
	Raccoon	AB	Direct Contact	On Soil
			Ingestion	Water Soil Grasses Fruit Caterpillar Benthic Invertebrates Meadow Voles
		C	Direct Contact	On Soil
			Ingestion	Water Soil Grasses Fruit Caterpillars Meadow Voles
		D, E	Direct Contact	On Soil
			Ingestion	Water Soil Grasses Sugar Maple trees Fruit Caterpillars Meadow Voles
	Red Fox	AB	Direct Contact	In and on Soil
			Ingestion	Water Soil Grasses Bufflehead Mallard Eastern Cottontail Rabbits Meadow Voles
		C, D, E	Direct Contact	In and on Soil

Category	Ecological Receptor	Location	Exposure Pathway	Environmental Media
			Ingestion	Water Soil Grasses Eastern Cottontail Rabbits Meadow Voles
	Short-tailed Weasel	AB, C, D, E	Direct Contact	On Soil
			Ingestion	Water Soil Meadow Voles

4.1.5 Ecological Health Conceptual Model

The Ecological Health Conceptual Site model remains unchanged from the 2020 ERA (Ecometrix, 2022a). In this Addendum, for non-radiological COPCs, only exposure pathways related to soil were evaluated. For radiological COPCs, all exposure pathways and receptors identified in the 2020 ERA were evaluated.

4.1.6 Uncertainties in the Problem Formulation

The uncertainties in the Problem Formulation remain unchanged from the 2020 ERA (Ecometrix, 2022a). No new sources of uncertainty were introduced based on the new data and new guidelines that were used.

4.2 Exposure Assessment

4.2.1 Exposure Points

The measured soil concentrations for non-radiological COPCs were utilized from soil characterization work (soil quality data summarized in **Appendix B**) and the 2019 Environmental Studies report (Ecometrix, 2022c) for Polygon E.

The exposure points for radiological COPCs were obtained from the same general sources as those used in the 2020 ERA (Ecometrix, 2022a) as described below, unless otherwise noted:

- Air emissions: OPG regularly monitors its radiological emissions from the DN site; therefore, there are updated air emissions data for the period 2020 to 2023. At the time of the writing of this report, weekly air emissions data were available for the period 2020 up to Q2 of 2023 as reported in OPG's quarterly safety performance indicator (SPI) reports.

- Fish tissue (white sucker in Lake Ontario): White sucker samples are collected on a quarterly basis from Lake Ontario and reported in OPG's EMP reports. The data from 2020, 2021, and 2022 were used to update the radiological doses.

- Water data for Lake Ontario are also available for the period 2020 to 2022. However, as the previous ERA relied upon data collected from a comprehensive 2019 report by Ecometrix (Ecometrix, 2022c), those data were relied upon for the Addendum as they were collected close to the DN site and are still considered representative of current conditions.

- The most up to date lake sediment, pond water, pond sediment, soil, vegetation, and fish tissue data (with the exception of White Sucker) were collected as part of a comprehensive environmental study carried out by Ecometrix in 2019 (Ecometrix, 2022c). Therefore, no updates were required to those media.

4.2.2 Exposure Averaging

For soil, the upper confidence limit of the mean (UCLM) was calculated for Polygon E based on the relevant soil data (i.e., 2019 and 2021 soil sampling studies). Both UCLM and maximum concentrations were used as exposure values.

The UCLM is a reasonably conservative estimate of the exposure concentration for a mobile organism. For less mobile organisms such as plants and invertebrates, both average and upper limit concentrations represent exposures that would be experienced by some organisms on a long-term basis.

4.2.3 Exposure and Dose Calculations

Exposure and dose calculations were performed for each radiological COPC for each ecological receptor for each receptor location. For non-radiological COPCs, dose calculations were not necessary as birds and mammals were not retained for evaluation based on the negligible toxicity of the identified COPCs to terrestrial vertebrates. For other receptors, the concentrations of COPCs at exposure points were used as exposure values, as the toxicity benchmark values are typically expressed as concentrations (CSA, 2022).

4.2.3.1 Radiological Dose Calculations

Radiological dose calculations were estimated using the Ecometrix software IMPACT^{TM} DRL Version 5.5.2 (IMPACT), which is the same version that was used for the 2020 ERA (Ecometrix, 2022a). IMPACT^{TM} is consistent with the equations outlined in CSA N288.1 and the methods outlined in CSA N288.6 (CSA, 2020, 2022). IMPACT^{TM} uses the specific activity model for tritium and C-14 as per CSA N288.1 and as recommended by CSA N288.6 (CSA, 2020, 2022).

4.2.4 Exposure Factors

No changes were required to any of the exposure factors used in the non-radiological or radiological exposure assessment (see Tables 4-9 to 4-12 in the 2020 DN ERA (Ecometrix, 2022a)), with the exception of two specific activity model values for C-14 and the occupancy factors for aquatic and terrestrial plants. In the 2020 update to CSA N288.1 (the 2020 ERA cited the previous 2014 iteration of N288.1), the stable carbon content for freshwater invertebrates was updated from 111 to 120 gC/kg fw. Furthermore, a stable carbon content for aquatic plants was set at 500 gC/kg dw or 125 gC/kg fw; note that this update did not result in any changes from the 2020 ERA given that this is the same value used for terrestrial plants, and the value for terrestrial plants had been adopted for aquatic plants. The occupancy factors for aquatic and terrestrial plants were updated to better reflect expected occupancy times for sediment surface, soil surface, and water column residency times. As such, the occupancy factors for aquatic plants were changed from 0 to 0.5 (fraction of time spent on the sediment surface) and from 1 to 0.5 (fraction of time spent in the water column). The occupancy factors for terrestrial plants were changed from 0.5 to 0 (fraction of plant immersed in soil) and 0.5 to 1 (fraction of plant above the soil surface).

4.2.5 Dispersion Models

No changes to the dispersion models were needed to support this ERA Addendum and as such, no additional calibrations of IMPACT™ version 5.5.2 since the 2020 ERA (Ecometrix, 2022a) were required.

4.2.6 Exposure Point Concentrations and Doses

4.2.6.1 Exposure Point Concentrations

The measured concentrations of non-radionuclide COPCs used for the exposure evaluation for Polygon E are presented in **Table 4-6**.

Table 4-6: Exposure Point Concentrations for Soil COPCs in Polygon E

	Units	Maximum	UCLM
PHC F1	mg/kg	270	18
PHC F2	mg/kg	460	32
PHC F3	mg/kg	1000	103
Sodium Adsorption Ratio	-	6.70	0.78

The measured concentrations of radionuclides used for the exposure evaluation for the different polygons are listed in **Table 4-7** through **Table 4-11**. In cases where a measured concentration is not provided, the concentration is modelled using exposure factors discussed in **Section 4.2.4**. The emissions used for modelling are provided in **Table 4-12**.

Table 4-7: Exposure Point Concentrations for Radionuclides in Lake Ontario

	Surface Water[1]		Sediment[2]		Round Whitefish[3]		White Sucker[4]		Alewife[5]		Mussels[6]	
	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM
Radionuclides												
Unit	Bq/L	Bq/L	Bq/kg(dw)	Bq/kg(dw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)
Carbon-14	2.30E-01	3.13E-02	9.89E-01	2.47E-01	3.40E+01	3.24E+01	3.36E+01	3.10E+01	3.46E+01	3.37E+01	3.79E+01	3.49E+01
Cobalt-60	3.14E-01	3.46E-02	2.08E-01	8.01E-02	1.00E-01	1.00E-01	1.00E-01	1.00E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Cesium-134	5.75E-01	9.41E-02	5.44E-01	1.86E-01	1.00E-01	1.00E-01	1.00E-01	1.00E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Cesium-137	7.25E-01	1.42E-01	1.11E+00	3.19E-01	3.00E-01	2.42E-01	3.00E-01	1.89E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Tritium	1.54E+01	1.72E+00	1.35E+01	5.96E+00	5.00E+00	4.92E+00	5.60E+00	3.09E+00	2.30E+01	2.19E+01	1.00E+01	1.00E+01
Iodine-131	1.10E+00	4.10E-01	1.32E+00	6.48E-01	8.00E+00	8.00E+00	3.00E+00	3.00E+00	1.30E+01	1.30E+01	1.04E+02	1.04E+02

Notes:

[1] 2019 Environmental Study (Ecometrix, 2022c) (C-14, Co-60, Cs-134, Cs-137, HTO, I-131).

[2] 2019, 2018 Environmental Study (Ecometrix, 2018, 2019, 2022c) (C-14, Cobalt-60, Cesium-134, Cesium-137, HTO, Iodine-131); C-14 was converted from Bg/kg-C using a measured carbon content of 1.75%

[3] (SENES, 2009b) (I-131); EMP 2011 (C-14, Cobalt-60, Cesium-134, Cesium-137, HTO). C-14 was converted from Bg/kg-C using a freshwater fish tissue of 121.75 gC/kg fw (CSA, 2020)

[4] (SENES, 2009b) (I-131); REMP 2011-2015 (Cobalt -60); EMP 2020-2022 (C-14, Cesium-134, Cesium-137, HTO). C-14 was converted from Bg/kg-C using a freshwater fish tissue of 121.75 gC/kg fw (CSA, 2020)

[5] (SENES, 2009b). C-14 was converted from Bg/kg-C using a freshwater fish tissue of 121.75 gC/kg fw (CSA, 2020)

[6] (SENES, 2009b); mussels used to represent aquatic invertebrates. C-14 was converted from Bg/kg-C using an aquatic invertebrate tissue of 120 gC/kg fw (CSA, 2020)

Table 4-8: Exposure Point Concentrations for Radionuclides in Polygon AB

	Surface Water[1]		Sediment[2]		Northern Redbelly Dace[3]		Aquatic Plants[4]		Soil[5]		Earthworm[6]		Caterpillar[6]		Terrestrial Vegetation[7]		Fruit[8]	
	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	Mean	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM
Radionuclides Unit	Bq/L	Bq/L	Bq/kg(dw)	Bq/kg(dw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(dw)	Bq/kg(dw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)
Carbon-14	7.00E-02	6.16E-02	7.10E+00	7.08E+00	3.49E+01	3.18E+01	3.89E+01	3.51E+01	2.35E+00	2.35E+00	3.31E+01	3.17E+01	3.34E+01	2.89E+01	2.88E+01	2.80E+01	1.18E+01	1.18E+01
Cobalt-60	1.19E-01	9.03E-02	1.21E-01	1.09E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	0*	0*	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Cesium-134	1.46E-01	1.46E-01	3.38E-01	3.38E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	2.00E-01	2.00E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Cesium-137	2.09E-01	1.95E-01	1.51E+00	1.50E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	5.50E+00	5.50E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Tritium	4.68E+01	4.05E+01	4.29E+01	4.13E+01	7.70E+01	7.25E+01	4.30E+01	4.16E+01	1.72E+02	1.72E+02	1.50E+01	1.50E+01	5.30E+01	5.15E+01	4.95E+02	3.15E+02	8.60E+01	8.60E+01
Iodine-131	3.85E+00	2.31E+00	8.68E-01	8.36E-01	3.18E+02	3.18E+02	2.00E+00	2.00E+00	2.20E+00	2.20E+00	1.00E+01	1.00E+01	6.00E+00	6.00E+00	1.70E+01	1.70E+01	2.00E+00	2.00E+00

Notes:

All data obtained from SENES (2009b), unless otherwise indicated.

[1] 2019 Environmental Study (Ecometrix, 2022c) (C-14, Cobalt-60, Cesium-134, Cesium-137, HTO, Iodine-131).

[2] 2019 Environmental Study (Ecometrix, 2022c) (C-14, Cobalt-60, Cesium-134, Cesium-137, HTO, Iodine-131). C-14 was converted from Bg/kg-C using a measured carbon content of 24 g C /kg

[3] C-14 was converted from Bg/kg-C using a freshwater fish tissue of 121.75 gC/kg fw (CSA, 2020)

[4] C-14 was converted from Bg/kg-C using an aquatic plant tissue of 125 gC/kg fw (CSA, 2020)

[5] 2019 Environmental Study (Ecometrix, 2022c) (C-14, Cobalt-60, Cesium-134, Cesium-137, HTO, Iodine-131). C-14 was converted from Bg/kg-C using a measured carbon content of 1.75%.

[6] C-14 was converted from Bg/kg-C using an aquatic invertebrate tissue of 120 gC/kg fw (CSA, 2020)

[7] C-14 was converted from Bg/kg-C using a terrestrial vegetation tissue (forage) of 100 gC/kg fw (CSA, 2020). A dry to fresh weight ratio of 0.2 was used to convert non-radionuclide terrestrial vegetation concentrations reported on a dry weight to a wet weight basis (CSA, 2020).

[8] C-14 was converted from Bg/kg-C using a terrestrial vegetation tissue (fruit) of 50 gC/kg fw (CSA, 2020). Non-radionuclide fruit concentrations were not measured. Fruit concentrations were estimated using measured terrestrial vegetation concentrations on a dry weight basis and a dry fresh weight ratio of 0.1 for fruit (CSA, 2020)

*indicates negative value

Table 4-9: Exposure Point Concentrations for Polygon C

	Soil[1]		Earthworm[2]		Caterpillar[2]		Terrestrial Vegetation[3]		Fruit[4]	
	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM
Radionuclides										
Unit	Bq/kg(dw)	Bq/kg(dw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)
Carbon-14	6.69E-01	6.69E-01	3.79E+01	3.79E+01	5.22E+01	5.22E+01	5.77E+01	5.77E+01	1.27E+01	1.27E+01
Cobalt-60	0*	0*	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Cesium-134	1.00E-01	1.00E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Cesium-137	7.00E-01	7.00E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Tritium	2.80E+00	2.80E+00	3.70E+01	3.70E+01	1.85E+02	1.85E+02	2.66E+02	2.66E+02	1.51E+02	1.51E+02
Iodine-131	2.40E+00	2.40E+00	9.00E+00	9.00E+00	8.00E+00	8.00E+00	1.40E+01	1.40E+01	2.00E+00	2.00E+00

Notes:
All data obtained from SENES (2009b), unless otherwise indicated.
[1] 2019 Environmental Study (Ecometrix, 2022c) (C-14, Cobalt-60, Cesium-134, Cesium-137, HTO, Iodine-131). C-14 was converted from Bg/kg-C with a measured carbon content of 1.99%
[2]C-14 was converted from Bg/kg-C using an aquatic invertebrate tissue of 120 gC/kg fw (CSA, 2020)
[3]C-14 was converted from Bq/kg-C using a terrestrial vegetation tissue (forage) of 100 gC/kg fw (CSA, 2020)
[4] C-14 was converted from Bq/kg-C using a terrestrial vegetation tissue (fruit) of 50 gC/kg fw (CSA, 2020). Non-radionuclide fruit concentrations were not measured. Fruit concentrations were estimated using measured terrestrial vegetation concentrations on a dry weight basis and a dry fresh weight ratio of 0.1 for fruit (CSA, 2020)
* negative value

Table 4-10: Exposure Point Concentrations for Polygon D

	Surface Water[1]		Sediment[2]		Frogs[3]		Aquatic Plants[4]		Soil[1, 5]		Earthworm[6]		Caterpillar[6]		Terrestrial Vegetation[7]		Fruit[8]	
	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM
Radionuclides																		
Unit	Bq/L	Bq/L	Bq/kg(dw)	Bq/kg(dw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(dw)	Bq/kg(dw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)	Bq/kg(fw)
Carbon-14	8.90E-02	8.90E-02	6.75E+01	6.75E+01	3.38E+01	3.38E+01	5.75E+01	5.75E+01	7.17E+00	7.17E+00	3.84E+01	3.84E+01	3.53E+01	3.53E+01	5.68E+01	4.87E+01	1.46E+01	1.42E+01
Cobalt-60	5.55E-02	5.55E-02	0*	0*	1.00E+00	1.00E+00	1.00E+00	1.00E+00	0*	0*	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Cesium-134	7.11E-02	7.11E-02	3.35E-01	3.35E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	2.00E-01	2.00E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Cesium-137	6.69E-02	6.69E-02	7.03E+00	6.71E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	6.30E+00	6.30E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Tritium	5.80E+01	5.80E+01	5.01E+01	4.77E+01	3.80E+01	3.80E+01	5.80E+01	5.80E+01	3.00E+01	3.00E+01	1.90E+01	1.90E+01	9.20E+01	9.20E+01	5.50E+01	4.25E+01	9.30E+01	8.80E+01
Iodine-131	2.21E-01	2.21E-01	5.30E-01	5.26E-01	2.20E+01	2.20E+01	3.00E+00	3.00E+00	3.00E-01	3.00E-01	1.20E+01	1.20E+01	4.00E+00	4.00E+00	2.30E+01	2.30E+01	2.00E+00	2.00E+00

Notes:
All data obtained from SENES (2009b), unless otherwise indicated.
[1] 2019 Environmental Study (Ecometrix, 2022c) (C-14, Cobalt-60, Cesium-134, Cesium-137, HTO, Iodine-131).
[2] 2019 Environmental Study (Ecometrix, 2022c) (C-14, Cobalt-60, Cesium-134, Cesium-137, HTO, Iodine-131). C-14 was converted from Bg/kg-C with a measured carbon content of 144 g G/kg
[3]C-14 was converted from Bg/kg-C using a freshwater fish tissue of 121.75 gC/kg fw (CSA, 2020)
[3]C-14 was converted from Bg/kg-C using an aquatic plant tissue of 125 gC/kg fw (CSA, 2020)
[4] C-14 was converted from Bg/kg-C with a measured carbon content of 2.77%
[5]C-14 was converted from Bg/kg-C using an aquatic invertebrate tissue of 111 gC/kg fw (CSA, 2020)
[6]C-14 was converted from Bg/kg-C using a terrestrial vegetation tissue (forage) of 100 gC/kg fw (CSA, 2020). A dry to fresh weight ratio of 0.2 was used to convert non-radionuclide terrestrial vegetation concentrations reported on a dry weight to a wet weight basis (CSA, 2020)
[7]C-14 was converted from Bg/kg-C using a terrestrial vegetation tissue (fruit) of 50 gC/kg fw (CSA, 2020). Non-radionuclide fruit concentrations were not measured. Fruit concentrations were estimated using measured terrestrial vegetation concentrations on a dry weight basis and a dry fresh weight ratio of 0.1 for fruit (CSA, 2020)
* negative value

Table 4-11: Exposure Point Concentrations for Polygon E

	Surface Water[1]		Soil[2,3]		Fruit[4]	
	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM
Radionuclides						
Unit	Bq/L	Bq/L	Bq/kg(dw)	Bq/kg(dw)	Bq/kg(fw)	Bq/kg(fw)
Carbon-14	2.30E-01	3.13E-02	1.86E+00	4.46E-01	1.49E+01	1.49E+01
Cobalt-60	3.14E-01	3.46E-02	6.00E-01	8.50E-02	1.00E+00	1.00E+00
Cesium-134	5.75E-01	9.41E-02	4.00E-01	1.82E-01	1.00E+00	1.00E+00
Cesium-137	7.25E-01	1.42E-01	4.60E+00	9.00E-01	1.00E+00	1.00E+00
Tritium	1.54E+01	1.72E+00	1.67E+02	5.31E+01	1.86E+02	1.86E+02
Iodine-131	4.03E+01	7.03E+00	2.20E+00	5.65E-01	2.00E+00	2.00E+00

Notes:
[1] 2019 Environmental Study (Ecometrix, 2022c) (C-14, Cobalt-60, Cesium-134, Cesium-137, HTO, Iodine-131).
[2] 2019 Environmental Study (Ecometrix, 2022c) (C-14, Cobalt-60, Cesium-134, Cesium-137, HTO, Iodine-131). C-14 was converted from Bg/kg-C with a measured carbon content of 0.79%.
[3]C-14 was converted from Bg/kg-C assuming a carbon content of 5%.
[4]C-14 was converted from Bg/kg-C using a terrestrial vegetation tissue (fruit) of 50 gC/kg fw (CSA, 2020). Non-radionuclide fruit concentrations were not measured. Fruit concentrations were estimated using measured terrestrial vegetation concentrations on a dry weight basis and a dry fresh weight ratio of 0.1 for fruit (CSA, 2020).

Table 4-12: Emissions to Air used to Model Exposure Point Concentrations

	Air[1]	
	Maximum	UCLM
Radionuclides		
Unit	Bq/s	Bq/s
Carbon-14	8.60E+04	6.21E+04
Cobalt-60	1.65E-01	1.34E-01
Cesium-134	*	*
Cesium-137	*	*
Tritium Oxide (HTO)	1.82E+07	1.13E+07
Elemental Tritium (HT)	7.94E+07	3.30E+07
Iodine-131	6.45E+00	5.30E+00

Notes:
[1] Maximum and UCLM were determined based on weekly air emission reporting data between Q1 2020 and Q2 2023 (CNSC, 2020a, 2020b, 2020c, 2020d, 2021a, 2021b, 2021c, 2021d, 2022a, 2022b, 2022c, 2022d, 2023a, 2023b). UCLM was calculated as mean+2×standard error.
* The particulate emissions data was used to represent gross beta radionuclides (Cobalt-60, Cesium-134, and Cesium-137). Cobalt-60 is used as the surrogate for gross beta.

4.2.6.2 Exposure Doses for Radionuclides

The estimated radiological doses are presented in **Table 4-13** to **Table 4-17** for receptors at Lake Ontario and Polygons AB, C, D, and E. It is noted that these doses incorporate any emissions from the Mo-99/TDS, which was placed in operation starting in 2023.

The dose rate for ecological receptors in close proximity to the NSS-DWMF (approximately 5 m from any wall) could be up to 1 µGy/h (0.024 mGy/d), assuming full capacity of the Darlington Waste Management Facility (DWMF) (OPG, 2016).

The dose rate to any ecological receptor at the NSS-DWMF property boundary could be up to 0.5 µGy/h (0.012 mGy/d), assuming full capacity of the NSS-DWMF (OPG, 2016). Based on measured dose rates at the NSS-DWMF property boundary from Q1 2020 to Q2 2023 (OPG, 2020a, 2020b, 2020c, 2021e, 2021f, 2021g, 2021h, 2022f, 2022g, 2022h, 2022i, 2023g), the average dose rate was 0.087 µGy/h (0.002 mGy/d). The average dose rate at the RWSB perimeter was 0.067 µGy/h (0.0016 mGy/d), based on the Q1 2020 to Q2 2023 monitoring results.

The above dose rates estimated for ecological receptors are conservative as it assumes the receptor is always located at the NSS-DWMF and does not incorporate an occupancy factor based on the fraction of time a receptor is likely to be in close proximity to the NSS-DWMF. Based on expected radiological dose rates to ecological receptors in Polygon E located on the DN site (**Table 4-17**), the dose from the NSS-DWMF at full capacity would be the largest contributor to total dose for receptors in Polygon E.

Table 4-13: Estimated Radiation Doses for Aquatic and Riparian Receptors for Lake Ontario (mGy/d)

Receptor	Carbon-14		Cobalt-60		Cesium-134		Cesium-137		HTO		Organically bound tritium (OBT)		Iodine-131		Total Dose	
	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM
Round Whitefish	2.31E-05	2.20E-05	5.10E-07	5.10E-07	4.90E-07	4.90E-07	1.32E-06	1.06E-06	6.91E-07	6.80E-07	2.98E-07	3.33E-08	2.64E-05	2.64E-05	5.28E-05	5.12E-05
White Sucker	2.28E-05	2.11E-05	5.10E-07	5.10E-07	4.90E-07	5.44E-07	1.32E-06	8.32E-07	7.74E-07	4.27E-07	2.98E-07	3.33E-08	9.90E-06	9.90E-06	3.61E-05	3.33E-05
Alewife	2.35E-05	2.29E-05	5.10E-06	5.10E-06	4.90E-06	4.90E-06	4.40E-06	4.40E-06	3.18E-06	3.03E-06	2.98E-07	3.33E-08	4.29E-05	4.29E-05	8.43E-05	8.33E-05
Lake Trout	8.91E-04	1.21E-04	9.62E-05	1.06E-05	9.87E-03	1.62E-03	1.12E-02	2.19E-03	1.60E-06	1.78E-07	2.98E-07	3.33E-08	2.68E-05	1.00E-05	2.21E-02	3.95E-03
American Eel	8.91E-04	1.21E-04	9.41E-05	1.05E-05	9.87E-03	1.62E-03	1.12E-02	2.19E-03	1.60E-06	1.78E-07	2.98E-07	3.33E-08	2.59E-05	9.68E-06	2.21E-02	3.94E-03
Benthic Invertebrates	2.55E-05	2.35E-05	1.25E-06	1.25E-06	1.73E-06	1.73E-06	2.35E-06	2.35E-06	1.39E-06	1.39E-06	2.99E-07	3.34E-08	2.17E-04	2.17E-04	2.50E-04	2.47E-04
Bufflehead	2.83E-05	2.61E-05	1.45E-06	1.25E-06	3.78E-06	3.20E-06	3.28E-06	2.72E-06	2.19E-06	1.37E-06	1.95E-07	1.05E-07	8.42E-07	7.43E-07	4.00E-05	3.55E-05
Mallard	2.83E-05	2.61E-05	1.37E-06	1.18E-06	3.58E-06	3.02E-06	3.10E-06	2.57E-06	2.19E-06	1.37E-06	1.95E-07	1.05E-07	8.03E-07	7.04E-07	3.96E-05	3.50E-05

Note:

No values exceed the aquatic benchmark of 9.6 mGy/d or the terrestrial benchmark of 2.4 mGy/d.

Table 4-14: Estimated Radiation Doses for Aquatic and Terrestrial Receptors for Polygon AB (mGy/d)

Receptor	Carbon-14		Cobalt-60		Cesium-134		Cesium-137		Tritium		OBT		Iodine-131		Total Dose	
	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM
Northern Redbelly Dace	2.38E-05	2.16E-05	5.10E-06	5.10E-06	4.90E-06	4.90E-06	4.40E-06	4.40E-06	1.06E-05	1.00E-05	9.06E-07	7.84E-07	1.05E-03	1.05E-03	1.10E-03	1.10E-03
Turtles	2.71E-04	2.39E-04	1.29E-05	9.80E-06	1.18E-03	1.18E-03	2.34E-03	2.19E-03	4.85E-06	4.20E-06	9.06E-07	7.84E-07	7.36E-05	4.42E-05	3.88E-03	3.66E-03
Frogs	2.71E-04	2.39E-04	1.29E-05	9.80E-06	1.18E-03	1.18E-03	2.34E-03	2.19E-03	4.85E-06	4.20E-06	9.06E-07	7.84E-07	7.36E-05	4.42E-05	3.88E-03	3.66E-03
Aquatic Plants	2.64E-05	2.39E-05	2.10E-06	2.10E-06	2.70E-06	2.70E-06	3.30E-06	3.30E-06	5.94E-06	5.75E-06	7.12E-07	6.16E-07	5.40E-06	5.40E-06	4.66E-05	4.37E-05
Benthic Invertebrates	2.45E-04	2.15E-04	1.71E-05	1.31E-05	2.65E-05	2.65E-05	5.13E-05	4.81E-05	4.86E-06	4.21E-06	9.08E-07	7.86E-07	7.82E-05	4.73E-05	4.24E-04	3.55E-04
Bufflehead	2.47E-04	2.18E-04	1.40E-05	1.07E-05	3.99E-05	3.99E-05	4.85E-05	4.53E-05	3.08E-06	2.38E-06	1.75E-07	1.17E-07	3.41E-07	2.51E-07	3.53E-04	3.16E-04
Mallard	2.10E-04	1.85E-04	1.12E-05	8.58E-06	3.18E-05	3.18E-05	3.85E-05	3.60E-05	3.13E-06	2.45E-06	1.75E-07	1.17E-07	2.97E-07	2.25E-07	2.96E-04	2.65E-04
Muskrat	4.25E-05	3.84E-05	2.98E-07	2.74E-07	3.99E-06	3.99E-06	4.36E-06	4.34E-06	6.27E-06	5.23E-06	4.28E-07	3.13E-07	2.83E-06	2.43E-06	6.07E-05	5.49E-05
Earthworm	2.25E-05	2.16E-05	1.80E-06	1.80E-06	2.60E-06	2.60E-06	3.40E-06	3.40E-06	2.07E-06	2.07E-06	1.37E-05	7.66E-06	2.70E-05	2.70E-05	7.31E-05	6.61E-05
American Robin	2.23E-05	2.18E-05	3.00E-06	2.99E-06	1.09E-05	1.09E-05	3.79E-05	3.79E-05	3.29E-06	2.77E-06	2.54E-07	1.97E-07	8.37E-06	8.37E-06	8.60E-05	8.49E-05
Bank Swallow	2.50E-05	2.16E-05	2.46E-06	2.45E-06	7.97E-06	7.97E-06	2.11E-05	2.11E-05	3.58E-06	3.00E-06	2.68E-07	2.08E-07	4.23E-06	4.22E-06	6.46E-05	6.06E-05
Song Sparrow	3.27E-05	3.18E-05	5.99E-06	5.98E-06	2.05E-05	2.05E-05	6.29E-05	6.29E-05	7.06E-06	6.22E-06	4.90E-07	3.98E-07	1.33E-05	1.33E-05	1.43E-04	1.41E-04
Yellow Warbler	2.46E-05	2.15E-05	2.66E-06	2.65E-06	8.48E-06	8.48E-06	2.16E-05	2.15E-05	3.64E-06	3.07E-06	2.70E-07	2.11E-07	4.23E-06	4.22E-06	6.55E-05	6.16E-05
Green Heron	2.38E-05	2.17E-05	1.44E-06	1.42E-06	3.66E-06	3.66E-06	3.32E-06	3.31E-06	4.79E-06	4.09E-06	1.75E-07	1.17E-07	2.33E-06	2.32E-06	3.95E-05	3.66E-05
Terrestrial Plants (Grass)	1.96E-05	1.90E-05	1.80E-06	1.80E-06	2.50E-06	2.50E-06	3.40E-06	3.40E-06	6.84E-05	4.35E-05	1.29E-09	7.21E-10	4.42E-05	4.42E-05	1.40E-04	1.14E-04
Eastern Cottontail	3.94E-05	3.83E-05	7.52E-08	7.46E-08	1.02E-05	1.02E-05	6.87E-05	6.86E-05	3.28E-05	2.12E-05	1.74E-06	1.15E-06	3.24E-05	3.20E-05	1.85E-04	1.72E-04
Meadow Vole	3.94E-05	3.83E-05	3.04E-08	3.01E-08	7.85E-06	7.85E-06	6.60E-05	6.60E-05	3.28E-05	2.12E-05	1.74E-06	1.15E-06	2.38E-05	2.35E-05	1.72E-04	1.58E-04
White-tailed Deer	3.94E-05	3.83E-05	5.27E-07	5.21E-07	2.36E-05	2.36E-05	4.31E-05	4.31E-05	3.66E-05	2.36E-05	1.88E-06	1.23E-06	4.90E-05	4.75E-05	1.94E-04	1.78E-04
Common Shrew	4.11E-05	3.56E-05	1.06E-07	1.05E-07	1.18E-05	1.18E-05	7.00E-05	7.00E-05	6.58E-06	5.54E-06	5.63E-07	4.45E-07	2.51E-05	2.49E-05	1.55E-04	1.48E-04
Raccoon	3.29E-05	3.00E-05	1.82E-07	1.55E-07	1.66E-05	1.66E-05	7.80E-05	7.74E-05	1.31E-05	9.17E-06	8.49E-07	6.03E-07	2.95E-05	2.75E-05	1.71E-04	1.62E-04
Red Fox	8.19E-05	7.44E-05	2.14E-08	1.74E-08	8.81E-06	8.81E-06	1.30E-04	1.30E-04	1.62E-05	1.08E-05	7.00E-07	4.88E-07	1.86E-05	1.81E-05	2.57E-04	2.43E-04
Short-tailed Weasel	3.94E-05	3.83E-05	2.22E-09	1.76E-09	7.24E-06	7.24E-06	6.56E-05	6.56E-05	1.96E-05	1.30E-05	5.87E-07	4.18E-07	1.95E-05	1.92E-05	1.52E-04	1.44E-04

Note:
No values exceed the aquatic benchmark of 9.6 mGy/d or the terrestrial benchmark of 2.4 mGy/d.

Table 4-15: Estimated Radiation Doses for Terrestrial Receptors for Polygon C (mGy/d)

Receptor	Carbon-14		Cobalt-60		Cesium-134		Cesium-137		HTO		OBT		Iodine-131		Total Dose	
	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM
Earthworm	2.58E-05	2.58E-05	1.80E-06	1.80E-06	2.60E-06	2.60E-06	3.40E-06	3.40E-06	5.11E-06	5.11E-06	9.63E-06	5.39E-06	2.43E-05	2.43E-05	7.26E-05	6.84E-05
American Robin	2.49E-05	2.49E-05	2.96E-06	2.96E-06	9.22E-06	9.22E-06	1.05E-05	1.05E-05	9.59E-06	6.93E-06	8.52E-07	5.59E-07	9.12E-06	9.12E-06	6.71E-05	6.41E-05
Song Sparrow	3.82E-05	3.82E-05	5.92E-06	5.92E-06	1.78E-05	1.78E-05	1.93E-05	1.93E-05	1.90E-05	1.48E-05	1.54E-06	1.07E-06	1.45E-05	1.45E-05	1.16E-04	1.12E-04
Yellow Warbler	3.79E-05	3.79E-05	2.61E-06	2.61E-06	7.54E-06	7.54E-06	7.73E-06	7.73E-06	1.32E-05	1.06E-05	1.02E-06	7.30E-07	4.62E-06	4.62E-06	7.47E-05	7.18E-05
Terrestrial Plants (Grass)	3.92E-05	3.92E-05	1.80E-06	1.80E-06	2.50E-06	2.50E-06	3.40E-06	3.40E-06	3.68E-05	3.68E-05	9.06E-10	5.07E-10	3.64E-05	3.64E-05	1.20E-04	1.20E-04
Eastern Cottontail	7.89E-05	7.89E-05	7.26E-08	7.26E-08	6.93E-06	6.93E-06	1.20E-05	1.20E-05	3.80E-05	2.87E-05	3.38E-06	2.27E-06	3.07E-05	3.07E-05	1.70E-04	1.60E-04
Meadow Vole	7.89E-05	7.89E-05	2.90E-08	2.90E-08	4.64E-06	4.64E-06	9.71E-06	9.71E-06	3.80E-05	2.87E-05	3.38E-06	2.27E-06	2.39E-05	2.39E-05	1.58E-04	1.48E-04
White-tailed Deer	7.89E-05	7.89E-05	5.02E-07	5.02E-07	2.09E-05	2.09E-05	1.46E-05	1.46E-05	3.60E-05	2.85E-05	2.97E-06	2.07E-06	3.97E-05	3.97E-05	1.93E-04	1.85E-04
Common Shrew	6.43E-05	6.43E-05	1.04E-07	1.04E-07	8.59E-06	8.59E-06	1.37E-05	1.37E-05	3.28E-05	2.35E-05	3.15E-06	2.03E-06	2.86E-05	2.86E-05	1.51E-04	1.41E-04
Raccoon	6.29E-05	6.29E-05	8.15E-08	8.15E-08	7.57E-06	7.57E-06	1.27E-05	1.27E-05	3.41E-05	2.44E-05	3.15E-06	2.03E-06	2.74E-05	2.74E-05	1.48E-04	1.37E-04
Red Fox	7.44E-05	7.44E-05	4.59E-09	4.59E-09	3.73E-06	3.73E-06	1.69E-05	1.69E-05	3.94E-05	2.65E-05	3.02E-06	1.83E-06	1.88E-05	1.88E-05	1.56E-04	1.42E-04
Short-tailed Weasel	7.89E-05	7.89E-05	3.05E-10	3.05E-10	3.94E-06	3.94E-06	9.04E-06	9.04E-06	4.09E-05	2.70E-05	2.98E-06	1.77E-06	2.01E-05	2.01E-05	1.56E-04	1.41E-04

Note:

No values exceed the terrestrial benchmark of 2.4 mGy/d.

Table 4-16: Estimated Radiation Doses for Aquatic and Terrestrial Receptors for Polygon D (mGy/d)

Receptor	Carbon-14		Cobalt-60		Cesium-134		Cesium-137		HTO		OBT		Iodine-131		Total Dose	
	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM
Turtles	3.45E-04	3.45E-04	5.91E-06	5.91E-06	5.74E-04	5.74E-04	7.52E-04	7.52E-04	6.01E-06	6.01E-06	1.12E-06	1.12E-06	4.35E-06	4.35E-06	1.69E-03	1.69E-03
Frogs	2.30E-05	2.30E-05	1.50E-06	1.50E-06	2.30E-06	2.30E-06	3.20E-06	3.20E-06	5.25E-06	5.25E-06	1.12E-06	1.12E-06	5.50E-05	5.50E-05	9.14E-05	9.14E-05
Aquatic Plants	3.91E-05	3.91E-05	2.10E-06	2.10E-06	2.70E-06	2.70E-06	3.30E-06	3.30E-06	8.02E-06	8.02E-06	8.82E-07	8.82E-07	8.10E-06	8.10E-06	6.42E-05	6.42E-05
Earthworm	2.61E-05	2.61E-05	1.80E-06	1.80E-06	2.60E-06	2.60E-06	3.40E-06	3.40E-06	2.63E-06	2.63E-06	8.64E-06	4.83E-06	3.24E-05	3.24E-05	7.76E-05	7.38E-05
American Robin	2.66E-05	2.63E-05	2.98E-06	2.98E-06	1.09E-05	1.09E-05	4.23E-05	4.23E-05	3.20E-06	2.83E-06	2.32E-07	1.97E-07	1.22E-06	1.22E-06	8.73E-05	8.67E-05
Song Sparrow	3.92E-05	3.84E-05	5.95E-06	5.95E-06	2.04E-05	2.04E-05	6.99E-05	6.99E-05	7.31E-06	6.62E-06	4.73E-07	4.12E-07	1.87E-06	1.87E-06	1.45E-04	1.44E-04
Yellow Warbler	2.62E-05	2.62E-05	2.63E-06	2.63E-06	8.40E-06	8.40E-06	2.37E-05	2.37E-05	4.75E-06	4.46E-06	3.04E-07	2.72E-07	6.15E-07	6.15E-07	6.67E-05	6.63E-05
Terrestrial Plants (Grass)	3.86E-05	3.31E-05	1.80E-06	1.80E-06	2.50E-06	2.50E-06	3.40E-06	3.40E-06	7.60E-06	5.88E-06	8.13E-10	4.55E-10	5.98E-05	5.98E-05	1.14E-04	1.06E-04
Terrestrial Plants (Sugar Maple)	3.86E-05	3.31E-05	1.80E-05	1.80E-05	1.40E-05	1.40E-05	7.80E-06	7.80E-06	7.60E-06	5.88E-06	8.13E-06	4.55E-06	1.36E-04	1.36E-04	2.30E-04	2.19E-04
Eastern Cottontail	7.76E-05	6.66E-05	7.38E-08	7.38E-08	1.01E-05	1.01E-05	7.79E-05	7.79E-05	6.64E-06	5.45E-06	5.53E-07	4.66E-07	2.10E-05	2.10E-05	1.94E-04	1.82E-04
Meadow Vole	7.76E-05	6.66E-05	2.97E-08	2.97E-08	7.81E-06	7.81E-06	7.53E-05	7.53E-05	6.64E-06	5.45E-06	5.53E-07	4.66E-07	9.83E-06	9.83E-06	1.78E-04	1.65E-04
White-tailed Deer	7.76E-05	6.66E-05	5.14E-07	5.14E-07	2.30E-05	2.30E-05	4.71E-05	4.71E-05	6.64E-06	5.35E-06	5.17E-07	4.26E-07	5.09E-05	5.09E-05	2.06E-04	1.94E-04
Common Shrew	4.35E-05	4.35E-05	1.05E-07	1.05E-07	1.17E-05	1.17E-05	7.93E-05	7.93E-05	8.63E-06	8.18E-06	6.42E-07	5.89E-07	7.07E-06	7.07E-06	1.51E-04	1.50E-04
Raccoon	5.31E-05	4.88E-05	8.30E-08	8.30E-08	1.08E-05	1.08E-05	7.88E-05	7.88E-05	7.47E-06	6.74E-06	5.81E-07	5.16E-07	1.08E-05	1.08E-05	1.62E-04	1.57E-04
Red Fox	7.32E-05	6.28E-05	6.03E-09	6.03E-09	6.71E-06	6.71E-06	1.46E-04	1.46E-04	4.13E-06	3.11E-06	1.90E-07	1.25E-07	4.29E-06	4.29E-06	2.34E-04	2.23E-04
Short-tailed Weasel	7.76E-05	6.66E-05	1.20E-09	1.20E-09	7.15E-06	7.15E-06	7.48E-05	7.48E-05	6.63E-06	5.61E-06	4.57E-07	3.96E-07	3.68E-06	3.68E-06	1.70E-04	1.58E-04

Note:
No values exceed the aquatic benchmark of 9.6 mGy/d or the terrestrial benchmark of 2.4 mGy/d.

Table 4-17: Estimated Radiation Doses for Terrestrial Receptors for Polygon E (mGy/d)

Receptor	Carbon-14		Cobalt-60		Cesium-134		Cesium-137		HTO		OBT		Iodine-131		Total Dose	
	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM
Earthworm	1.83E-05	1.32E-05	1.86E-05	2.64E-06	8.09E-06	3.68E-06	3.50E-05	6.84E-06	1.56E-04	8.72E-05	1.56E-05	8.75E-06	1.11E-05	2.85E-06	2.62E-04	1.25E-04
American Robin	2.23E-05	1.93E-05	1.60E-05	3.78E-06	1.15E-05	7.59E-06	3.16E-05	9.33E-06	2.69E-05	1.64E-05	1.35E-06	8.10E-07	8.31E-06	2.15E-06	1.18E-04	5.93E-05
Bank Swallow	2.02E-05	1.46E-05	7.18E-06	1.01E-06	4.01E-06	1.64E-06	1.59E-05	3.12E-06	4.38E-05	2.45E-05	2.13E-06	1.19E-06	4.15E-06	1.07E-06	9.74E-05	4.71E-05
Song Sparrow	3.83E-05	3.69E-05	2.80E-05	8.54E-06	2.47E-05	1.85E-05	5.47E-05	2.01E-05	2.17E-05	1.59E-05	1.16E-06	8.18E-07	1.33E-05	3.46E-06	1.82E-04	1.04E-04
Yellow Warbler	2.04E-05	1.52E-05	7.42E-06	1.27E-06	4.61E-06	2.29E-06	1.64E-05	3.66E-06	4.17E-05	2.34E-05	2.03E-06	1.14E-06	4.16E-06	1.07E-06	9.67E-05	4.80E-05
Terrestrial Plants (Grass)	2.36E-05	1.70E-05	6.71E-05	9.51E-06	3.02E-05	1.37E-05	1.32E-04	2.58E-05	1.50E-04	8.41E-05	1.47E-09	8.24E-10	4.26E-05	1.10E-05	4.45E-04	1.61E-04
Terrestrial Plants (Sugar maple)	2.36E-05	1.70E-05	2.04E-05	2.89E-06	9.00E-06	4.10E-06	3.75E-05	7.33E-06	1.50E-04	8.40E-05	1.47E-05	8.24E-06	1.28E-05	3.30E-06	2.68E-04	1.27E-04
Eastern Cottontail	4.74E-05	3.43E-05	2.96E-05	4.20E-06	1.32E-05	5.80E-06	5.50E-05	1.08E-05	6.67E-05	3.71E-05	3.19E-06	1.76E-06	1.81E-05	4.71E-06	2.33E-04	9.86E-05
Meadow Vole	4.74E-05	3.43E-05	2.96E-05	4.20E-06	1.29E-05	5.74E-06	5.44E-05	1.06E-05	6.67E-05	3.71E-05	3.19E-06	1.76E-06	1.79E-05	4.64E-06	2.32E-04	9.84E-05
White-tailed Deer	4.74E-05	3.43E-05	1.52E-05	2.15E-06	1.11E-05	3.69E-06	3.02E-05	5.91E-06	7.58E-05	4.23E-05	3.59E-06	1.99E-06	9.80E-06	2.69E-06	1.93E-04	9.29E-05
Common Shrew	3.32E-05	2.40E-05	2.96E-05	4.20E-06	1.30E-05	5.82E-06	5.65E-05	1.11E-05	6.67E-05	3.71E-05	3.19E-06	1.76E-06	1.83E-05	4.71E-06	2.20E-04	8.86E-05
Raccoon	3.69E-05	2.75E-05	2.97E-05	4.21E-06	1.42E-05	6.58E-06	5.70E-05	1.17E-05	5.47E-05	3.07E-05	2.53E-06	1.41E-06	1.86E-05	5.06E-06	2.14E-04	8.73E-05
Red Fox	4.47E-05	3.23E-05	2.72E-05	3.85E-06	1.24E-05	5.39E-06	1.07E-04	2.09E-05	3.78E-05	2.08E-05	9.52E-07	5.03E-07	1.65E-05	4.27E-06	2.46E-04	8.81E-05
Short-tailed Weasel	4.74E-05	3.43E-05	2.96E-05	4.20E-06	1.32E-05	5.80E-06	5.49E-05	1.07E-05	3.51E-05	1.93E-05	5.98E-07	3.05E-07	1.80E-05	4.65E-06	1.99E-04	7.93E-05

Note:

No values exceed the terrestrial benchmark of 2.4 mGy/d.

4.2.7 Uncertainties in Exposure Assessment

Uncertainties in the exposure assessment remain as reported in the 2020 DN ERA (Ecometrix, 2022a). No new sources of uncertainty were introduced based on the new data / information that was utilized (**Appendix A**).

4.3 Toxicity Assessment

4.3.1 Toxicological Benchmarks

Terrestrial plant and soil invertebrate benchmarks are based on soil concentrations. For the selected COPCs, the TRVs used are Canadian soil quality guidelines (agricultural soil contact values) (CCME, 1999).

Table 4-18: Toxicological Benchmarks for Soil for Terrestrial Invertebrates and Plants

Parameter	Soil Organism TRV mg/kg dw	Reference	Plant TRV mg/kg dw	Reference
PHC F1	210	CCME, 1999	210	CCME, 1999
PHC F2	150	CCME, 1999	150	CCME, 1999
PHC F3	300	CCME, 1999	300	CCME, 1999
SAR	5	CCME, 1999	5	CCME, 1999

4.3.2 Radiation Benchmarks

Radiation dose benchmarks of 400 µGy/h (9.6 mGy/d) and 100 µGy/h (2.4 mGy/d) (UNSCEAR, 2008) were selected for this assessment of effects on aquatic biota and terrestrial biota, respectively, as recommended in the CSA N288.6 standard. This is a total dose benchmark; therefore, the doses to biota due to each radionuclide of concern are summed to compare against this benchmark.

4.3.3 Uncertainties in the Toxicity Assessment

The uncertainties in the toxicity assessment remain unchanged from the 2020 ERA (Ecometrix, 2022a). No new uncertainties were identified based on the new toxicity benchmarks identified.

4.4 Risk Characterization

4.4.1 Risk Estimation

Ecological risk from radiological COPCs is assessed through comparison with the benchmarks of 2.4 mGy/d and 9.6 mGy/d for terrestrial and aquatic biota, respectively. The dose to ecological receptors from all pathways is presented in **Table 4-19**.

Table 4-19: Summary of Total Radiation Dose Estimates for Ecological Receptors for Lake Ontario, Polygon AB, C, D, and E (mGy/d)

Receptor	Lake Ontario		AB		C		D		E		Percent Benchmark at Maximum Location	
	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM
Round Whitefish	5.28E-05	5.12E-05	-	-	-	-	-	-	-	-	0.001%	0.001%
White Sucker	3.61E-05	3.33E-05	-	-	-	-	-	-	-	-	0.000%	0.000%
Alewife	8.43E-05	8.33E-05	-	-	-	-	-	-	-	-	0.001%	0.001%
Lake Trout	2.21E-02	3.95E-03	-	-	-	-	-	-	-	-	0.230%	0.041%
American Eel	2.21E-02	3.94E-03	-	-	-	-	-	-	-	-	0.230%	0.041%
Northern Redbelly Dace	-	-	1.10E-03	1.10E-03	-	-	-	-	-	-	0.011%	0.011%
Turtles	-	-	3.88E-03	3.66E-03	-	-	3.38E-03	3.38E-03	-	-	0.040%	0.038%
Frogs	-	-	3.88E-03	3.66E-03	-	-	1.83E-04	1.83E-04	-	-	0.040%	0.038%
Aquatic Plants	-	-	4.66E-05	4.37E-05	-	-	1.28E-04	1.28E-04	-	-	0.001%	0.001%
Benthic Invertebrates	2.50E-04	2.47E-04	4.24E-04	3.55E-04	-	-	-	-	-	-	0.004%	0.004%
Bufflehead	4.00E-05	3.55E-05	3.53E-04	3.16E-04	-	-	-	-	-	-	0.015%	0.013%
Mallard	3.96E-05	3.50E-05	2.96E-04	2.65E-04	-	-	-	-	-	-	0.012%	0.011%
Muskrat	-	-	6.07E-05	5.49E-05	-	-	-	-	-	-	0.003%	0.002%
Earthworm	-	-	7.31E-05	6.61E-05	7.26E-05	6.84E-05	7.76E-05	7.38E-05	2.62E-04	1.25E-04	0.011%	0.005%
American Robin	-	-	8.60E-05	8.49E-05	6.71E-05	6.41E-05	8.73E-05	8.67E-05	1.18E-04	5.93E-05	0.005%	0.004%
Bank Swallow	-	-	6.46E-05	6.06E-05	-	-	-	-	9.74E-05	4.71E-05	0.004%	0.003%
Song Sparrow	-	-	1.43E-04	1.41E-04	1.16E-04	1.12E-04	1.45E-04	1.44E-04	1.82E-04	1.04E-04	0.008%	0.006%
Yellow Warbler	-	-	6.55E-05	6.16E-05	7.47E-05	7.18E-05	6.67E-05	6.63E-05	9.67E-05	4.80E-05	0.004%	0.003%
Green Heron	-	-	3.95E-05	3.66E-05	-	-	-	-	-	-	0.002%	0.002%
Terrestrial Plants (Grass)	-	-	1.40E-04	1.14E-04	1.20E-04	1.20E-04	1.14E-04	1.06E-04	4.45E-04	1.61E-04	0.019%	0.007%
Terrestrial Plants (Sugar Maple)	-	-	-	-	-	-	2.30E-04	2.19E-04	2.68E-04	1.27E-04	0.011%	0.009%
Eastern Cottontail	-	-	1.85E-04	1.72E-04	1.70E-04	1.60E-04	1.94E-04	1.82E-04	2.33E-04	9.86E-05	0.010%	0.008%
Meadow Vole	-	-	1.72E-04	1.58E-04	1.58E-04	1.48E-04	1.78E-04	1.65E-04	2.32E-04	9.84E-05	0.010%	0.007%
White-tailed Deer	-	-	1.94E-04	1.78E-04	1.93E-04	1.85E-04	2.06E-04	1.94E-04	1.93E-04	9.29E-05	0.009%	0.008%
Common Shrew	-	-	1.55E-04	1.48E-04	1.51E-04	1.41E-04	1.51E-04	1.50E-04	2.20E-04	8.86E-05	0.009%	0.006%
Raccoon	-	-	1.71E-04	1.62E-04	1.48E-04	1.37E-04	1.62E-04	1.57E-04	2.14E-04	8.73E-05	0.009%	0.007%
Red Fox	-	-	2.57E-04	2.43E-04	1.56E-04	1.42E-04	2.34E-04	2.23E-04	2.46E-04	8.81E-05	0.011%	0.010%
Short-tailed Weasel	-	-	1.52E-04	1.44E-04	1.56E-04	1.41E-04	1.70E-04	1.58E-04	1.99E-04	7.93E-05	0.008%	0.007%

Note:
There are no exceedances of the aquatic benchmark of 9.6 mGy/d or the terrestrial benchmark of 2.4 mGy/d

For non-radiological COPCs, the ecological risk is estimated by dividing the exposure point concentration by the toxicological benchmark, yielding a HQ. The benchmark is based on direct contact by plants and soil invertebrates. When the HQ is greater than 1, a potential for adverse ecological effects is inferred, with bolded/shaded values indicating benchmark exceedances. Hazard quotients are provided in **Table 4-20**.

Table 4-20: Hazard Quotients for Polygon E

COPC	HQ for Terrestrial Invertebrates and Plants	
	Maximum	UCLM
PHC F1	**1.3**	0.09
PHC F2	**3.1**	0.21
PHC F3	**3.3**	0.34
SAR	**1.3**	0.16

While the HQs based on maximum concentrations were greater than 1, the UCLM represents the concentration that a greater proportion of the terrestrial invertebrate and plant communities would be exposed to.

4.4.2 Discussion of Chemical and Radiation Effects

4.4.2.1 Effects Monitoring Evidence

Data used for the problem formulations, screening, and ecological risk assessment were taken from the most recent environmental studies at the site and subsequent to the 2020 ERA (Ecometrix, 2022a), including annual EMP reports (from years 2020 to 2022) and ECA reports (from years 2020 to 2022) prepared for the DN site. No additional data are available beyond what is presented at this time to clarify potential effects at the site.

4.4.2.2 Likelihood of Effects

For radiological COPCs, there were no exceedances of the 9.6 mGy/d radiation benchmark for aquatic biota at any location, nor any exceedances of the 2.4 mGy/d radiation benchmark for terrestrial or riparian biota at any location.

For non-radiological COPCs, the assessment focused on plants and soil invertebrates in Polygon E. The following is a summary of results:

- Maximum concentrations of SAR, PHC F1, PHC F2, and PHC F3 exceeded benchmarks for ecological health. However, maximum concentrations assume that the entire ecological population of each receptor is only exposed to the maximum, and not to a range of concentrations. Therefore, comparison to the UCLM, is more representative of expected risks.

- Based on UCLM exposure concentrations, the HQs were below 1, indicating that there are no unacceptable risks for plants and soil organisms.
- Additionally, the terrestrial habitat in Polygon E is minimal with limited vegetation; therefore, any toxic effects at these discrete locations would have little population or community level impact.

The Monarch and the Butternut tree were identified as the only terrestrial invertebrate and plant Species at Risk, respectively, on the DN site that may be exposed to chemical COPCs; as Species at Risk, the assessment endpoint for these receptors is the health of the individual. The maximum concentrations of SAR, PHC F1, PHC F2, and PHC F3 occur in the southwest portion of the DNNP lands, where the land is highly disturbed with limited to no vegetation. Given the lack of vegetation, Monarchs would not feed in this area. Additionally, there are no Butternut trees in the vicinity of the locations where soil concentrations exceed toxicity benchmarks; the closest soil sample to the Butternuts had concentrations less than toxicity benchmarks. As such, risks to Species at Risk on the DN site are considered acceptable.

4.4.3 Uncertainties in the Risk Characterization

The uncertainties in the risk characterization remain as presented in the 2020 ERA (Ecometrix, 2022a). No new sources of uncertainty were introduced based on the assessment in this Addendum.

5.0 Conclusions and Recommendations

5.1 Conclusions

5.1.1 Conclusions of the Human Health Risk Assessment (HHRA)

5.1.1.1 Radiological HHRA

In summary, consistent with the 2020 DN ERA (Ecometrix, 2022a), there are no health risks for human receptors as a result of radiological exposure.

The 2020 to 2022 public dose estimates for the critical groups are at most approximately 0.06% of the regulatory public dose limit of 1 mSv/a, and at most approximately 0.04% of the dose from background radiation in the vicinity of DN (1.4 mSv/year excluding medical doses). Demonstration that these critical groups are protected implies that other receptor groups near DN with anticipated lower exposure are also protected.

5.1.1.2 Non-Radiological HHRA

Following the initial COPC screening process, the only COPC (and relevant exposure pathways) retained for further assessment in the non-radiological HHRA was hydrazine in water and fish. Potential risks to human receptors were characterized quantitatively in terms of ILCRs for potential carcinogens (hydrazine). The target risk level is 10^{-6} for cancer risk (ILCR).

The results of the quantitative HHRA are as follows.

- No health risks to human receptors are expected due to exposure to hydrazine in drinking water. The acceptable cancer risk level was not exceeded for any of the receptors based on exposure to the maximum or mean hydrazine concentration in drinking water (based on hydrazine released with the CCW effluent). This is different than the conclusions of the 2020 DN ERA as in this Addendum, risks were calculated incorporating the understanding that hydrazine is known to degrade rapidly under chlorinated conditions typically used for treatment/distribution of drinking water (EC and HC, 2011).
- No health risks to human receptors are expected due to exposure to hydrazine in fish tissue. The acceptable cancer risk level was not exceeded for any receptors based on exposure to mean hydrazine concentration in fish tissue (based on hydrazine released with the CCW effluent). This is different than the conclusions of the 2020 DN ERA (Ecometrix, 2022a) as in this Addendum, risks were calculated using an updated water-to-fish bioconcentration factor which is considered to be more representative of the limited opportunity for fish to be exposed on a continuous basis to hydrazine, given hydrazine releases from the CCW are intermittent. As such, adverse effects on humans due to hydrazine originating from DN through fish ingestion are not expected.

In summary, health risks are not expected for human receptors due to exposure to hydrazine, in drinking water and in fish.

5.1.2 Conclusions of the Ecological Risk Assessment (EcoRA)

5.1.2.1 Radiological EcoRA

For radiological COPCs, there were no exceedances of the 9.6 mGy/d radiation benchmark for aquatic biota at any location, nor any exceedances of the 2.4 mGy/d radiation benchmark for terrestrial or riparian biota at any location. Additionally, dose rates to receptors due to the NSS-DWMF are similar to those assessed in the previous EcoRA, and were well below their respective benchmarks. Since there were no exceedances of the dose benchmarks, Species at Risk would be also protected.

Therefore, adverse effects to ecological receptors based on exposure to radiological COPCs are not expected for any assessed receptors or locations on the DN site based on updated radiological data collected between 2020 and 2022.

5.1.2.2 Non-Radiological EcoRA

The potential for ecological effects was assessed by comparing exposure levels to toxicological benchmarks and characterized quantitatively in terms of HQs. A HQ greater than 1 indicates a need to more closely assess the risk to the receptor.

The assessment focused on plants and soil invertebrates in polygon E, based on recent soil data not available during the 2020 DN ERA (Ecometrix, 2022a).

Although the maximum concentrations of SAR, PHC F1, PHC F2, and PHC F3 exceeded benchmarks for ecological health, a comparison to UCLM concentrations to benchmarks that are protective of plants and soil invertebrates were below benchmarks for all COPCs (SAR, PHC F1, PHC F2, and PHC F3). Given that the objective of the EcoRA is to protect ecological populations, comparison to a UCLM statistic rather than the maximum is defensible for the purposes of drawing conclusions related to risk. Therefore, risks were considered to be negligible for all ecological receptors, including plants and soil invertebrates. For Species at Risk, comparison to the maximum concentration is appropriate; however, the location of maximum concentrations is limited to an area that is highly disturbed with little to no vegetation, no Butternut trees, and would not serve as habitat or a food source for the Monarch. As such, risks to Species at Risk on the DN site are considered acceptable. As such, adverse effects to ecological receptors based on exposure to non-radiological COPCs are not expected for these COPCs / exposure pathways. Other COPCs / exposure pathways were not evaluated in this Addendum as concentrations were either unchanged or less than those in the 2020 ERA (Ecometrix, 2022a).

Overall, Darlington Nuclear is operating in a manner that is protective of human and ecological receptors residing in the surrounding area.

5.2 Cumulative Effects from On-Site Sources

Consideration of cumulative effects is focused on sources within the DN Site and includes the DNGS, TRF, NSS-DWMF, DNNP lands, and other OPG site activities within the DN property boundary. Environmental monitoring data collected at DN would include the contribution, if any, from PNGS effluent and emissions. However, considering the DN site is approximately 34 km east of the PN Site, the influence from Pickering Nuclear Generating Station emissions at DN would be small.

Air and soil quality studies have been completed to support the future DNNP development on the east side of the DN Site (**Figure 2-1**).

The information from these studies has been incorporated into the ERA Addendum as appropriate and screened for potential COPCs.

DNNP site preparation has been ongoing since 2022. DNNP Construction Phase activities are expected to commence in 2025 once the Licence to Construct has been obtained. When new and relevant on-site data become available in the future, they will be incorporated into the next full ERA update currently scheduled for completion in 2026.

The combined effects of DNNP site preparation activities in conjunction with DNGS operations do not represent a risk to human and ecological receptors.

5.3 Climate Change Considerations

OPG's Climate Change Plan outlines goals to be a net-zero carbon company by 2040 and be a catalyst for a net zero carbon economy by 2050. These goals are supported by advancing initiatives under the four pillars of Mitigate, Adapt, Innovate, and Lead. OPG's adaptation commitment is to ensure climate risks have been considered and appropriately addressed in OPG's operations and asset management processes. OPG continues to advance these processes.

The climate change portfolio draws authority from OPG's environmental management system.

OPG's internal adaptation strategy describes priority work areas for advancing reliability, including the completion of climate-related assessments on existing generation assets to identify risk areas. OPG has collected data, generated projection maps, and performed studies to projected climatic variables, including ensemble of model-generated projected changes in precipitation and air temperature on annual and seasonal basis. OPG will continue building climate assessment considerations into existing processes and programs at DNGS and will continue efforts to foster industry collaboration and develop sector-specific adaptation strategies and best practices.

Furthermore, the DN site continues to be maintained using engineering best practices which account for considerations of extreme weather events. OPG's existing Emergency Management Program addresses actions to be taken to respond to emergencies due to extreme weather events.

This ERA Addendum has relied on data collected between 2020 and 2022, which is updated from the previous iteration. The data reflects changes to climate over this time period. Each subsequent ERA update will continue to use updated data, where relevant, which are similarly expected to reflect climate change impacts during that period.

5.4 Recommendations for the Monitoring Program

Risks were deemed negligible for human and ecological receptors due to exposure to both radiological and non-radiological COPCs. OPG will look for opportunities to decrease the detection limits of hydrazine in water if, in the future, it is recommended that hydrazine is measured in lake water to better quantify actual exposure concentrations rather than have the dataset masked by elevated detection limits. A hydrazine detection limit of 0.05 µg/L in surface water is recommended for any future sampling programs.

5.5 Risk Management Recommendations

There are no risk management recommendations based on the outcome of this ERA Addendum.

The 2020 ERA (Ecometrix, 2022a) noted that a soil characterization study of the yard waste and building materials storage area was being undertaken by OPG, with a recommendation to use those results to determine next steps for management of soil from the yard waste and building material storage area. The soil samples collected at the DNNP site in 2021 included analysis of non-radiological substances and some of the samples include concentrations of SAR, PHC F1, PHC F2, and/or PHC F3 that are greater than the plant and soil invertebrate benchmarks identified in **Section 4.3.1** of this report, which correspond to HQs greater than 1. Therefore, soils at the DNNP site associated with these exceedances should be managed in accordance with the soil management practice developed to support DNNP.

6.0 Quality Assurance/Quality Control

The ERA Addendum makes extensive use of effluent and environmental monitoring data. These data are derived from chemical and radiochemical analyses of samples collected from effluent streams and environmental media around the DN site. The environmental data provided by OPG were collected by qualified staff and analyzed by qualified performing laboratories, such as the station chemistry laboratory and the Whitby Health Physics Laboratory. The EMP has its own quality assurance (QA) program that encompasses activities such as sample collection, laboratory analysis, laboratory quality control, and external laboratory comparison (OPG, 2019). Other samples such as air and soil samples were collected as part of the environmental sampling program for DNNP. These samples were collected and analyzed in accordance with the CSA N288.4 QA requirements for the project. Each sampling campaign involved preparation of a Sampling and Analysis Plan that outlined the data quality objectives, sampling and analysis protocol, required detection limits, roles and responsibilities, quality assurance and health and safety requirements. An inspection and test plan was completed at certain stages throughout the program to verify that work was being completed as specified.

Throughout the planning and preparation of the ERA Addendum, all Ecometrix staff worked under an International Organization for Standardization (ISO) 9001:2015 certified Quality Management System. All work was internally reviewed and verified. Reviews included verification of data and calculations, as well as review of report content and formatting. Comments have been dispositioned and addressed as appropriate by report revisions. The review process has been documented through an electronic paper trail of review comments and dispositions.

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Appendix A Screening Tables for Chemical COPCs

Table A-1: Non-Radiological Screening of Air COPCs for Human Health (ESDM Modelling)

Parameter	Maximum POI Concentration in 2020 ERA		COPC in 2020 ERA?	ESDM Modelling: Maximum POI Concentration Yearly ($\mu g/m^3$)			ESDM Modelling: Maximum POI Concentration 2020-2022 ($\mu g/m^3$)	ESDM Modelling: Averaging Period	Equivalent Max POI Concentration for Screening		Selected Human Health Screening Criteria	Screening Criteria Averaging Period	Source / Regulation Schedule Number[b]	Limiting Effect	Reference	Exceeds Screening Criteria?	Carried Forward as COPC for Addendum?
	Concentration ($\mu g/m^3$)	Averaging Period		2020[1]	2021[2]	2022[3]			Concentration ($\mu g/m^3$)	Averaging Period[a]							
Armeen hdt (tallow alkyl)	0.30	24 hr	No	0.28	0.28	0.28	0.28	24 hr	0.28	24 hr	20	24 hr	Sch. 3	Health	MECP ACB[4]	Yes	No
Ammonia	17	24 hr	No	9.9	9.9	9.9	9.9	24 hr	9.9	24 hr	100	24 hr	Sch. 3	Health	MECP ACB	Yes	No
Benzo(a)pyrene (sum of PAH)	3.70E-05	24 hr	No	3.60E-05	3.60E-05	3.60E-05	3.60E-05	24 hr	3.60E-05	24 hr	5.00E-05	24 hr	-	Health	MECP AAQC[5]	Yes	No
	3.60E-06	Annual	No	3.60E-06	3.60E-06	3.60E-06	3.60E-06	Annual	3.60E-06	Annual	1.00E-05	Annual	Sch. 3	Health	MECP ACB	Yes	No
Cadmium	2.60E-04	24 hr	No	2.50E-04	2.50E-04	2.50E-04	2.50E-04	24 hr	2.50E-04	24 hr	2.50E-02	24 hr	Sch. 3	Health	MECP ACB	Yes	No
Carbon Dioxide	16,228	24 hr	No	15,947	15,947	15,947	15,947	24 hr	15,947	24 hr	255,800	24 hr	SL-PA	Health	MECP ACB	Yes	No
Chloride (as hydrogen chloride)	0.23	24 hr	No	0.22	0.22	0.22	0.22	24 hr	0.22	24 hr	20	24 hr	Sch. 3	Health	MECP ACB	Yes	No
Chromium (VI)	4.30E-04	24 hr	No	1.60E-04	1.60E-04	1.60E-04	1.60E-04	24 hr	1.60E-04	24 hr	3.50E-04	24 hr	-	Health	MECP AAQC (as PM_{10})	Yes	No
	3.70E-05	Annual	No	1.60E-05	1.60E-05	1.60E-05	1.60E-05	Annual	1.60E-05	Annual	1.40E-04	Annual	Sch. 3	Health	MECP ACB	Yes	No
Cobalt	0.0039	24 hr	No	0.0038	0.0038	0.0038	0.0038	24 hr	0.0038	24 hr	0.1	24 hr	-	Health	MECP AAQC	Yes	No
Fluoride	0.02	24 hr	No	0.02	2.0E-02	0.02	0.02	24 hr	0.02	24 hr	*No Health-Based Guideline Available*				-	No[f]	No[f]
									0.0038	Annual							
	0.0061	30 day	No	0.0060	0.0060	0.0060	0.0060	30 day	0.0060	30 day	*No Health-Based Guideline Available*				-	No[f]	No[f]
									0.0030	Annual							
Hydrazine	3.90E-04	Annual	No	1.42E-04	1.42E-04	1.42E-04	1.42E-04	Annual	1.42E-04	Annual	1.00E-03	Annual	SL-JSL	Health	MECP ACB	Yes	No
Iron	0.27	24 hr	No	0.15	0.15	0.15	0.15	24 hr	0.15	24 hr	4	24 hr	Sch. 3	Health	MECP ACB	Yes	No
Manganese	0.07	24 hr	No	0.03	0.03	0.03	0.03	24 hr	0.03	24 hr	0.4	24 hr	Sch. 3	Health	MECP ACB	Yes	No
Morpholine	3.6	24 hr	No	3.2	3.2	3.2	3.2	24 hr	3.2	24 hr	200	24 hr	SL-JSL	Health	MECP ACB	Yes	No
Nickel	0.06	24 hr	No	0.05	0.05	0.05	0.05	24hr	0.05	24hr	0.10	24 hr	-	Health	MECP AAQC (as PM_{10})	Yes	No
	0.0057	Annual	No	0.0054	0.0054	0.0054	0.0054	Annual	0.0054	Annual	0.04	Annual	Sch. 3	Health	MECP ACB	Yes	No
Nitrogen Oxides[c]	**205**	**1 hr**	Yes	205	205	205	205	1 hr	205	1 hr	113[d]	1 hr	-	Health	CCME CAAQS[6]	**Yes**	No[g]
	30.2	24 hr	No	30.2	30.2	30.2	30.2	24 hr	30.2	24 hr	200	24 hr	Sch. 3	Health	MECP ACB	Yes	No
									6	Annual	32[d]	Annual	-	Health	CCME CAAQS	No	No
Phosphorus	0.0061	24 hr	No	0.0060	0.0060	0.0060	0.0060	24 hr	0.006	24 hr	0.5	24 hr	SL-MD	Health	MECP ACB	Yes	No
Sodium Hypochlorite	1.24	24 hr	No	0.84	0.84	0.84	0.84	24 hr	0.84	24 hr	9	24 hr	SL-PA	Health	MECP ACB	Yes	No
Sodium Sulfite	0.07	24 hr	No	0.07	0.07	0.07	0.07	24 hr	0.07	24 hr	0.14	24 hr	SL-JSL	Health	MECP ACB	Yes	No
Sulphur Dioxide	0.1	24 hr	No	0.14	0.14	0.14	0.14	24 hr	0.14	24 hr	275	24 hr	Sch. 3	Health & Vegetation	MECP ACB	Yes	No
									0.027	Annual	13[e]	Annual	-	Health	CCME CAAQS	No	No
	1	1 hr	No	1.1	1.1	1.1	1.1	1 hr	1.1	1 hr	183[e]	1 hr	-	Health	CCME CAAQS	Yes	No
Vanadium	0.02	24 hr	No	0.02	0.02	0.02	0.02	24 hr	0.02	24 hr	2	24 hr	Sch. 3	Health	MECP ACB	Yes	No

References

1. 2020 Emission Summary and Dispersion Modelling Report For Darlington Nuclear Generating Station. Report No. NK38-REP-00541-10062-R001.
2. 2021 Emission Summary and Dispersion Modelling Report For Darlington Nuclear Generating Station. Report No. NK38-REP-00541-10066-R000.
3. 2022 Emission Summary and Dispersion Modelling Report For Darlington Nuclear Generating Station. Report No. NK38-REP-00541-10070-R000.
4. Ministry of the Environment, Conservation and Parks (MECP), Ontario. Air Contaminants Benchmarks (ACB) List: Standards, guidelines and screening levels for assessing point of impingement concentrations of air contaminants.
5. MECP Ambient Air Quality Criteria (AAQC). Accessed in November 2023 from https://www.ontario.ca/page/ontarios-ambient-air-quality-criteria
6. Canadian Council of Ministers of the Environment (CCME), Canadian Ambient Air Quality Standards (CAAQS). Available from: https://ccme.ca/en/air-quality-report#slide-7.

Notes

[a] The max POI concentrations were converted to the averaging period of benchmarks by following instruction provided in Section 4.4 of the document "Air Dispersion Modelling Guideline for Ontario, Version 3.0" by MOECC.
[b] Schedule 3 Standards under O. Reg. 419/05: Air Pollution – Local Air Quality.
[c] Nitrogen oxides (NO_x) are defined as the sum of nitrogen dioxide (NO_2) and nitric oxide (NO). Emissions of NO_x consist mainly of NO, with some NO_2. In ambient air, NO converts to NO_2. NO_2 has adverse health effects at much lower concentrations than NO. Therefore, air quality guidelines are typically based on the health effects of NO_2.
[d] The 1-hour and Annual CAAQS's for nitrogen dioxide are 60 and 17 ppb, respectively. These values were converted to $\mu g/m^3$ using the ratio 1 ppb NO_2 = 1.88 $\mu g/m^3$
[e] The 1-hour and Annual CAAQS's for sulphur dioxide are 70 and 5 ppb, respectively. These values were converted to $\mu g/m^3$ using the ratio 1 ppb SO_2 = 2.62 $\mu g/m^3$
[f] There is limited information available concerning inhalation exposure to particulates of inorganic fluoride compounds. Air standards are driven by effects on vegetation and will be considered in the EcoRA.
[g] Refer to Section 3.1.2.1 of the Addendum report for further discussion
POI - Point of Impingement
SL-JSL - Jurisdictional Screening Level
SL-MD - Ministry-derived Screening Levels
SL-PA - Previously Accepted Screening Level
PM_{10} - Particulate matter with a particle diameter of 10 µm or less.

Value	Indicates parameter exceeded screening benchmark

Table A-2: Non-Radiological Screening of Air COPCs for Human Health (DNNP Air Monitoring)

Parameter	Maximum Measured Concentration ($\mu g/m^3$) [1, a]	Averaging Period	Selected Human Health Screening Criteria	Screening Criteria Averaging Period	Source / Regulation Schedule Number [b]	Limiting Effect	Reference	Exceeds Screening Criteria?	Carried Forward as COPC for Addendum?
Particulate Matter (PM)									
Total Suspended Particulates (TSP)	**348.2**	**24 hr**	120	24 hr	-	Visibility	MECP AAQC [2]	**Yes**	No [h]
$PM_{2.5}$	113.6	1 hr	-	-	-	-	-	-	-
	51.7	**24 hr**	27	24 hr	-	Health	MECP AAQC	**Yes**	No [h]
PM_{10}	726.7	1 hr	-	-	-	-	-	-	-
	271.1	**24 hr**	50	24 hr	-	Health	MECP AAQC	**Yes**	No [h]
Gases									
Nitrogen Dioxide (NO_2)	**127**	**1 hr**	113 [c]	1 hr	-	Health	CCME CAAQS [3]	**Yes**	No [h]
	44	24 hr	200	24 hr	Sch. 3	Health	MECP ACB [4]	No	No
Sulphur Dioxide (SO_2)	**402**	**1 hr**	183 [d]	1 hr	-	Health	CCME CAAQS	**Yes**	No [h]
	59	24 hr	275	24 hr	Sch. 3	Health & Vegetation	MECP ACB	No	No
Volatile Organic Compounds (VOCs)									
2-Propanone (Acetone)	22.2	24 hr	11,880	24 hr	-	Health	MECP AAQC	Yes	No
Dichlorodifluoromethane (FREON 12)	2.9	24 hr	500,000	24 hr	-	Health	MECP AAQC	Yes	No
Chloromethane	2.4	24 hr	320	24 hr	-	Health	MECP AAQC	Yes	No
Trichlorofluoromethane (FREON 11)	2.5	24 hr	6,000	24 hr	-	Health	MECP AAQC	Yes	No
2-propanol	13.3	24 hr	7,300	24 hr	-	Health	MECP AAQC	Yes	No
Methyl Ethyl Ketone (2-Butanone)	5.9	24 hr	1,000	24 hr	-	Health	MECP AAQC	Yes	No
1,1-Dichloroethylene	6.2	24 hr	10	24 hr	-	Health	MECP AAQC	No	No
Methylene Chloride (Dichloromethane)	4.6	24 hr	220	24 hr	-	Health	MECP AAQC	Yes	No
	2.1	Annual [f]	44	Annual	-	Health	MECP AAQC	No	No
Carbon Tetrachloride	1.4	24 hr	2.4	24 hr	-	Health	MECP AAQC	Yes	No
1,1-Dichloroethane	2.5	24 hr	165	24 hr	-	Health	MECP AAQC	No	No
1,2-Dichloroethane	0.9	24 hr	2	24 hr	-	Health	MECP AAQC	No	No
	0.4	Annual [f]	0.4	Annual	-	Health	MECP AAQC	No	No
1,1,1-Trichloroethane	35.3	24 hr	115,000	24 hr	-	Health	MECP AAQC	No	No
Tetrachloroethylene (PCE)	7.1	24 hr	360	24 hr	-	Health	MECP AAQC	Yes	No
	1.1	Annual [f]	2.3	Annual	-	Health	MECP AAQC	No	No
Benzene	1.2	24 hr	2.3	24 hr	-	Health	MECP AAQC	Yes	No
	0.5	**Annual [f]**	0.45	Annual	-	Health	MECP AAQC	**Yes [g]**	No [h]
Toluene	17.6	24 hr	2,000	24 hr	-	Odour	MECP AAQC	Yes	No
Ethylbenzene	1.9	24 hr	1,000	24 hr	-	Health	MECP AAQC	Yes	No
p+m-Xylene	9.7	24 hr	730	24 hr	-	Health	MECP AAQC	Yes	No
o-Xylene	7.5	24 hr	730	24 hr	-	Health	MECP AAQC	Yes	No
Styrene	0.9	24 hr	400	24 hr	-	Health	MECP AAQC	Yes	No
1,3,5-Trimethylbenzene	5.4	24 hr	220	24 hr	-	Health	MECP AAQC	No	No
1,2,4-Trimethylbenzene	28.5	24 hr	220	24 hr	-	Health	MECP AAQC	No	No
Hexane	633	24 hr	7,500	24 hr	-	Health	MECP AAQC	Yes	No
Heptane	6.1	24 hr	11,000	24 hr	-	Health	MECP AAQC	Yes	No
Cyclohexane	1.5	24 hr	6,100	24 hr	-	Health	MECP AAQC	Yes	No
Naphthalene	5.2	24 hr	22.5	24 hr	-	Health	MECP AAQC	Yes	No
Total Xylenes	17.2	24 hr	730	24 hr	-	Health	MECP AAQC	Yes	No
Propene	2.4	24 hr	4,000	24 hr	-	Health	MECP AAQC	Yes	No
Polycyclic Aromatic Hydrocarbons (PAHs)									
Benzo(a)pyrene (BAP) [e]	**2.28E-04**	**24 hr**	5.00E-05	24 hr	-	Health	MECP AAQC	**Yes**	No [h]

References

1. Darlington New Nuclear Project Baseline Air Quality Monitoring 2021-2022 Annual Report. Report No. NK054-REP-07730-1281633.
2. MECP Ambient Air Quality Criteria (AAQC). Accessed in November 2023 from https://www.ontario.ca/page/ontarios-ambient-air-quality-criteria
3. Canadian Council of Ministers of the Environment (CCME), Canadian Ambient Air Quality Standards (CAAQS). Available from: https://ccme.ca/en/air-quality-report#slide-7.
4. Ministry of the Environment, Conservation and Parks (MECP), Ontario. Air Contaminants Benchmarks (ACB) List: Standards, guidelines and screening levels for assessing point of impingement concentrations of air contaminants.

Notes

[a] The concentrations of NO_2 and SO_2 were converted from ppb to $\mu g/m^3$ using the following ratios: 1 ppb NO_2 = 1.88 $\mu g/m^3$ and 1 ppb SO_2 = 2.62 $\mu g/m^3$.

[b] Schedule 3 Standards under O. Reg. 419/05: Air Pollution – Local Air Quality.

[c] The 1-hour and Annual CAAQS's for nitrogen dioxide are 60 and 17 ppb, respectively. These values were converted to $\mu g/m^3$ using the ratio 1 ppb NO_2 = 1.88 $\mu g/m^3$.

[d] The 1-hour and Annual CAAQS's for sulphur dioxide are 70 and 5 ppb, respectively. These values were converted to $\mu g/m^3$ using the ratio 1 ppb SO_2 = 2.62 $\mu g/m^3$.

[e] The screening of PAHs is represented by benzo(a)pyrene, as it has the lowest AAQC of 5.0E-05 $\mu g/m^3$.

[f] Represents weighted averages, where the non-detectable samples in the average are equal to the detection limit

[g] Note, over 50% of benzene samples were reported as non-detects (i.e. below the laboratory detection limit)

[h] Refer to Section 3.1.2.1 of the Addendum report for further discussion

Table A-3: Human Health Screening Criteria for Screening Surface Water COPCs

Parameter	Unit	Drinking Water CWQG (1)	ODWS/MOE GW1 Component Value (2)	Guideline from Other Source		95th Percentile Background, 2019 Environmental Study (3)	Detection Limit (3)	Selected Human Health Screening Criteria	Reference
				Value	Source				
Physical/Conventional Characteristics									
Field Temperature	Celsius	-	-	-	-	21.64	-	-	-[a]
Field pH	pH	None	-	-	-	8.99	-	None	-[a]
pH	pH	None	-	-	-	8.42	-	None	-[a]
Field Sp. Conductance	µS/cm	-	-	-	-	569.4	-	-	-[a]
Conductivity	umho/cm	-	-	-	-	570.5	1	-	-[a]
Field Turbidity	NTU	-	-	-	-	-	-	-	-[a]
Turbidity	NTU	-	-	-	-	6.08	0.1	-	-[a]
Alkalinity (Total as CaCO3)	mg/L	-	-	-	-	200.0	1	-	-[a]
Total Hardness (CaCO3)	mg/L	-	-	-	-	266.9	0.5 - 1	-	-[a]
Total Suspended Solids	mg/L	-	-	-	-	11.15	1 - 10	-	-[a]
Total Residual Chlorine	mg/L	Not Required	-	-	-	0.019	0.0012	Not Required	-[a]
Nutrients									
Dissolved Organic Carbon	mg/L	-	-	-	-	8.105	0.5	-	-[a]
Total Kjeldahl Nitrogen (TKN)	mg/L	-	-	-	-	0.453	0.1	-	-[a]
Total Ammonia-N	mg/L	None required	-	-	-	0.191	0.01 - 1	None required	-[a]
Total Un-ionized Ammonia	mg/L	-	-	-	-	0.0211	0.00051 - 0.044	None required	-[a]
Total BOD	mg/L	-	-	-	-	<2	2	-	-[a]
Total Chemical Oxygen Demand (COD)	mg/L	-	-	-	-	18.1	4	-	-[a]
Orthophosphate (P)	mg/L	-	-	-	-	0.009013[g]	0.01	-	-[a]
Total Phosphorus	mg/L	-	-	-	-	0.045	0.02 - 2.51	-	-[a]
Anion									
Chloride (Cl)	mg/L	-	250000	-	-	-	-	250000	(2)
Nitrate (N)	mg/L	10	-	-	-	0.58	0.1	10	(1)
Nitrite (N)	mg/L	1	-	-	-	0.00612[g]	0.01	1	(1)
Hydrocarbons									
Benzene	µg/L	5	5	-	-	0[g]	0.1 - 0.5	5	(1,2)
Ethylbenzene	µg/L	140	2.4	-	-	0[g]	0.1 - 0.5	2.4	(2)
Toluene	µg/L	60	24	-	-	-	-	24	(2)
m,p-xylene	µg/L	-	-	-	-	-	-	90	(1)
o-xylene	µg/L	-	-	-	-	-	-	90	(1)
Xylene, Total	µg/L	90	300	-	-	-	-	90	(1)
F1 (C6-C10)	µg/L	-	820	-	-	0[g]	25	820	(2)
F1 (C6-C10) - BTEX	µg/L	-	820	-	-	-	-	820	(2)
F2 (C10-C16 Hydrocarbons)	µg/L	-	300	-	-	0[g]	100	300	(2)
F3 (C16-C34 Hydrocarbons)	µg/L	-	1000	-	-	142.51[g]	200	1000	(2)
F4 (C34-C50 Hydrocarbons)	µg/L	-	1100	-	-	-	-	1100	(2)
Ethylene Glycol	mg/L	-	-	3.2	US EPA (4)	-	-	2	(4)
Propylene Glycol	mg/L	-	-	80	US EPA (4)	-	-	10	(4)
Biological									
Chlorophyll	µg/L	-	-	-	-	3.09	0.1 - 0.2	-	-[a]
Background	CFU/100mL	-	-	-	-	-	-	-	-[a]
Total Coliforms	CFU/100mL	Non detectable	-	-	-	220	10	Non detectable	(1)
Fecal coliform	CFU/100mL	-	-	-	-	20.5	10	Non detectable	(1)[b]
Escherichia coli	CFU/100mL	Non detectable	-	-	-	20	10	Non detectable	(1)
Metals									
Total Aluminum (Al)	µg/L	2900	-	9500	BC CSR (5)	84.3	0.5 - 5	2900	(5)
Dissolved (0.2u) Aluminum (Al)	µg/L	-	-	-	-	6.05	5	2900	(5)[f]
Total Antimony (Sb)	µg/L	6	6	-	-	0.1846[g]	0.02 - 0.5	6	(1,2)
Total Arsenic (As)	µg/L	10	25	-	-	0.829	0.02 - 1	10	(1)
Total Barium (Ba)	µg/L	2000	1000	-	-	38.64	0.02 - 2	1000	(2)
Total Beryllium (Be)	µg/L	-	4	-	-	0.007[g]	0.01 - 0.5	4	(2)
Total Bismuth (Bi)	µg/L	-	-	-	-	0.0038[g]	0.005 - 1	-	-[a]
Total Boron (B)	µg/L	5000	5000	-	-	158	10 - 50	5000	(1,2)
Total Cadmium (Cd)	µg/L	7	5	-	-	0.00788[g]	0.005 - 0.1	5	(2)
Total Calcium (Ca)	µg/L	Not Required	-	-	-	70680	0.05 - 250	None required	-[a]
Total Cesium (Cs)	µg/L	-	-	1	ATSDR (6)	0.0124[g]	0.05 - 0.2	1	(6)
Total Chromium (Cr)	µg/L	50	50	-	-	0.9694[g]	0.1 - 5	50	(1,2)
Chromium (+3)	µg/L	None	-	-	-	0[g]	0.5 - 5	None	-[a]
Chromium (VI)	µg/L	50	25	-	-	0.31525[g]	0.5	25	(2)
Total Cobalt (Co)	µg/L	-	3	-	-	0.121[g]	0.005 - 0.5	3	(2)
Total Copper (Cu)	µg/L	2000	1000	-	-	0.8516[g]	0.05 - 1	1000	(2)
Gadolinium (Gd)	µg/L	-	-	140	US EPA (7)	-	-	140	(7)
Total Iron (Fe)	µg/L	None	-	-	-	174.6	1 - 100	None	(1)
Total Lead (Pb)	µg/L	5	10	-	-	0.1174[g]	0.005 - 0.5	5	(1)
Total Lithium (Li)	µg/L	-	-	8	US EPA (4)	4.714	0.5 - 5	4	(4)
Total Magnesium (Mg)	µg/L	None required	-	-	-	25840	0.05 - 250	None required	-[a]
Total Manganese (Mn)	µg/L	120	-	-	-	20.8	0.05 - 2	120	(1)
Mercury (Hg)	µg/L	1	1	-	-	0.002405[g]	0.01	1	(1,2)
Total Molybdenum (Mo)	µg/L	-	70	-	-	1.238	0.05 - 1	70	(2)
Total Nickel (Ni)	µg/L	-	100	-	-	0.6306[g]	0.02 - 1	100	(2)
Total Potassium (K)	µg/L	-	-	-	-	5528	0.05 - 1000	-	-[a]
Total Selenium (Se)	µg/L	50	10	-	-	0.1616[g]	0.04 - 2	10	(2)
Total Silicon (Si)	µg/L	-	-	-	-	1943	50	1943	(3)
Total Silver (Ag)	µg/L	-	100	-	-	0.00282[g]	0.005 - 0.1	100	(2)
Total Sodium (Na)	µg/L	-	200000	-	-	25480	0.05 - 250	200000	(2)
Total Strontium (Sr)	µg/L	7000	-	-	-	453.8	0.05 - 1	7000	(1)
Total Tellurium (Te)	µg/L	-	-	-	-	-	-	-	-[a]
Total Thallium (Tl)	µg/L	-	2	-	-	0.0088[g]	0.002 - 0.05	2	(2)
Total Thorium (Th)	µg/L	-	-	250	WHO (8)	0.0094[g]	0.005 - 1	250	(8)
Total Tin (Sn)	µg/L	-	-	2400	US EPA (4)	0.09528[g]	0.2 - 5	2400	(4)
Total Titanium (Ti)	µg/L	-	-	15	WHO (9)	4.7056[g]	0.5 - 5	15	(9)
Total Tungsten (W)	µg/L	-	-	3.2	US EPA (4)	0.11595[g]	0.01 - 1	3.2	(4)
Total Uranium (U)	µg/L	20	20	-	-	0.9486	0.002 - 0.1	20	(1,2)
Total Vanadium (V)	µg/L	-	6.2	-	-	0.9878[g]	0.2 - 5	6.2	(2)
Total Zinc (Zn)	µg/L	-	5000	-	-	2.7904[g]	0.1 - 5	5000	(2)
Dissolved Zinc (Zn)	µg/L	-	-	-	-	2.9245[g]	5	5000	(2)[f]
Total Zirconium (Zr)	µg/L	-	-	0.32	US EPA (4)	0.0668[g]	0.1 - 1	0.32	(4)
Other									
Hydrazine	µg/L	-	-	0.01	US EPA IRIS (10)	<0.1	0.1	0.01	(10)
Morpholine	µg/L	-	-	1700	HC (11)	1[g]	4	1700	(11)
Alcohol ethoxylates	µg/L	-	-	-	-	See Table A-5b	-	-[e]	-[a]
Polychlorinated Biphenyls	µg/L	-	3	-	-	-	-	3	(2)
Bromoform	µg/L	-	25	-	-	0[g]	0.2 - 1	25	(2)
Chloroform	µg/L	-	25	-	-	0[g]	0.1 - 0.5	25	(2)
Bromodichloromethane	µg/L	-	16	-	-	0[g]	0.1 - 0.5	16	(2)
Trihalomethanes (THMs)	µg/L	100[d]	-	-	-	-	-	100	(1)[d]

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Notes:

[a] The parameter is not considered of human health concern, and therefore no screening benchmark is necessary.
[b] The CWQG value for E.coli and total coliforms is used to screen fecal coliforms.
[c] iPWQO values for both 1,2- and 1,3- propylene glycol were available. The lower value for 1,3-propylene glycol is illustrated here for a conservative approach.
[d] Refers to the total of chlorodibromomethane, chloroform, bromodichloromethane and bromoform.
[e] Screening criteria selection for alcohol ethoxylates is detailed in Table A.6b, c.
[f] Total metal guideline is applied to dissolved.
[g] Values are stats results using un-detected uncensored data.

Table A-4 Screening of Lake Water for Human Health (no new data since 2020 ERA)

Parameter	Unit	Selected Benchmark	Reference	2020 ERA Max [12]	COPC in the 2020 ERA?	Exceeds Screening Criteria	Carried Forward as COPC for Addendum?
Nutrients							
Nitrate (N)	mg/L	10	(1)	2.2	No	No	No
Nitrite (N)	mg/L	1	(1)	0.013	No	No	No
Hydrocarbons							
Benzene	µg/L	5	(1,2)	0.14	No	No	No
Ethylbenzene	µg/L	2.4	(2)	0	No	No	No
F1 (C6-C10)	µg/L	820	(2)	0	No	No	No
F1 (C6-C10) - BTEX	µg/L	820	(2)	0	No	No	No
F2 (C10-C16 Hydrocarbons)	µg/L	300	(2)	0	No	No	No
F3 (C16-C34 Hydrocarbons)	µg/L	1000	(2)	170	No	No	No
F4 (C34-C50 Hydrocarbons)	µg/L	1100	(2)	0	No	No	No
Biological							
Total Coliforms	CFU/100mL	Non detectable	(1)	**2100**	No[b]	**Yes**	No [b]
Fecal coliform	CFU/100mL	Non detectable	(1)	**2000**	No[b]	**Yes**	No [b]
Escherichia coli	CFU/100mL	Non detectable	(1)	**2000**	No[b]	**Yes**	No [b]
Metals							
Total Aluminum (Al)	µg/L	2900	(5)	142	No	No	No
Dissolved (0.2u) Aluminum (Al)	µg/L	2900	(5)[c]	21	No	No	No
Total Antimony (Sb)	µg/L	6	(1,2)	0.176	No	No	No
Total Arsenic (As)	µg/L	10	(1)	0.841	No	No	No
Total Barium (Ba)	µg/L	1000	(1,2)	32.3	No	No	No
Total Beryllium (Be)	µg/L	4	(2)	0.007	No	No	No
Total Boron (B)	µg/L	5000	(1,2)	27	No	No	No
Total Cadmium (Cd)	µg/L	5	(1,2)	0.016	No	No	No
Total Cesium (Cs)	µg/L	1	(6)	0.087	No	No	No
Total Chromium (Cr)	µg/L	50	(1,2)	1.346	No	No	No
Chromium (+3)	µg/L	None	-	0	No	No	No
Chromium (VI)	µg/L	25	(2)	0.34	No	No	No
Total Cobalt (Co)	µg/L	3	(2)	0.091	No	No	No
Total Copper (Cu)	µg/L	1000	(2)	1	No	No	No
Total Iron (Fe)	µg/L	None	(1)	178	No	No	No
Total Lead (Pb)	µg/L	5	(1)	0.157	No	No	No
Total Lithium (Li)	µg/L	4	(4)	**10.2**	Yes	**Yes**	No [e]
Total Manganese (Mn)	µg/L	120	(1)	18.1	No	No	No
Mercury (Hg)	µg/L	1	(1,2)	0.0031	No	No	No
Total Molybdenum (Mo)	µg/L	70	(2)	1.35	No	No	No
Total Nickel (Ni)	µg/L	100	(2)	0.703	No	No	No
Total Selenium (Se)	µg/L	10	(2)	0.189	No	No	No
Total Silicon (Si)	µg/L	1943	(3)	932	No	No	No
Total Silver (Ag)	µg/L	100	(2)	0.006	No	No	No
Total Sodium (Na)	µg/L	200000	(2)	39600	No	No	No
Total Strontium (Sr)	µg/L	7000	(1)	625	No	No	No
Total Thallium (Tl)	µg/L	2	(2)	0.014	No	No	No
Total Thorium (Th)	µg/L	250	(8)	0.014	No	No	No
Total Tin (Sn)	µg/L	2400	(4)	0.405	No	No	No
Total Titanium (Ti)	µg/L	15	(9)	5.2	No	No	No
Total Tungsten (W)	µg/L	3.2	(4)	0.134	No	No	No
Total Uranium (U)	µg/L	20	(1,2)	0.61	No	No	No
Total Vanadium (V)	µg/L	6.2	(2)	0.64	No	No	No
Total Zinc (Zn)	µg/L	5000	(2)	3.138	No	No	No
Dissolved Zinc (Zn)	µg/L	5000	(2)[c]	13	No	No	No
Total Zirconium (Zr)	µg/L	0.32	(4)	**0.34**	Yes	**Yes**	No [e]
Other							
Hydrazine	µg/L	0.01	(10)	**0.11**	Yes	**Yes**	No [e]
Morpholine	µg/L	1700	(11)	2	No	No	No
Bromoform	µg/L	25	(2)	0	No	No	No
Chloroform	µg/L	25	(2)	0	No	No	No
Bromodichloromethane	µg/L	16	(2)	0	No	No	No

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4. United States Environmental Protection Agency (US EPA). 2023. Regional Screening Levels (RSLs) for tap water (target hazard quotients (THQ) of 0.1). https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables
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11. Health Canada (2002). A Summary of the Health Hazard Assessment of Morpholine in Wax Coatings of Apples. https://www.canada.ca/en/health-canada/services/food-nutrition/food-safety/information-product/summary-health-hazard-assessment-morpholine-coatings-apples.html. [Converted TDI (0.48 mg/kgBW/day) to DW criterion.]
12. OPG (Ontario Power Generation), 2022. 2020 Environmental Risk Assessment for the Darlington Nuclear Site. Report No. D-REP-07701-00001-R002. April.

Notes:

[a] ND: No Data

[b] Not considered to be nuclear or hazardous substance, so are not COPCs under CSA N288.6 and not associated with Darlington Nuclear. The rationale for not carrying these parameters forward as COPCs is discussed in Section 3.1.2.2.1.

[c] Total metal guideline is applied to dissolved.

[d] There is no expected human health concern for silicon, so it was not carried forward as a COPC. See Section 3.1.2.2.1.

[e] Parameters previously assessed as COPCs in the 2020 DN ERA are not carried forward as COPCs for this Addendum, as no new concentrations data is available since the 2020 DN ERA.

Value	Indicates parameter exceeded screening benchmark

Table A-5: Screening of CCW Effluent (ECA Data) for Human Health

Parameter	Unit	Human Health Screening Criteria [a]	Source / Basis	2020 DN ERA			Measured Maximum Concentrations from ECAs			Max Concentrations in CCW	Estimated Max Mixing Zone Concentrations	Carried forward as COPC for Addendum?
				Max Concentrations in CCW	Estimated Max Mixing Zone Concentrations	COPC in 2020 ERA?	2020	2021	2022			
Un-ionized Ammonia	mg/L	None required	CDWQ (1) [b]	0.01	0.0014	No	<0.01	0.01	0.01	0.01	0.0014	No
Hydrazine	mg/L	0.00001	US EPA IRIS (10)	0.006	**0.0009**	**Yes**	0.004	0.003	0.0076	0.0076	**0.0011**	**Yes**
Morpholine	mg/L	1.7	HC (11)	0.006	0.0009	No	0.009	0.002	0.003	0.009	0.0013	No
pH	pH units	None	CDWQ (1) [c]	7.9-8.6	7.9-8.6 [e]	No	7.8-8.3	8.5	7.7-8.4	7.8-8.5	7.8-8.5 [e]	No
TRC	mg/L	Not Required	CDWQ (1) [d]	0.01	0.0014	No	0.009	0.01	0.01	0.01	0.0014	No

Notes:

[a] See Table A-2 for references of selected screening benchmarks.

[b] A maximum allowable concentration for ammonia is not required according to the HC CWQG. Ammonia is naturally occurring or added as part of chloramination for drinking water disinfection.

[c] HC (2022) recommends a range of 7.0-10.5; the control of pH is important to maximize treatment effectiveness, control corrosion and reduce leaching from distribution system and plumbing components.

[d] Free chlorine concentrations in most Canadian drinking water distribution systems range from 0.04 to 2.0 mg/L (HC, 2022).

[e] The maximum pH in the CCW was directly compared, representing the possibly maximum mixing zone pH value.

TRC - Total Residual Chlorine

Value	Indicates parameter exceeded screening benchmark

Table A-6a: Screening of 2016 CCW Effluent for Human Health

Parameter	Units	Selected Human Health Screening Criteria[a]	Measured Stream Concentrations						Carried Forward as a COPC for Addendum?
			RLW	BB	IAD	WTP	CCW	Estimated Max Mixing Zone Concentrations	
			Max Value	Max Value	Max Value	Max Value	Max Value		
Morpholine	µg/L	1700	6	-	-	-	-	-	No
Gadolinium (Gd)	µg/L	140	46	-	-	-	9.6	1.37	No
Mercury (Hg)	µg/L	1	<0.1	-	-	-	<0.1	<0.014	No
Total Aluminum (Al)	µg/L	2900	59.9	-	19.2	0.012	150	21.43	No
Total Cadmium (Cd)	µg/L	5	0.257	0.013	0.008	4.76	0.015	0.002	No
Total Chromium (Cr)	µg/L	50	6.97	0.44	0.64	9.91	0.79	0.11	No
Total Copper (Cu)	µg/L	1000	15.5	0.914	3.25	13.8	1.92	0.27	No
Total Iron (Fe)	µg/L	None	32	13.1	37.7	-	250	35.71	No
Total Lead (Pb)	µg/L	5	19.8	0.213	0.086	0.199	0.335	0.05	No
Total Lithium (Li)	µg/L	4	330	-	-	-	3.82	0.55	No
Total Molybdenum (Mo)	µg/L	70	7.78	-	-	65.6	1.59	0.23	No
Total Nickel (Ni)	µg/L	100	50.6	0.087	0.752	1.83	0.932	0.13	No
Total Selenium (Se)	µg/L	10	1	0.04	0.141	2.05	0.199	0.03	No
Total Zinc (Zn)	µg/L	5000	25.5	2.95	-	21.2	8.79	1.26	No
Nitrate (N)	mg/L	10	-	-	-	4.88	0.44	0.06	No
Total Phosphorus	mg/L	-	0.177	-	-	-	0.029	0.004	No
Ethylene Glycol	mg/L	2	<20	-	<5	-	<5	<0.71	No
Propylene Glycol	mg/L	10	<20	-	<5	-	<5	<0.71	No
F1 (C6-C10)	µg/L	820	<25	-	-	<25	<25	<3.57	No
F1 (C6-C10) - BTEX	µg/L	820	<25	-	-	<25	<25	<3.57	No
F2 (C10-C16 Hydrocarbons)	µg/L	300	<100	-	-	<100	<100	<14.29	No
F3 (C16-C34 Hydrocarbons)	µg/L	1000	<200	-	-	<200	<200	<28.57	No
Total Residual Chlorine (TRC)	µg/L	Not Required	-	-	-	4	-	-	No

Notes:

[a] See Table A-2 for references for these selected screening benchmarks.

RLW - Radioactive Liquid Waste
BB - Boiler Blowdown
IAD - Inactive Drainage
WTP - Water Treatment Plant
CCW - Condenser Cooling Water

Value Indicates parameter exceeded screening benchmark

Table A-6b: Screening of 2016 CCW Effluent for Human Health

Parameter	Unit	Detection Limit	Derived DW Screening Criteria (1)	Maximum Concentration in CCW (EcoMetrix, 2016)	Estimated Max Mixing Zone Concentrations	Carried forward to detailed screening?
Alcohol Ethoxylates C8-9	µg/L	0.03	None	ND	ND	No
Alcohol Ethoxylates C10-11	µg/L	0.03	None	ND	ND	No
Alcohol Ethoxylates C12 -13	µg/L	0.03	None	108.7	15.5	No
Alcohol Ethoxylates C14-15	µg/L	0.03	None	16	2.3	No
Alcohol Ethoxylates C16-18	µg/L	0.03	None	1	0.1	No
Total Alcohol Ethoxylates	µg/L	0.03	512500 [b]	121	17.3	No
Nonylphenol Ethoxycarboxylate	µg/L	0.01	None	ND	ND	No
Linear Alkylbenzene Sulphonates C10	µg/L	0.06	None	1.1	0.2	No
Linear Alkylbenzene Sulphonates C12	µg/L	0.06	None	15.3	2.2	No
Total Linear Alkylbenzene Sulphonates	µg/L	0.06	929333 [b]	15.3	2.2	No

Reference

1. Revised Human and Environmental Risk Assessment (HERA) Report - Linear Alkylbenzene Sulphonate, Table 10 (HERA, 2013)

Notes:

[a] ND = non-detect

Value	Indicates parameter exceeded screening benchmark

Table A-7 Screening of Analytes in 2019 Stormwater for Human Health

Parameter	Maximum Stormwater Loading		Modeled Diluted Concentration in Lake Water		Human Health Screening Benchmark [a]	Exceeds Screening Benchmark?	Carried Forward as COPC for Addendum?
	Value	Unit	Value	Unit			
Biological							
Escherichia coli	80,972	CFU/s	**0.83**	CFU/100 ml	Non detectable	**Yes**	No [b]
Fecal Coliform	2,746,200	CFU/s	**28.25**	CFU/100 ml	Non detectable	**Yes**	No [b]
Total Coliform	120,152	CFU/s	**1.24**	CFU/100 ml	Non detectable	**Yes**	No [b]
Anions							
Chloride	630792	mg/s	64.90	mg/L	250000	No	No
Nitrate as N	188.838	mg/s	0.02	mg/L	10	No	No
Nitrite as N	7.32036	mg/s	0.0008	mg/L	1	No	No
Dissolved Phosphorus	31.2144	mg/s	0.0032	Tab	0.02	No	No
Metals and Inorganics							
Total Aluminum (Al)	765085.14	µg/s	78.71	µg/L	2900	No	No
Dissolved Aluminum (Al)	24208.22944	µg/s	2.4906	µg/L	2900	No	No
Dissolved (0.2u) Aluminum (Al)	8896.86	µg/s	0.9153	µg/L	2900	No	No
Total Antimony (Sb)	211.83	µg/s	0.0218	µg/L	6	No	No
Dissolved Antimony (Sb)	211.83	µg/s	0.0218	µg/L	6	No	No
Total Arsenic (As)	423.66	µg/s	0.0436	µg/L	10	No	No
Dissolved Arsenic (As)	423.66	µg/s	0.0436	µg/L	10	No	No
Total Barium (Ba)	42052.8	µg/s	4.3264	µg/L	1000	No	No
Dissolved Barium (Ba)	39424.5	µg/s	4.0560	µg/L	1000	No	No
Total Beryllium (Be)	<211.83	µg/s	<0.0218	µg/L	4	No	No
Dissolved Beryllium (Be)	<211.83	µg/s	<0.0218	µg/L	4	No	No
Total Boron (B)	31214.4	µg/s	3.21	µg/L	5000	No	No
Dissolved Boron (B)	26755.2	µg/s	2.75	µg/L	5000	No	No
Total Cadmium (Cd)	85.8624	µg/s	0.0088	µg/L	5	No	No
Dissolved Cadmium (Cd)	42.366	µg/s	0.0044	µg/L	5	No	No
Total Chromium (Cr)	2540.096	µg/s	0.261	µg/L	50	No	No
Dissolved Chromium (Cr)	2118.3	µg/s	0.218	µg/L	50	No	No
Total Cobalt (Co)	465.088	µg/s	0.048	µg/L	3	No	No
Dissolved Cobalt (Co)	211.83	µg/s	0.022	µg/L	3	No	No
Total Copper (Cu)	5276.96	µg/s	0.543	µg/L	1000	No	No
Dissolved Copper (Cu)	1694.64	µg/s	0.174	µg/L	1000	No	No
Hexavalent Chromium	416.546354	µg/s	0.043	µg/L	25	No	No
Total Lead (Pb)	2879.968	µg/s	0.296	µg/L	5	No	No
Dissolved Lead (Pb)	211.83	µg/s	0.022	µg/L	5	No	No
Total Lithium (Li)	2499.594	µg/s	0.257	µg/L	4	No	No
Dissolved Lithium (Li)	2118.3	µg/s	0.218	µg/L	4	No	No
Total Manganese (Mn)	45435.52	µg/s	4.67	µg/L	120	No	No
Dissolved Manganese (Mn)	30245.6	µg/s	3.11	µg/L	120	No	No
Total Mercury (Hg)	4.2366	µg/s	0.00044	µg/L	1	No	No
Total Molybdenum (Mo)	402.477	µg/s	0.0414	µg/L	70	No	No
Dissolved Molybdenum (Mo)	377.0574	µg/s	0.0388	µg/L	70	No	No
Total Nickel (Ni)	1252.16	µg/s	0.1288	µg/L	100	No	No
Dissolved Nickel (Ni)	423.66	µg/s	0.0436	µg/L	100	No	No
Total Selenium (Se)	847.32	µg/s	0.087	µg/L	10	No	No
Dissolved Selenium (Se)	137.31	µg/s	0.014	µg/L	10	No	No
Total Silicon (Si)	1275141.9	µg/s	131.2	µg/L	1943	No	No
Dissolved Silicon (Si)	630792	µg/s	64.9	µg/L	1943	No	No
Total Silver (Ag)	42.366	µg/s	0.0044	µg/L	100	No	No
Dissolved Silver (Ag)	42.366	µg/s	0.0044	µg/L	100	No	No
Total Sodium (Na)	367962000	µg/s	37856	µg/L	200000	No	No
Dissolved Sodium (Na)	341679000	µg/s	35152	µg/L	200000	No	No
Total Strontium (Sr)	473094	µg/s	48.67	µg/L	7000	No	No
Dissolved Strontium (Sr)	473094	µg/s	48.67	µg/L	7000	No	No
Total Thallium (Tl)	21.183	µg/s	0.00218	µg/L	2	No	No
Dissolved Thallium (Tl)	21.183	µg/s	0.00218	µg/L	2	No	No
Dissolved Thorium (Th)	<137.31	µg/s	<0.014	µg/L	250	No	No
Total Thorium (Th)	847.32	µg/s	0.087	µg/L	250	No	No
Total Tin (Sn)	423.66	µg/s	0.044	µg/L	2400	No	No
Dissolved Tin (Sn)	423.66	µg/s	0.044	µg/L	2400	No	No
Total Titanium (Ti)	22952.5542	µg/s	2.36	µg/L	15	No	No
Dissolved Titanium (Ti)	2118.3	µg/s	0.2179	µg/L	15	No	No
Dissolved Tungsten (W)	423.66	µg/s	0.0436	µg/L	3.2	No	No
Total Tungsten (W)	438.048	µg/s	0.0451	µg/L	3.2	No	No
Total Vanadium (Va)	1341.6	µg/s	0.1380	µg/L	6.2	No	No
Dissolved Vanadium (Va)	353.217	µg/s	0.0363	µg/L	6.2	No	No
Total Uranium (U)	237.644	µg/s	0.0244	µg/L	20	No	No
Dissolved Uranium (U)	233.9187	µg/s	0.0241	µg/L	20	No	No
Total Zinc (Zn)	134160	µg/s	13.80	µg/L	5000	No	No
Dissolved Zinc (Zn)	23654.7	µg/s	2.43	µg/L	5000	No	No
Dissolved Zirconium (Zr)	423.66	µg/s	0.044	µg/L	0.32	No	No
Total Zirconium (Zr)	423.66	µg/s	0.044	µg/L	0.32	No	No
PCB							
Aroclor 1016	<21.183	µg/s	<0.0022	µg/L	- [c]	-	-
Aroclor 1221	<21.183	µg/s	<0.0022	µg/L	- [c]	-	-
Aroclor 1232	<21.183	µg/s	<0.0022	µg/L	- [c]	-	-
Aroclor 1242	<21.183	µg/s	<0.0022	µg/L	- [c]	-	-
Aroclor 1248	<21.183	µg/s	<0.0022	µg/L	- [c]	-	-
Aroclor 1254	<21.183	µg/s	<0.0022	µg/L	- [c]	-	-
Aroclor 1260	<21.183	µg/s	<0.0022	µg/L	- [c]	-	-
Aroclor 1262	<21.183	µg/s	<0.0022	µg/L	- [c]	-	-
Aroclor 1268	<21.183	µg/s	<0.0022	µg/L	- [c]	-	-
Polychlorinated Biphenyls	<21.183	µg/s	<0.0022	µg/L	3	No	No
PHC							
Petroleum Hydrocarbons - F1 (C6-C10)-BTEX	<10591.5	µg/s	<1.09	µg/L	820	No	No
Petroleum Hydrocarbons - F1 (C6-C10)	<10591.5	µg/s	<1.09	µg/L	820	No	No
Petroleum Hydrocarbons - F2 (C10-C16)	<42366	µg/s	<4.36	µg/L	300	No	No
Petroleum Hydrocarbons - F3 (C16-C34)	84732	µg/s	8.72	µg/L	1000	No	No
Petroleum Hydrocarbons - F4 (C34-C50)	<84732	µg/s	<8.72	µg/L	1100	No	No
Oil & Grease, Total Rec	445.92	mg/s	0.05	mg/L	- [c]	-	-
Benzene	<84.732	µg/s	<0.0087	µg/L	5	No	No
Ethylbenzene	<84.732	µg/s	<0.0087	µg/L	2.4	No	No
m,p-Xylenes	231.2904	µg/s	0.024	µg/L	90	No	No
o-Xylene	84.732	µg/s	0.009	µg/L	90	No	No
Toluene	420.368	µg/s	0.043	µg/L	24	No	No
Xylenes, Total	289.113	µg/s	0.030	µg/L	90	No	No

Notes:

[a] See Table A-2 for references for these selected screening benchmarks. For all metals, the screening criteria for total metal and inorganics were also used to screen concentration of the dissolved metal ions.

[b] Not considered to be a nuclear or hazardous substance, so are not COPCs under CSA N288.6 and not associated with Darlington Nuclear.

[c] Individual polychlorinated biphenyl (PCB) congeners as well as total oil and grease are displayed, but without benchmarks since these parameters are encompassed by screenings of other parameters.

Value	Indicates parameter exceeded screening benchmark

Table A-8: Screening of Air Quality for Ecological Health (ESDM Modelling)

Parameter	Maximum POI Concentration in 2020 ERA ($\mu g/m^3$)		COPC in 2020 ERA?	ESDM Modelling: Maximum POI Concentration Yearly ($\mu g/m^3$)			ESDM Modelling: Averaging Period	Maximum POI Concentration, 2020-2022 ($\mu g/m^3$)		Selected Ecological Screening Criteria	Screening Criteria Averaging period	Source / Regulation Schedule Number [b]	Limiting Effect	Reference	Exceeds Screening Criteria?	Carried Forward as COPC for Addendum?
	Concentration	Averaging Period [a]		2020 [1]	2021 [2]	2022 [3]		Concentration	Averaging Period [a]							
Armeen hdt (tallow alkyl)	0.058	Annual	No	0.28	0.28	0.28	24hr	0.054	Annual	40	Annual	-	Health	TCEQ [4]	No	No
Ammonia	11.1	24hr	No	9.9	9.9	9.9	24hr	9.9	24hr	100	24hr	-	Health	MECP AAQC [5]	No	No
Benzo(a)pyrene (sum of PAH)	3.70E-05	24hr	No	3.6E-05	3.6E-05	3.6E-05	24hr	3.60E-05	24hr	5.00E-05	24hr	-	Health	MECP AAQC	No	No
	3.60E-06	Annual	No	3.6E-06	3.6E-06	3.6E-06	Annual	3.60E-06	Annual	1.00E-05	Annual	-	Health	MECP AAQC	No	No
Cadmium	2.60E-04	24hr	No	2.50E-04	2.50E-04	2.50E-04	24hr	2.50E-04	24hr	2.50E-02	24hr	-	Health	MECP AAQC	No	No
Carbon Dioxide	39,451	24hr	No	15,947	15,947	15,947	24hr	15,947	24hr	Not applicable - major component of air						
Chloride (as hydrogen chloride)	0.23	24hr	No	0.22	0.22	0.22	24hr	0.22	24hr	20	24hr	-	Health	MECP AAQC	No	No
Chromium (VI)	4.30E-04	24hr	No	1.60E-04	1.60E-04	1.60E-04	24hr	**1.60E-04**	24hr	1.40E-04	24hr	-	Health	MECP AAQC	**Yes**	No [c]
	3.70E-05	Annual	No	1.60E-05	1.60E-05	1.60E-05	Annual	1.60E-05	Annual	7.00E-05	Annual	-	Health	MECP AAQC	No	No
Cobalt	0.0039	24hr	No	3.80E-03	3.80E-03	3.80E-03	24hr	0.0038	24hr	0.1	24hr	-	Health	MECP AAQC	No	No
Fluoride	0.02	24hr	No	0.02	0.02	0.02	24hr	0.02	24hr	1.72	24hr	-	Vegetation	MECP AAQC	No	No
	0.006	30 day	No	0.006	0.006	0.006	30 day	0.006	30 day	0.69	30 day	-	Vegetation	MECP AAQC	No	No
Hydrazine	3.90E-04	Annual	No	1.42E-04	1.42E-04	1.42E-04	Annual	7.41E-04	24hr	1.00E-03	24hr	SL-JSL	Health	MECP ACB [6]	No	No
Iron	0.27	24hr	No	0.15	0.15	0.15	24hr	0.15	24hr	4	24hr	-	Health	MECP AAQC	No	No
Manganese	0.07	24hr	No	0.03	0.03	0.03	24hr	0.03	24hr	0.4	24hr	-	Health	MECP AAQC	No	No
Morpholine	3.60	24hr	No	3.2	3.2	3.2	24hr	3.2	24hr	200	24hr	SL-JSL	Health	MECP ACB [6]	No	No
Nickel	0.06	11.37	No	0.05	0.05	0.05	24hr	0.05	11.37	0.2	24hr	-	Health	MECP AAQC	No	No
	0.0057	Annual	No	0.0054	0.0054	0.0054	Annual	0.0054	Annual	0.04	Annual	-	Health	MECP AAQC	No	No
Nitrogen Oxides	205	1hr	No	205	205	205	1hr	205	1hr	400	1hr	-	Health	MECP AAQC	No	No
	30.2	24hr	No	30.2	30.2	30.2	24hr	30.20	24hr	200	24hr	-	Health	MECP AAQC	No	No
Phosphorus	1.17E-03	Annual	No	6.00E-03	6.00E-03	6.00E-03	24hr	1.15E-03	Annual	1.00E-01	Annual	-	Health	TCEQ	No	No
Sodium Hydroxide	0.122	24hr [f]	No	-	-	-	-	0.122 [d]	24hr	10	24 hr	-	Corrosion [e]	MECP AAQC	No	No
Sodium Hypochlorite	0.238	Annual	No	0.84	0.84	0.84	24hr	0.161	Annual	5	Annual	-	Health	TCEQ	No	No
Sodium Sulfite	0.070	24hr	No	0.07	0.07	0.07	24hr	0.070	24hr	Not applicable - species of limited concern (per description of the TCEQ)						
Suspended Particulate Matter (Total)	1.573	24hr [f]	No	-	-	-	-	1.573 [d]	24hr	120	24 hr	-	Visibility [e]	MECP AAQC	No	No
Sulphur Dioxide	0.1	24hr	No	0.14	0.14	0.14	24hr	0.14	24hr	275	24hr	Sch. 3	Health & Vegetation	MECP ACB	No	No
	1	1hr	No	1.1	1.1	1.1	1hr	1.1	1hr	105	1hr	-	Health	MECP AAQC	No	No
Sulphuric Acid	0.068	24hr [g]	No	-	-	-	-	0.068 [d]	24hr	5	24 hr	-	Health - URT [h]	MECP AAQC	No	No
Vanadium	0.02	24hr	No	0.02	0.02	0.02	24hr	0.02	24hr	2	24 hr	-	Health	MECP AAQC	No	No

References

1. 2020 Emission Summary and Dispersion Modelling Report For Darlington Nuclear Generating Station. Report No. NK38-REP-00541-10062-R001.
2. 2021 Emission Summary and Dispersion Modelling Report For Darlington Nuclear Generating Station. Report No. NK38-REP-00541-10066-R000.
3. 2022 Emission Summary and Dispersion Modelling Report For Darlington Nuclear Generating Station. Report No. NK38-REP-00541-10070-R000.
4. Texas Commission on Environmental Quality. Effects Screening levels. Accessed on November 2023. https://www.tceq.texas.gov/toxicology/esl
5. Ministry of the Environment, Conservation and Parks (MECP), Ontario. Ontario's Ambient Air Quality Criteria. Accessed on July, 2020. https://www.ontario.ca/page/ontarios-ambient-air-quality-criteria-sorted-contaminant-name
6. Ministry of the Environment, Conservation and Parks (MECP), Ontario. Air Contaminants Benchmarks (ACB) List: Standards, guidelines and screening levels for assessing point of impingement concentrations of air contaminants. Accessed November 2023. https://www.ontario.ca/document/air-contaminants-benchmarks-list-standards-guidelines-and-screening-levels-assessing-point#section-0
7. Canadian Council of Ministers of the Environment (CCME). Canadian Ambient Air Quality Standards (CAAQS).

Notes

a. The max POI concentrations were converted to the averaging period of benchmarks by following instructions provided in Section 4.4 of the document "Air Dispersion Modelling Guideline for Ontario, Version 3.0" by MOECC.
b. Schedule 3 Standards under O. Reg. 419/05: Air Pollution – Local Air Quality.
c. Chromium (VI) partitions to soil, and therefore the inhalation pathway is negligible compared to the soil and food ingestion pathways. It is not carried forward as a COPC in air.
d. In the absence of new ESDM modelling data between 2020-2022, the maximum POI concentration from the 2020 ERA was used for screening purposes.
e. In the absence of a health based guideline, the MECP corrosion guideline was used for sodium hydroxide, and the MECP visibility guideline was used for total particulate matter.
f. Converted from a 0.5hr averaging period to the noted averaging period.
g. Converted from an annual averaging period to 24hr averaging period.
h. URT - Upper Risk Threshold. URTs listed in Schedule 6 of O. Reg. 419/05 are not standards. URTs have separate and distinct regulatory and notification requirements. These requirements are set out in section 30 of O. Reg. 419/05.
POI - Point of Impingement
SL-JSL - Jurisdictional Screening Level
SL-MD - Ministry-derived Screening Levels

Value	Indicates parameter exceeded screening criteria.

Table A-9: Non-Radiological Screening of Air COPCs for Ecological Health (DNNP Air Monitoring)

Parameter	Maximum Measured Concentration (µg/m³) [1, a]	Averaging Period	Selected Human Health Screening Criteria	Screening Criteria Averaging Period	Source / Regulation Schedule Number [b]	Limiting Effect	Reference	Exceeds Screening Criteria?	Carried Forward as COPC for Addendum?
Particulate Matter (PM)									
Total Suspended Particulates (TSP)	**348.2**	24 hr	120	24 hr	-	Visibility [d]	MECP AAQC [2]	**Yes**	No [g]
$PM_{2.5}$	113.6	1 hr	-	-	-	-	-	-	No
	51.7	24 hr	27	24 hr	-	Health	MECP AAQC	**Yes**	No [g]
PM_{10}	726.7	1 hr	-	-	-	-	-	-	No
	271.1	24 hr	50	24 hr	-	Health	MECP AAQC	**Yes**	No [g]
Gases									
Nitrogen Dioxide (NO_2)	127	1 hr	400	1hr	-	Health	MECP AAQC	No	No
	44	24 hr	200	24hr	-	Health	MECP AAQC	No	No
Sulphur Dioxide (SO_2)	**402**	1 hr	104.8 [c]	1hr	-	Health	MECP AAQC	**Yes**	No [g]
	59	24 hr	275	24hr	Sch. 3	Health & Vegetation	MECP ACB [3]	No	No
Volatile Organic Compounds (VOCs)									
2-Propanone (Acetone)	22.2	24 hr	11,880	24 hr	-	Health	MECP AAQC	No	No
Dichlorodifluoromethane (FREON 12)	2.9	24 hr	500,000	24 hr	-	Health	MECP AAQC	No	No
Chloromethane	2.4	24 hr	320	24 hr	-	Health	MECP AAQC	No	No
Trichlorofluoromethane (FREON 11)	2.5	24 hr	6,000	24 hr	-	Health	MECP AAQC	No	No
2-propanol	13.3	24 hr	7,300	24 hr	-	Health	MECP AAQC	No	No
Methyl Ethyl Ketone (2-Butanone)	5.9	24 hr	1,000	24 hr	-	Health	MECP AAQC	No	No
1,1-Dichloroethylene	6.2	24 hr	10	24 hr	-	Health	MECP AAQC	No	No
Methylene Chloride (Dichloromethane)	4.6	24 hr	220	24 hr	-	Health	MECP AAQC	No	No
	2.1	Annual [f]	44	Annual	-	Health	MECP AAQC	No	No
Carbon Tetrachloride	1.4	24 hr	2.4	24 hr	-	Health	MECP AAQC	No	No
1,1-Dichloroethane	2.5	24 hr	165	24 hr	-	Health	MECP AAQC	No	No
1,2-Dichloroethane	0.9	24 hr	2	24 hr	-	Health	MECP AAQC	No	No
	0.4	Annual [f]	0.4	Annual	-	Health	MECP AAQC	No	No
1,1,1-Trichloroethane	35.3	24 hr	115,000	24 hr	-	Health	MECP AAQC	No	No
Tetrachloroethylene (PCE)	7.1	24 hr	360	24 hr	-	Health	MECP AAQC	No	No
	1.1	Annual [f]	2.3	Annual	-	Health	MECP AAQC	No	No
Benzene	1.2	24 hr	2.3	24 hr	-	Health	MECP AAQC	No	No
	0.5	Annual [f]	0.45	Annual	-	Health	MECP AAQC	**Yes**	No [g]
Toluene	17.6	24 hr	2,000	24 hr	-	Odour	MECP AAQC	No	No
Ethylbenzene	1.9	24 hr	1,000	24 hr	-	Health	MECP AAQC	No	No
p+m-Xylene	9.7	24 hr	730	24 hr	-	Health	MECP AAQC	No	No
o-Xylene	7.5	24 hr	730	24 hr	-	Health	MECP AAQC	No	No
Styrene	0.9	24 hr	400	24 hr	-	Health	MECP AAQC	No	No
1,3,5-Trimethylbenzene	5.4	24 hr	220	24 hr	-	Health	MECP AAQC	No	No
1,2,4-Trimethylbenzene	28.5	24 hr	220	24 hr	-	Health	MECP AAQC	No	No
Hexane	633	24 hr	7,500	24 hr	-	Health	MECP AAQC	No	No
Heptane	6.1	24 hr	11,000	24 hr	-	Health	MECP AAQC	No	No
Cyclohexane	1.5	24 hr	6,100	24 hr	-	Health	MECP AAQC	No	No
Naphthalene	5.2	24 hr	22.5	24 hr	-	Health	MECP AAQC	No	No
Total Xylenes	17.2	24 hr	730	24 hr	-	Health	MECP AAQC	No	No
Propene	2.4	24 hr	4,000	24 hr	-	Health	MECP AAQC	No	No
Polycyclic Aromatic Hydrocarbons (PAHs)									
Benzo(a)pyrene (BAP) [e]	**2.28E-04**	24 hr	5.00E-05	24 hr	-	Health	MECP AAQC	**Yes**	No [g]

References

1. Darlington New Nuclear Project Baseline Air Quality Monitoring 2021-2022 Annual Report. Report No. NK054-REP-07730-1281633.
2. MECP Ambient Air Quality Criteria (AAQC). Accessed in November 2023 from https://www.ontario.ca/page/ontarios-ambient-air-quality-criteria
3. Ministry of the Environment, Conservation and Parks (MECP), Ontario. Air Contaminants Benchmarks (ACB) List: Standards, guidelines and screening levels for assessing point of impingement concentrations of air contaminants.

Notes

[a] The concentrations of NO_2 and SO_2 were converted from ppb to µg/m³ using the following ratios: 1 ppb NO_2 = 1.88 µg/m³ and 1 ppb SO_2 = 2.62 µg/m³.
[b] Schedule 3 Standards under O. Reg. 419/05: Air Pollution – Local Air Quality.
[c] The 1-hour AAQC for sulphur dioxide is 40 ppb. This value was converted to µg/m³ using the ratio 1 ppb SO_2 = 2.62 µg/m³.
[d] In the absence of a health based guideline, the MECP visibility guideline was used for total particulate matter.
[e] The screening of PAHs is represented by benzo(a)pyrene, as it has the lowest AAQC of 5.0E-05 µg/m³.
[f] Represents weighted averages, where the non-detectable samples in the average are equal to the detection limit
[g] Refer to Section 4.1.3.1 of the Addendum report for further information.

Value	Indicates parameter exceeded screening criteria.

Table A-10: Ecological Screening Criteria for Surface Water COPCs

Parameter	Units	CCME CWQG (1)	FEQG (6-10)	PWQO (2)	Interim PWQO (2)	Suter and Tsao, 1996 (3)[a]	Borgmann et al. 2005 (4)[b]	Other Sources	95th Percentile Background, 2019 Environmental Study (5)	Detection Limit (5)	Selected Ecological Screening Criteria	Reference
Physical/Conventional Characteristics												
Field Temperature	Celsius	-	-	-	-	-	-	-	21.64	-	-	-[j]
Field pH	pH	6.5-9.0	-	6.5-8.5	-	-	-	-	8.99	-	6.5-8.5	(2)
pH	pH	6.5-9.0	-	6.5-8.5	-	-	-	-	8.42	-	6.5-8.5	(2)
Field Sp. Conductance	µS/cm	-	-	-	-	-	-	-	569.4	-	-	-[j]
Conductivity	umho/cm	-	-	-	-	-	-	-	570.5	1	-	-[j]
Field Turbidity	NTU	-	-	-	-	-	-	-	-	-	-	-[j]
Turbidity	NTU	-	-	-	-	-	-	-	6.08	0.1	-	-[j]
Alkalinity (Total as CaCO3)	mg/L	-	-	-	-	-	-	-	200.0	1	-	-[j]
Total Hardness (CaCO3)	mg/L	-	-	-	-	-	-	-	266.9	0.5 - 1	-	-[j]
Total Suspended Solids	mg/L	5 mg/L above the background value[c]	-	-	-	-	-	-	11.15	1 - 10	16.15	(1)
Total Residual Chlorine	mg/L	0.0005	-	0.002	-	-	-	-	0.019	0.0012	0.002[f]	(2)
Nutrients												
Dissolved Organic Carbon	mg/L	-	-	-	-	-	-	-	8.105	0.5	-	-[j]
Total Kjeldahl Nitrogen (TKN)	mg/L	-	-	-	-	-	-	-	0.453	0.1	-	-[j]
Total Ammonia-N	mg/L	0.044[d]	-	-	-	-	-	-	0.191	0.01 - 1	0.044	(1)
Total Un-ionized Ammonia	mg/L	0.019	-	0.02	-	-	-	-	0.0211	0.00051 - 0.044	0.019	(1)
Total BOD	mg/L	-	-	-	-	-	-	-	<2	2	-	-[j]
Total Chemical Oxygen Demand (COD)	mg/L	-	-	-	-	-	-	-	18.1	4	-	-[j]
Orthophosphate (P)	mg/L	-	-	-	-	-	-	-	0.009013[n]	0.01	-	-[j]
Total Phosphorus	mg/L	-	-	-	0.02	-	-	-	0.045	0.02 - 2.51	0.02	(2)
Anion												
Fluoride (F)	mg/L	0.12	-	-	-	-	-	-	-	-	0.12	(1)
Chloride (Cl)	mg/L	640	-	-	-	-	-	-	-	-	640	(1)
Nitrate (N)	mg/L	13	-	-	-	-	-	-	0.58	0.1	13	(1)
Nitrite (N)	mg/L	0.06	-	-	-	-	-	-	0.00612[n]	0.01	0.06	(1)
Hydrocarbons												
Benzene	µg/L	370	-	-	100	-	-	-	0[n]	0.1 - 0.5	370	(1)
Ethylbenzene	µg/L	90	-	-	8	-	-	-	0[n]	0.1 - 0.5	90	(1)
Toluene	µg/L	2	-	-	0.8	-	-	-	-	-	2	(1)
m,p-xylene	µg/L	-	-	-	2[i]	-	-	-	-	-	2	(2)
o-xylene	µg/L	-	-	-	40	-	-	-	-	-	40	(2)
Xylene, Total	µg/L	-	-	-	2[i]	-	-	-	-	-	2	(2)
F1 (C6-C10)	µg/L	167	-	-	-	-	-	-	0[n]	25	167	(1)
F1 (C6-C10) - BTEX	µg/L	167	-	-	-	-	-	-	-	-	167	(1)
F2 (C10-C16 Hydrocarbons)	µg/L	42	-	-	-	-	-	-	0[n]	100	42	(1)
F3 (C16-C34 Hydrocarbons)	µg/L	-	-	-	-	-	-	-	142.51[n]	200	200	(5)[g]
F4 (C34-C50 Hydrocarbons)	µg/L	-	-	-	-	-	-	-	-	-	200	(5)[g]
Ethylene Glycol	mg/L	192	-	-	2	-	-	-	-	-	192	(1)
Propylene Glycol	mg/L	500	-	-	10[l]	-	-	-	-	-	500	(1)
Biological												
Chlorophyll	µg/L	-	-	-	-	-	-	-	3.09	0.1 - 0.2	-	-[j]
Background	CFU/100mL	-	-	-	-	-	-	-	-	-	-	-[j]
Total Coliforms	CFU/100mL	-	-	100	-	-	-	-	220	10	100	(2)[h]
Fecal coliform	CFU/100mL	-	-	100	-	-	-	-	20.5	10	100	(2)[h]
Escherichia coli	CFU/100mL	-	-	100	-	-	-	-	20	10	100	(2)
Metals												
Total Aluminum (Al)	µg/L	100	2000	-	-	-	-	-	84.3	0.5 - 5	100	(1)
Dissolved (0.2u) Aluminum (Al)	µg/L	-	-	-	75	-	-	-	6.05	5	75	(2)
Total Antimony (Sb)	µg/L	-	-	20	-	-	-	-	0.1846[n]	0.02 - 0.5	20	(2)
Total Arsenic (As)	µg/L	5	-	100	5	-	-	-	0.829	0.02 - 1	5	(1)
Total Barium (Ba)	µg/L	-	-	-	-	4	315	1000 (12)	38.64	0.02 - 2	1000	(12)
Total Beryllium (Be)	µg/L	-	-	1100	-	-	-	-	0.007[n]	0.01 - 0.5	1100	(2)
Total Bismuth (Bi)	µg/L	-	-	-	-	-	2.5	-	0.0038[n]	0.005 - 1	2.5	(4)
Total Boron (B)	µg/L	1500	-	-	200	-	-	-	158	10 - 50	1500	(1)
Total Cadmium (Cd)	µg/L	0.17[e]	-	0.2	0.5	-	-	-	0.00788[n]	0.005 - 0.1	0.17	(1)
Total Calcium (Ca)	µg/L	-	-	-	-	11,600	-	-	70680	0.05 - 250	11,600	(3)
Total Cesium (Cs)	µg/L	-	-	-	-	-	315	-	0.0124[n]	0.05 - 0.2	315	(4)
Total Chromium (Cr)	µg/L	8.9	-	8.9	-	-	-	-	0.9694[n]	0.1 - 5	8.9	(1)
Chromium (+3)	µg/L	8.9	-	8.9	-	-	-	-	0[n]	0.5 - 5	8.9	(1)
Chromium (VI)	µg/L	1	5	1	-	-	-	-	0.31525[n]	0.5	1	(1)
Total Cobalt (Co)	µg/L	-	1	-	0.9	-	-	-	0.121[n]	0.005 - 0.5	1	(6)
Total Copper (Cu)	µg/L	2.57[e]	Biotic Ligand Model[o]	5	5	-	-	-	0.8516[n]	0.05 - 1	2.57	(1)
Gadolinium (Gd)	µg/L	-	-			-	15	-	-	-	15	(4)
Total Iron (Fe)	µg/L	300	-	300	-	-	-	-	174.6	1 - 100	300	(1)
Total Lead (Pb)	µg/L	3.59[e]	10	25	5	-	-	-	0.1174[n]	0.005 - 0.5	3.59	(1)
Total Lithium (Li)	µg/L	-	-	-	-	14	65	-	4.714	0.5 - 5	14	(3)
Total Magnesium (Mg)	µg/L	-	-	-	-	8,200	-	-	25840	0.05 - 250	8,200	(3)
Total Manganese (Mn)	µg/L	120[d, e]	-	-	-	-	-	-	20.8	0.05 - 2	120	(1)
Mercury (Hg)	µg/L	0.026	-	0.2	-	-	-	-	0.002405[n]	0.01	0.026	(1)
Total Molybdenum (Mo)	µg/L	73.000	-	-	40	-	-	-	1.238	0.05 - 1	40	(2)
Total Nickel (Ni)	µg/L	103[e]	-	25	-	-	-	-	0.6306[n]	0.02 - 1	25	(2)
Total Potassium (K)	µg/L	-	-	-	-	5,300	-	-	5528	0.05 - 1000	5,300	(3)
Total Selenium (Se)	µg/L	1	-	100	-	-	-	-	0.1616[n]	0.04 - 2	1	(1)
Total Silicon (Si)	µg/L	-	-	-	-	-	-	-	1943	50	-	-[j]
Total Silver (Ag)	µg/L	0.25	-	0.1	-	-	-	-	0.00282[n]	0.005 - 0.1	0.1	(2)
Total Sodium (Na)	µg/L	-	-	-	-	68,000	-	-	25480	0.05 - 250	68,000	(3)
Total Strontium (Sr)	µg/L	-	2500	-	-	-		-	453.8	0.05 - 1	2500	(7)
Total Tellurium (Te)	µg/L	-	-	-	-	-	151.9	-	-	-	151.9	(4)
Total Thallium (Tl)	µg/L	0.8	-	-	0.3	-	-	-	0.0088[n]	0.002 - 0.05	0.8	(1)
Total Thorium (Th)	µg/L	-	-	-	-	-	0.52	-	0.0094[n]	0.005 - 1	0.52	(4)
Total Tin (Sn)	µg/L	-	-	-	-	73	315	-	0.09528[n]	0.2 - 5	73	(3)
Total Titanium (Ti)	µg/L	-	-	-	-	-	27.2	-	4.7056[n]	0.5 - 5	27.2	(4)
Total Tungsten (W)	µg/L	-	-	-	30	-	-	-	0.11595[n]	0.01 - 1	30	(2)
Total Uranium (U)	µg/L	15	-	-	5	-	-	-	0.9486	0.002 - 0.1	15	(1)
Total Vanadium (V)	µg/L		120	-	6	-	-	-	0.9878[n]	0.2 - 5	120	(8)
Total Zinc (Zn)	µg/L	7[k]	-	30	20	-	-	-	2.7904[n]	0.1 - 5	7	(1)
Dissolved Zinc (Zn)	µg/L	7	-	-	-	-	-	-	2.9245[n]	5	7	(1)
Total Zirconium (Zr)	µg/L	-	-	-	4	-	-	-	0.0668[n]	0.1 - 1	4	(2)
Other												
Hydrazine	µg/L	-	2.6	-	-	-	-	-	<0.1	0.1	2.6	(9)
Morpholine	µg/L	-	-	-	4	-	-	-	1[n]	4	4	(2)
Bromoform	µg/L	-	-	-	60	-	-	-	0[n]	0.2 - 1	60	(2)
Chloroform	µg/L	1.8	-	-	-	-	-	-	0[n]	0.1 - 0.5	1.8	(1)
Bromodichloromethane	µg/L	-	-	-	200	-	-	-	0[n]	0.1 - 0.5	200	(2)
Alcohol ethoxylates	µg/L	-	-	-	-	-	-	-	See Table A-13b	-	-[m]	-
bis(2-Ethylhexyl)phthalate	µg/L	-	-	60	-	-	-	-	-	-	60	(2)

Table A-10: Ecological Screening Criteria for Surface Water COPCs

References:

1. CCME Canadian Water Quality Guidelines for Protection of Aquatic Life. Accessed in November 2023.
2. MOECC: Water management: policies, guidelines, provincial water quality objectives (1994).
3. Suter and Tsao, (1996). Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota: 1996 Revision.
4. Borgmann et al., (2005). Toxicity of Sixty-Three Metals and Metalloids to Hyalella Azteca at Two Levels of Water Hardness.
5. Ecometrix. (2020). Darlington New Nuclear Project Supporting Environmental Studies – Environment. Report prepared for OPG. Report No. NK054-REP-01210-0001. May.
6. Environment Canada (2017). Canadian Environmental Quality Guidelines, Cobalt, May.
7. ECCC (2020). Federal Environmental Quality Guidelines - Strontium. July.
8. ECCC (2006). Federal Environmental Quality Guidelines, Vanadium. May.
9. Environment Canada (2013). Federal Environmental Quality Guidelines, Hydrazine. May.
10. ECCC (2022). Federal Environmental Quality Guidelines, Aluminium, August).
11. British Columbia, (2021). British Columbia Working Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture Feb 2021.

Notes:

[a] Secondary Chronic Values (SCV) were selected for COPCs. If the SCV was not available, the lowest LC50 value was modified by a safety factor of 10.

[b] To be conservative, the measured LC50 values of H. Azteca (software or hardwater) was divided by a safety factor of 10. If there is no measured value, the tap water LC50 (nominal) values were adjusted by a safety factor of 10, considering the

[c] 5 mg/L above the mean background value was used according to the CCME CWQG "narrative" for clear flow.

[d] pH 9 assumed to determine CWQG value for all pH dependent parameters.

[e] Hardness of 110 mg/L CaCO3 was used to calculate hardness dependent CWQG values.

[f] PWQO is selected as the benchmark for TRC, as there is no current methodology to reach the CCME guideline of 0.0005 mg/L.

[g] If the 95th percentile background value is less than the detection limit (as uncensored data was used in the 2019 study), the detection limit was selected as the selected criteria. Otherwise, the 95 percentile value was used as the screening

[h] The PWQO value for E.coli is used to screen total and fecal coliforms

i To be conservative, the lowest iPWQO value for xylene isomer, m-xylene, is represented as the iPWQO value for m,p-xylene and total xylene.

[j] The Analyte is not considered of ecological health concern, and therefore no screening criteria are necessary.

[k] The CCME CWQG value is for dissolved zinc. This value is also applied to screen the total zinc concentration.

[l] iPWQO values for both 1,2- and 1,3- propylene glycol was available. The lower value for 1,3-propylene glycol is illustrated here for conservative approach.

[m] Screening criteria selection for alcohol ethoxylates is detailed in Table A-13b,c.

[n] Values are stats results using un-detected uncensored data.

[o] Copper Biotic Ligand Model has been requested from ECCC; will be run with site-specific water quality data once available.

Table A-11: Screening of Lake Water Quality for Ecological Health (no new data since 2020 ERA)

Parameter	Units	Ecological Screening Criteria	Reference	2020 ERA Max	COPC in the 2020 ERA?	Exceeds Screening Criteria	Carried Forward as COPC for Addendum?
Physical/Conventional Characteristics							
Field Temperature	Celsius	-	-	22.67	-	-	-
Field pH	pH	6.5-8.5	(2)	**6.69-9.21**	Yes	**Yes**	No [i]
pH	pH	6.5-8.5	(2)	8.02-8.44	No	No	No
Field Sp. Conductance	µS/cm	-	-	860	-	-	-
Conductivity	umho/cm	-	-	570	-	-	-
Field Turbidity	NTU	-	-	26.1	-	-	-
Turbidity	NTU	-	-	11	-	-	-
Alkalinity (Total as CaCO3)	mg/L	-	-	150	-	-	-
Total Hardness (CaCO3)	mg/L	-	-	270	-	-	-
Total Suspended Solids	mg/L	16.15	(1)	**33**	Yes	**Yes**	No [i]
Total Residual Chlorine	mg/L	0.002	(2)	<0.0012 [a]	No	No	No
Nutrients							
Dissolved Organic Carbon	mg/L	-	-	6	-	-	-
Total Kjeldahl Nitrogen (TKN)	mg/L	-	-	0.48	-	-	-
Total Ammonia-N	mg/L	0.044	(1)	**0.26 [b]**	Yes	**Yes**	No [i]
Total Un-ionized Ammonia	mg/L	0.019	(1)	**0.051 [c]**	Yes	**Yes**	No [i]
Nitrate (N)	mg/L	13	(1)	2.2	No	No	No
Nitrite (N)	mg/L	0.06	(1)	0.013	No	No	No
Total BOD	mg/L	-	-	2	-	-	-
Total Chemical Oxygen Demand (COD)	mg/L	-	-	13	-	-	-
Orthophosphate (P)	mg/L	-	-	0.013	No	No	No
Total Phosphorus	mg/L	0.02	(2)	**0.059**	No [d]	**Yes**	No [d]
Hydrocarbons							
Benzene	µg/L	370	(1)	0.14	No	No	No
Ethylbenzene	µg/L	90	(1)	0	No	No	No
F1 (C6-C10)	µg/L	167	(1)	0	No	No	No
F1 (C6-C10) - BTEX	µg/L	167	(1)	0	No	No	No
F2 (C10-C16 Hydrocarbons)	µg/L	42	(1)	0	No	No	No
F3 (C16-C34 Hydrocarbons)	µg/L	200	(5)	170	No	No	No
F4 (C34-C50 Hydrocarbons)	µg/L	200	(5)	0	No	No	No
Biological							
Chlorophyll	µg/L	-	-	9.08	-	-	-
Background	CFU/100mL	-	-	9600	-	-	-
Total Coliforms	CFU/100mL	100	(2)	**2100**	No [e]	**Yes**	No [e]
Fecal coliform	CFU/100mL	100	(2)	**2000**	No [e]	**Yes**	No [e]
Escherichia coli	CFU/100mL	100	(2)	**2000**	No [e]	**Yes**	No [e]
Metals							
Total Aluminum (Al)	µg/L	100	(1)	**142**	No [f]	**Yes**	No [f]
Dissolved (0.2u) Aluminum (Al)	µg/L	75	(2)	21	No	No	No
Total Antimony (Sb)	µg/L	20	(2)	0.176	No	No	No
Total Arsenic (As)	µg/L	5	(1)	0.841	No	No	No
Total Barium (Ba)	µg/L	1000	(12)	32.3	Yes [g]	No	No
Total Beryllium (Be)	µg/L	1100	(2)	0.007	No	No	No
Total Bismuth (Bi)	µg/L	2.5	(4)	0.027	No	No	No
Total Boron (B)	µg/L	1500	(1)	27	No	No	No
Total Cadmium (Cd)	µg/L	0.17	(1)	0.016	No	No	No
Total Calcium (Ca)	µg/L	11,600	(3)	**62,100**	No [h]	**Yes**	No [h]
Total Cesium (Cs)	µg/L	315	(4)	0.087	No	No	No
Total Chromium (Cr)	µg/L	8.9	(1)	1.346	No	No	No
Chromium (+3)	µg/L	8.9	(1)	0	No	No	No
Chromium (VI)	µg/L	1	(1)	0.34	No	No	No
Total Cobalt (Co)	µg/L	1	(6)	0.091	No	No	No
Total Copper (Cu)	µg/L	2.57	(1)	1	No	No	No
Total Iron (Fe)	µg/L	300	(1)	178	No	No	No
Total Lead (Pb)	µg/L	3.59	(1)	0.157	No	No	No
Total Lithium (Li)	µg/L	14	(3)	10.2	No	No	No
Total Magnesium (Mg)	µg/L	8,200	(3)	**11,400**	No [h]	**Yes**	No [h]
Total Manganese (Mn)	µg/L	120	(1)	18.1	No	No	No
Mercury (Hg)	µg/L	0.026	(1)	0.0031	No	No	No
Total Molybdenum (Mo)	µg/L	40	(2)	1.35	No	No	No
Total Nickel (Ni)	µg/L	25	(2)	0.703	No	No	No
Total Potassium (K)	µg/L	5,300	(3)	**6,500**	No [h]	**Yes**	No [h]
Total Selenium (Se)	µg/L	1	(1)	0.189	No	No	No
Total Silicon (Si)	µg/L	-	-	932	-	-	-
Total Silver (Ag)	µg/L	0.1	(2)	0.006	No	No	No
Total Sodium (Na)	µg/L	68,000	(3)	39,600	No	No	No
Total Strontium (Sr)	µg/L	2500	(6)	625	No	No	No
Total Thallium (Tl)	µg/L	0.8	(1)	0.014	No	No	No
Total Thorium (Th)	µg/L	0.52	(4)	0.014	No	No	No
Total Tin (Sn)	µg/L	73	(3)	0.405	No	No	No
Total Titanium (Ti)	µg/L	27.2	(4)	5.2	No	No	No
Total Tungsten (W)	µg/L	30	(2)	0.134	No	No	No
Total Uranium (U)	µg/L	15	(1)	0.61	No	No	No
Total Vanadium (V)	µg/L	120	(8)	0.64	No	No	No
Total Zinc (Zn)	µg/L	7	(1)	3.138	No	No	No
Dissolved Zinc (Zn)	µg/L	7	(1)	**13**	Yes	**Yes**	No [i]
Total Zirconium (Zr)	µg/L	4	(2)	0.34	No	No	No
Other							
Hydrazine	µg/L	2.6	(7)	0.11	No	No	No
Morpholine	µg/L	4	(2)	2	No	No	No
Bromoform	µg/L	60	(2)	0	No	No	No
Chloroform	µg/L	1.8	(1)	0	No	No	No
Bromodichloromethane	µg/L	200	(2)	0	No	No	No

References:

1. CCME Canadian Water Quality Guidelines for Protection of Aquatic Life. Accessed in July 2020.
2. MOECC: Water management: policies, guidelines, provincial water quality objectives (1994).
3. Suter and Tsao, (1996). Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota: 1996 Revision.
4. Borgmann et al., (2005). Toxicity of Sixty-Three Metals and Metalloids to Hyalella Azteca at Two Levels of Water Hardness.
5. Ecometrix. (2020). Darlington New Nuclear Project Supporting Environment Studies – Environment. Report prepared for OPG. Report No. NK054-REP-01210-0001. May.
6. ECCC (2020). Federal Environmental Quality Guidelines - Strontium. July.
7. Environment Canada (2013). Federal Environmental Quality Guidelines, Vanadium. May.

Notes:

[a] Due to machine calibration issues in the summer, the maximum observed concentration for TRC was 0.028 mg/L. The problematic results were removed from the screening dataset.

[b] The maximum observed concentration during the 2019 study was 0.40 mg/L due to the lab contamination during the spring sampling season. Problematic results were removed from the screening dataset.

[c] The maximum observed concentration during the 2019 study was 0.081 mg/L due to the lab contamination during the spring sampling season. Problematic results were removed from the screening dataset.

[d] Phosphorus is a nutrient and not a toxicant. Therefore it was not carried forward as a COPC.

[e] E.coli and other coliforms are not of concern for ecological health. They are not carried forward as COPCs.

[f] Although the concentration of total aluminum exceeded the selected screening criteria, its more bioavailable form, dissolved aluminum, did not exceed. Therefore, aluminum was not carried forward as a COPC.

[g] Barium exceeded screening and was retained as a COPC in the 2020 DN ERA. Due to a change in the screening criteria, barium no longer screens in as a COPC.

[h] Major ions (Ca, Mg, K) are not considered toxic at environmental concentrations. They are not carried forward as COPCs.

[i] Parameters previously assessed as COPCs in the 2020 DN ERA are not carried forward as COPCs for this Addendum, as no new concentrations data is available since the 2020 DN ERA.

Value	Indicates parameter exceeded screening criteria.

Table A-12: Screening of CCW Effluent (ECA Data) for Ecological Health

Parameter	Unit	Ecological Surface Water Screening Criteria[a]	2020 DN ERA			Measured Maximum Concentrations from ECAs			Max Concentrations in CCW	Estimated Max Mixing Zone Concentrations	Carried forward as COPC for Addendum?
			Max Concentrations in CCW	Estimated Max Mixing Zone Concentrations	COPC in 2020 ERA?	2020	2021	2022			
Un-ionized Ammonia	mg/L	0.019	0.01	0.0014	No	<0.01	0.01	0.01	0.01	0.0014	No
Hydrazine	mg/L	0.0026	0.006	0.0009	No	0.004	0.003	0.0076	0.0076	0.0011	No
Morpholine	mg/L	0.004	0.006	0.0009	No	0.009	0.002	0.003	0.009	0.0013	No
pH	pH units	6.5 - 8.5	7.9-8.6	7.9-8.6[b]	No	7.8-8.3	8.5	7.7-8.4	7.8-8.5	7.8-8.5[b]	No
TRC	mg/L	0.002	0.01	0.0014	No	0.009	0.01	0.01	0.01	0.0014	No

Notes:

[a] See Table A-10 for references of selected screening criteria.

[b] The maximum pH in the CCW was directly compared, representing the possibly maximum mixing zone pH value.

TRC - Total Residual Chlorine

Value Indicates parameter exceeded screening criteria.

Table A-13a: Screening of 2016 CCW Effluent for Ecological Health (no new data since 2020 ERA)

Parameter	Units	Selected Surface Water Screening Criteria[a]	Measured Stream Concentrations					Estimated Max Mixing Zone Concentrations	Carried Forward as COPC for Addendum?
			RLW	BB	IAD	WTP	CCW		
			Max Value	Max Value	Max Value	Max Value	Max Value		
Morpholine	µg/L	4	6	-	-	-	-	-	No[b]
Gadolinium (Gd)	µg/L	15	46	-	-	-	9.6	1.37	No
Mercury (Hg)	µg/L	0.026	<0.1	-	-	-	<0.1	<0.014	No[b]
Total Aluminum (Al)	µg/L	100	59.9	-	19.2	0.012	150	21.43	No[b]
Total Cadmium (Cd)	µg/L	0.17	0.257	0.013	0.008	4.76	0.015	0.002	No[b]
Total Chromium (Cr)	µg/L	8.9	6.97	0.44	0.64	9.91	0.79	0.11	No[b]
Total Copper (Cu)	µg/L	2.57	15.5	0.914	3.25	13.8	1.92	0.27	No[b]
Total Iron (Fe)	µg/L	300	32	13.1	37.7	-	250	35.71	No
Total Lead (Pb)	µg/L	3.59	19.8	0.213	0.086	0.199	0.335	0.05	No[b]
Total Lithium (Li)	µg/L	14	330	-	-	-	3.82	0.55	No[b]
Total Molybdenum (Mo)	µg/L	40	7.78	-	-	65.6	1.59	0.23	No[b]
Total Nickel (Ni)	µg/L	25	50.6	0.087	0.752	1.83	0.932	0.13	No[b]
Total Selenium (Se)	µg/L	1	1	0.04	0.141	2.05	0.199	0.03	No[b]
Total Zinc (Zn)	µg/L	7	25.5	2.95	-	21.2	8.79	1.26	No[b]
Nitrate (N)	mg/L	13	-	-	-	4.88	0.44	0.06	No
Total Phosphorus	mg/L	0.02	0.177	-	-	-	0.029	0.004	No[b]
Ethylene Glycol	mg/L	192	<20	-	<5	-	<5	<0.71	No
Propylene Glycol	mg/L	500	<20	-	<5	-	<5	<0.71	No
F1 (C6-C10)	µg/L	167	<25	-	-	<25	<25	<3.57	No
F1 (C6-C10) - BTEX	µg/L	167	<25	-	-	<25	<25	<3.57	No
F2 (C10-C16 Hydrocarbons)	µg/L	42	<100	-	-	<100	<100	<14.29	No[b]
F3 (C16-C34 Hydrocarbons)	µg/L	200	<200	-	-	<200	<200	<28.57	No
Total Residual Chlorine (TRC)	µg/L	2	-	-	-	4	-	-	No[b]

Notes:

[a] See Table A-10 for references for these selected screening benchmarks.

[b] See discussion in Section 4.1.3.2.2.2.

RLW - Radioactive Liquid Waste

BB - Boiler Blowdown

IAD - Inactive Drainage

WTP - Water Treatment Plant

CCW - Condenser Cooling Water

Value Indicates parameter exceeded screening criteria.

Table A-13b: Screening of 2016 CCW Effluent for Ecological Health (no new data since 2020 ERA)

Parameter	Units	Detection Limit	FEQG (1)	CWQG (2)	HERA (3)	Selected Surface Water Screening Criteria	Reference	Maximum Concentration in CCW (EcoMetrix, 2016)	Estimated Max Mixing Zone Concentrations	Carried forward to detailed screening?
Alcohol Ethoxylates C8-9	µg/L	0.03	179	-	-	179	(1)	ND	ND	No
Alcohol Ethoxylates C10-11	µg/L	0.03	80	-	-	80	(1)	ND	ND	No
Alcohol Ethoxylates C12 -13	µg/L	0.03	32	-	-	32	(1)	108.7	15.5	No[b]
Alcohol Ethoxylates C14-15	µg/L	0.03	11	-	-	11	(1)	16	2.3	No[b]
Alcohol Ethoxylates C16-18	µg/L	0.03	2	-	-	2	(1)	1	0.1	No
Total Alcohol Ethoxylates	µg/L	0.03	-	-	-	None	-	121	17.3	No[b]
Nonylphenol Ethoxycarboxylate	µg/L	0.01	-	1	-	1	(2)	ND	ND	No
Linear Alkylbenzene Sulphonates C10	µg/L	0.06	-	-	1700	1700	(3)	1.1	0.2	No
Linear Alkylbenzene Sulphonates C12	µg/L	0.06	-	-	320	320	(3)	15.3	2.2	No
Total Linear Alkylbenzene Sulphonates	µg/L	0.06	-	-	-	None	-	15.3	2.2	No[b]

References:

1. Federal Environmental Quality Guidelines - Alcohol Ethoxylates, n = 0 (EC, 2013b)
2. Canadian Water Quality Guideline for the Protection of Aquatic Life (CCME, 2002)
3. Revised Human and Environmental Risk Assessment (HERA) Report - Linear Alkylbenzene Sulphonate, Table 10 (HERA, 2013)

Notes:

[a] ND = non-detect

[b] See discussion in Section 4.1.3.2.2.2.

Value — Indicates parameter exceeded screening criteria.

Table A-13c: Screening of 2016 CCW Effluent for Ecological Health (no new data since 2020 ERA)

AEO Fraction	Ethoxylate Number	FEQG (1) (ng/L)	Maximum Concentration in CCW (EcoMetrix, 2016)	Estimated Max Mixing Zone Concentrations	Carried Forward as COPC for Addendum?
C12 (ng/L)	E4	128000	80253	11465	No
	E5	158000	5136	734	No
	E6	193000	5164	738	No
	E7	233000	4847	692	No
	E8	279000	5568	795	No
	E9	332000	4268	610	No
	E10	392000	3375	482	No
C13 (ng/L)	E3	62000	1674	239	No
	E4	78000	1762	252	No
	E5	96000	224	32	No
	E6	118000	93	13	No
	E7	142000	14	2	No
	E8	170000	32	5	No
	E9	203000	14	2	No
	E10	240000	39	6	No
C14 (ng/L)	E3	37000	11832	1690	No
	E4	46000	2692	385	No
	E5	57000	2278	325	No
	E6	70000	2094	299	No
	E7	84000	1601	229	No
	E8	102000	1257	180	No
	E9	121000	1377	197	No
	E10	144000	829	118	No
C15 (ng/L)	E3	21000	202	29	No
	E4	26000	2176	311	No
	E5	33000	943	135	No
	E6	40000	830	119	No
	E7	49000	461	66	No
	E8	59000	752	107	No
	E9	71000	625	89	No
	E10	84000	128	18	No

References:

1. Federal Environmental Quality Guidelines - Alcohol Ethoxylates (EC, 2013b)

Notes:

AEO Fraction - alcohol ethoxylates fraction

Value Indicates parameter exceeded screening criteria.

Table A-14: Screening of Stormwater Quality for Ecological Health (no new data since 2020 ERA)

Parameter	2020 ERA Stormwater Loadings and Diluted Concentrations: Maximum Stormwater Loading – Value	Maximum Stormwater Loading – Units	Estimated Diluted Concentration in Lake Water – Value	Estimated Diluted Concentration in Lake Water – Units	Selected Surface Water Screening Criteria [a]	COPC in 2020 ERA?	Exceeds Screening Criteria?	Carried Forward as COPC for Addendum?
Physical/Conventional Characteristics								
Alkalinity, Bicarbonate (HCO3)	54010	mg/s	5.56	mg/L	-[b]	-	-	No
Alkalinity, Carbonate (CO3)	1015.388	mg/s	0.10	mg/L	-[b]	-	-	No
Alkalinity, Hydroxide (OH)	423.66	mg/s	0.04	mg/L	-[b]	-	-	No
Alkalinity, Total	54010	mg/s	5.56	mg/L	-[b]	-	-	No
Conductivity	7.64	mS/cm	7.64	mS/cm	-[b]	-	-	No
Hardness, Calcium Carbonate, Total	147184800	µg/s	15142	µg/L	-[b]	-	-	No
pH	8.36	pH	8.36	pH	6.5-8.5	No	No	No
pH, field measured	8.97	pH	**8.97**	pH	6.5-8.5	No[d]	**Yes**	No[d]
Temperature, field measured	25.3	Celsius	25.30	Celsius	-[b]	-	-	No
Total Dissolved Solids	1080231.3	mg/s	111.1	mg/L	-[b]	-	-	No
Total Suspended Solids	68868.8	mg/s	7.09	mg/L	8.35	No	No	No
Nutrients								
Ammonia Nitrogen	757.77	mg/s	0.08	mg/L	0.44	No	No	No
Unionized Ammonia, calculated	57.486	mg/s	0.0059	mg/L	0.019	No	No	No
Biochemical Oxygen Demand, 5 Day	1270.98	mg/s	0.13	mg/L	-[b]	-	-	No
Biological								
Background Colonies	300380	CFU/s	3.09	CFU/100 ml	-[b]	-	-	No
Escherichia coli	80972	CFU/s	0.83	CFU/100 ml	100	No	No	No
Fecal Coliform	2746200	CFU/s	28.25	CFU/100 ml	100	No	No	No
Total Coliform	120152	CFU/s	1.24	CFU/100 ml	100	No	No	No
Anions								
Chloride	630792	mg/s	64.90	mg/L	640	No	No	No
Nitrate as N	188.838	mg/s	0.02	mg/L	13	No	No	No
Nitrite as N	7.32036	mg/s	0.0008	mg/L	0.06	No	No	No
Nitrogen, Nitrate-Nitrite	190.2906	mg/s	0.02	mg/L	-	-	-	No
Total Phosphorus	60.8192	mg/s	0.0063	mg/L	0.02	No	No	No
Dissolved Phosphorus	31.2144	mg/s	0.0032	mg/L	0.02	No	No	No
Radionuclides								
Gross Gamma Activity	2118.3	Bq/s	0.2179	mg/L	-	-	-	Yes[g]
Tritium (Hydrogen-3)	168291.2	µg/s	17.3139	mg/L	-	-	-	Yes[g]
Cesium-134	423.66	Bq/s	0.0436	mg/L	-	-	-	Yes[g]
Cesium-137	423.66	Bq/s	0.0436	mg/L	-	-	-	Yes[g]
Cobalt-60	423.66	Bq/s	0.0436	mg/L	-	-	-	Yes[g]
Iodine-131	423.66	µg/s	0.0436	mg/L	-	-	-	Yes[g]
Metals and Inorganics								
Total Aluminum (Al)	765085.14	µg/s	78.71	µg/L	100	No	No	No
Dissolved Aluminum (Al)	24208.22944	µg/s	2.49	µg/L	75	No	No	No
Dissolved (0.2u) Aluminum (Al)	8896.86	µg/s	0.92	µg/L	75	No	No	No
Total Antimony (Sb)	211.83	µg/s	0.022	µg/L	20	No	No	No
Dissolved Antimony (Sb)	211.83	µg/s	0.022	µg/L	20	No	No	No
Total Arsenic (As)	423.66	µg/s	0.044	µg/L	5	No	No	No
Dissolved Arsenic (As)	423.66	µg/s	0.044	µg/L	5	No	No	No
Total Barium (Ba)	42052.8	µg/s	4.3264	µg/L	1000	Yes[f]	No	No
Dissolved Barium (Ba)	39424.5	µg/s	4.0560	µg/L	1000	Yes[f]	No	No
Total Beryllium (Be)	<211.83	µg/s	<0.022	µg/L	1100	No	No	No
Dissolved Beryllium (Be)	<211.83	µg/s	<0.022	µg/L	1100	No	No	No
Total Bismuth (Bi)	<423.66	µg/s	<0.044	µg/L	2.5	No	No	No
Dissolved Bismuth (Bi)	423.66	µg/s	0.044	µg/L	2.5	No	No	No
Total Boron (B)	31214.4	µg/s	3.21	µg/L	1500	No	No	No
Dissolved Boron (B)	26755.2	µg/s	2.75	µg/L	1500	No	No	No
Total Cadmium (Cd)	85.8624	µg/s	0.0088	µg/L	0.17	No	No	No
Dissolved Cadmium (Cd)	42.366	µg/s	0.0044	µg/L	0.17	No	No	No
Total Calcium (Ca)	38129400	µg/s	3923	µg/L	11,600	No	No	No
Dissolved Calcium (Ca)	42052800	µg/s	4326	µg/L	11,600	No	No	No
Total Chromium (Cr)	2540.096	µg/s	0.26	µg/L	8.9	No	No	No
Dissolved Chromium (Cr)	2118.3	µg/s	0.22	µg/L	8.9	No	No	No
Total Cobalt (Co)	465.088	µg/s	0.048	µg/L	1	No	No	No
Dissolved Cobalt (Co)	211.83	µg/s	0.022	µg/L	1	No	No	No
Total Copper (Cu)	5276.96	µg/s	0.54	µg/L	2.57	No	No	No
Dissolved Copper (Cu)	1694.64	µg/s	0.17	µg/L	2.57	No	No	No
Hexavalent Chromium	416.546354	µg/s	0.043	µg/L	1	No	No	No
Total Iron (Fe)	1144832	µg/s	117.8	µg/L	300	No	No	No
Dissolved Iron (Fe)	42366	µg/s	4.4	µg/L	300	No	No	No
Total Lead (Pb)	2879.968	µg/s	0.30	µg/L	3.59	No	No	No
Dissolved Lead (Pb)	211.83	µg/s	0.022	µg/L	3.59	No	No	No
Total Lithium (Li)	2499.594	µg/s	0.26	µg/L	14	No	No	No
Dissolved Lithium (Li)	2118.3	µg/s	0.22	µg/L	14	No	No	No
Total Magnesium (Mg)	9987540	µg/s	1028	µg/L	8,200	No	No	No
Dissolved Magnesium	9987540	µg/s	1028	µg/L	8,200	No	No	No
Total Manganese (Mn)	45435.52	µg/s	4.67	µg/L	220	No	No	No
Dissolved Manganese (Mn)	30245.6	µg/s	3.11	µg/L	220	No	No	No
Total Mercury (Hg)	4.2366	µg/s	0.00044	µg/L	0.026	No	No	No
Total Molybdenum (Mo)	402.477	µg/s	0.041	µg/L	40	No	No	No
Dissolved Molybdenum (Mo)	377.0574	µg/s	0.039	µg/L	40	No	No	No
Total Nickel (Ni)	1252.16	µg/s	0.13	µg/L	25	No	No	No
Dissolved Nickel (Ni)	423.66	µg/s	0.044	µg/L	25	No	No	No
Total Potassium (K)	1355712	µg/s	139.48	µg/L	5,300	No	No	No
Dissolved Potassium (K)	1182735	µg/s	121.68	µg/L	5,300	No	No	No
Total Selenium (Se)	847.32	µg/s	0.087	µg/L	1	No	No	No
Dissolved Selenium (Se)	137.31	µg/s	0.014	µg/L	1	No	No	No
Total Silicon (Si)	1275141.9	µg/s	131.2	µg/L	-[b]	No	-	No
Dissolved Silicon (Si)	630792	µg/s	64.9	µg/L	-[b]	No	-	No
Total Silver (Ag)	42.366	µg/s	0.0044	µg/L	0.1	No	No	No
Dissolved Silver (Ag)	42.366	µg/s	0.0044	µg/L	0.1	No	No	No
Total Sodium (Na)	367962000	µg/s	37,856	µg/L	68,000	No	No	No
Dissolved Sodium (Na)	341679000	µg/s	35,152	µg/L	68,000	No	No	No
Total Strontium (Sr)	473094	µg/s	48.67	µg/L	2500	No	No	No
Dissolved Strontium (Sr)	473094	µg/s	48.67	µg/L	2500	No	No	No
Total Thallium (Tl)	21.183	µg/s	0.0022	µg/L	0.8	No	No	No
Dissolved Thallium (Tl)	21.183	µg/s	0.0022	µg/L	0.8	No	No	No
Dissolved Tellurium (Te)	<423.66	µg/s	<0.044	µg/L	151.9	No	No	No
Total Tellurium (Te)	<423.66	µg/s	<0.044	µg/L	151.9	No	No	No
Dissolved Thorium (Th)	<137.31	µg/s	<0.014	µg/L	0.52	No	No	No
Total Thorium (Th)	847.32	µg/s	0.087	µg/L	0.52	No	No	No
Total Tin (Sn)	423.66	µg/s	0.044	µg/L	73	No	No	No
Dissolved Tin (Sn)	423.66	µg/s	0.044	µg/L	73	No	No	No
Total Titanium (Ti)	22952.5542	µg/s	2.36	µg/L	27.2	No	No	No
Dissolved Titanium (Ti)	2118.3	µg/s	0.218	µg/L	27.2	No	No	No
Dissolved Tungsten (W)	423.66	µg/s	0.044	µg/L	30	No	No	No
Total Tungsten (W)	438.048	µg/s	0.045	µg/L	30	No	No	No
Total Vanadium (Va)	1341.6	µg/s	0.138	µg/L	120	No	No	No
Dissolved Vanadium (Va)	353.217	µg/s	0.036	µg/L	120	No	No	No
Total Uranium (U)	237.644	µg/s	0.024	µg/L	15	No	No	No
Dissolved Uranium (U)	233.9187	µg/s	0.024	µg/L	15	No	No	No
Total Zinc (Zn)	134160	µg/s	13.80	µg/L	7	No	No[e]	No[e]
Dissolved Zinc (Zn)	23654.7	µg/s	2.43	µg/L	7	No	No	No
Dissolved Zirconium (Zr)	423.66	µg/s	0.044	µg/L	4	No	No	No
Total Zirconium (Zr)	423.66	µg/s	0.044	µg/L	4	No	No	No
PCB								
Aroclor 1016	<21.183	µg/s	<0.0022	µg/L	-[c]	-	-	No
Aroclor 1221	<21.183	µg/s	<0.0022	µg/L	-[c]	-	-	No
Aroclor 1232	<21.183	µg/s	<0.0022	µg/L	-[c]	-	-	No
Aroclor 1242	<21.183	µg/s	<0.0022	µg/L	-[c]	-	-	No
Aroclor 1248	<21.183	µg/s	<0.0022	µg/L	-[c]	-	-	No
Aroclor 1254	<21.183	µg/s	<0.0022	µg/L	-[c]	-	-	No
Aroclor 1260	<21.183	µg/s	<0.0022	µg/L	-[c]	-	-	No
Aroclor 1262	<21.183	µg/s	<0.0022	µg/L	-[c]	-	-	No
Aroclor 1268	<21.183	µg/s	<0.0022	µg/L	-[c]	-	-	No
Polychlorinated Biphenyls	<21.183	µg/s	<0.0022	µg/L	-[c]	-	-	No
PHC								
Petroleum Hydrocarbons - F1 (C6-C10)-BTEX	<10591.5	µg/s	<1.09	µg/L	167	No	-	No
Petroleum Hydrocarbons - F1 (C6-C10)	<10591.5	µg/s	<1.09	µg/L	167	No	-	No
Petroleum Hydrocarbons - F2 (C10-C16)	<42366	µg/s	<4.36	µg/L	42	No	-	No
Petroleum Hydrocarbons - F3 (C16-C34)	84732	µg/s	8.72	µg/L	200	No	-	No
Petroleum Hydrocarbons - F4 (C34-C50)	<84732	µg/s	<8.72	µg/L	200	No	-	No
Oil & Grease, Total Rec	445.92	mg/s	0.05	mg/L	-	-	-	No
Benzene	<84.732	µg/s	<0.0087	µg/L	370	No	-	No
Ethylbenzene	<84.732	µg/s	<0.0087	µg/L	90	No	-	No
m,p-Xylenes	231.2904	µg/s	0.024	µg/L	2	No	-	No
o-Xylene	84.732	µg/s	0.009	µg/L	40	No	-	No
Toluene	420.368	µg/s	0.043	µg/L	0.8	No	-	No
Xylenes, Total	289.113	µg/s	0.030	µg/L	2	No	-	No

Notes:

[a] See Table A-10 for references for these selected screening criteria. For all metals, the screening criteria for total metal and inorganics were also used to screen concentration of the dissolved metal ions.
[b] Parameters not of ecological health concern. Screening was considered not necessary.
[c] PCBs do not partition in water, and they are not COPCs from nuclear stations. Therefore these parameters were not screened.
[d] The pH value was exceeding the PWQO guideline, but within the range of the CCME guideline. The range from 6.5-9.0 was considered not harmful to fish and benthic invertebrates. Not carried forward.
[e] The selected benchmark was defined for dissolved zinc. As the estimated concentration of dissolved zinc concentration did not exceed the guideline, total zinc was not carried forward.
[f] Barium exceeded screening and was retained as a COPC in the 2020 DN ERA. Due to a change in the screening criteria, barium no longer screens in as a COPC.
[g] Radionuclides are not screened, and are automatically carried forward as COPCs.

Value — Indicates parameter exceeded screening criteria.

Table A-15: Screening of Pond Water Quality for Ecological Health (no new data since 2020 ERA)

Parameter	Unit	Selected Screening Criteria	Reference	Coot's Pond			Treefrog Pond		
				2020 ERA Max	COPC in the 2020 ERA?	Carried Forward as COPC for Addendum?	2020 ERA Max	COPC in the 2020 ERA?	Carried Forward as COPC for Addendum?
Physical/Conventional Characteristics									
Field Temperature	Celsius	-	-	22.95	-	-	21.63	-	-
Field pH	pH	6.5-8.5	(2)	**7.39-9.62**	Yes	No [f]	6.88-8.26	No	No
pH	pH	6.5-8.5	(2)	**8.18-9.4**	Yes	No [f]	7.55-7.99	No	No
Field Sp. Conductance	µS/cm	-	-	583	-	-	528	-	-
Conductivity	umho/cm	-	-	650	-	-	580	-	-
Field Turbidity	NTU	-	-	15.2	-	-	3.6	-	-
Alkalinity (Total as CaCO3)	mg/L	-	-	200	-	-	270	-	-
Total Hardness (CaCO3)	mg/L	-	-	297	-	-	285	-	-
Nutrients									
Dissolved Organic Carbon	mg/L	-	-	9.8	-	-	11	-	-
Total Kjeldahl Nitrogen (TKN)	mg/L	-	-	0.72	-	-	1.1	-	-
Total Ammonia-N	mg/L	0.044	(1)	**0.18**	Yes	No [f]	**0.21**	Yes	No [f]
Total Un-ionized Ammonia	mg/L	0.019	(1)	**0.048**	Yes	No [f]	0.005	No	No
Nitrate (N)	mg/L	13	(1)	0	No	No	0	No	No
Nitrite (N)	mg/L	0.06	(1)	0.003	No	No	0.004	No	No
Total BOD	mg/L	-	-	5	-	-	2	-	-
Total Chemical Oxygen Demand (COD)	mg/L	-	-	48	-	-	34	-	-
Orthophosphate (P)	mg/L	-	-	0.011	-	-	0.066	No	No
Total Phosphorus	mg/L	0.02	(2)	**0.099**	No [a]	No [a]	**0.18**	No [a]	No [a]
Hydrocarbons									
Benzene	µg/L	370	(1)	0	No	No	0	No	No
Ethylbenzene	µg/L	90	(1)	0	No	No	0	No	No
F1 (C6-C10)	µg/L	167	(1)	0	No	No	0	No	No
F1 (C6-C10) - BTEX	µg/L	167	(1)	0	No	No	0	No	No
F2 (C10-C16 Hydrocarbons)	µg/L	42	(1)	0	No	No	0	No	No
F3 (C16-C34 Hydrocarbons)	µg/L	200	(5)	160	No	No	89	No	No
F4 (C34-C50 Hydrocarbons)	µg/L	200	(5)	0	No	No	0	No	No
Biological				0			0		
Chlorophyll	µg/L	-	-	26.4	-	-	6.94	-	-
Background	CFU/100mL	-	-	12000	-	-	8400	-	-
Total Coliforms	CFU/100mL	100	(2)	**280**	No [b]	No [b]	**640**	No [b]	No [b]
Fecal coliform	CFU/100mL	100	(2)	40	No [b]	No [b]	350	No [b]	No [b]
Escherichia coli	CFU/100mL	100	(2)	40	No [a]	No [a]	340	No [b]	No [b]
Metals									
Total Aluminum (Al)	µg/L	100	(1)	**369**	No [c]	No [c]	18.2	No	No
Dissolved (0.2u) Aluminum (Al)	µg/L	75	(2)	25	No	No	11	No	No
Total Antimony (Sb)	µg/L	20	(2)	0.268	No	No	0.063	No	No
Total Arsenic (As)	µg/L	5	(1)	1.32	No	No	0.298	No	No
Total Barium (Ba)	µg/L	1000	(12)	56.5	Yes [d]	No	39.8	Yes [d]	No
Total Beryllium (Be)	µg/L	1100	(2)	0.017	No	No	0.003	No	No
Total Bismuth (Bi)	µg/L	2.5	(4)	0.006	No	No	0.003	No	No
Total Boron (B)	µg/L	1500	(1)	230	No	No	21	No	No
Total Cadmium (Cd)	µg/L	0.17	(1)	0.0095	No	No	0.005	No	No
Total Calcium (Ca)	µg/L	11,600	(3)	**74,500**	No [e]	No [e]	**97,900**	No [e]	No [e]
Total Cesium (Cs)	µg/L	315	(4)	0.018	No	No	0.011	No	No
Total Chromium (Cr)	µg/L	8.9	(1)	1.58	No	No	1.2	No	No
Chromium (+3)	µg/L	8.9	(1)	0	No	No	0	No	No
Chromium (VI)	µg/L	1	(1)	0.31	No	No	0.24	No	No
Total Cobalt (Co)	µg/L	1	(6)	0.235	No	No	0.24	No	No
Total Copper (Cu)	µg/L	2.57	(1)	1.72	No	No	0.388	No	No
Total Iron (Fe)	µg/L	300	(1)	**433**	Yes	No [f]	**520**	Yes	No [f]
Total Lead (Pb)	µg/L	3.59	(1)	0.614	No	No	0.07	No	No
Total Lithium (Li)	µg/L	14	(3)	5.92	No	No	0.4046	No	No
Total Magnesium (Mg)	µg/L	8,200	(3)	**30,000**	No [e]	No [e]	**9,900**	No [e]	No [e]
Total Manganese (Mn)	µg/L	220	(1)	68.5	No	No	**310**	No	No
Mercury (Hg)	µg/L	0.026	(1)	0.0029	No	No	0.0038	No	No
Total Molybdenum (Mo)	µg/L	40	(2)	1.04	No	No	0.15	No	No
Total Nickel (Ni)	µg/L	25	(2)	0.88	No	No	0.271	No	No
Total Potassium (K)	µg/L	5,300	(3)	**7,030**	No [e]	No [e]	**5,870**	No [e]	No [e]
Total Selenium (Se)	µg/L	1	(1)	0.079	No	No	0.114	No	No
Total Silicon (Si)	µg/L	-	-	2270	-	-	4440	-	-
Total Silver (Ag)	µg/L	0.1	(2)	0.003	No	No	0.002	No	No
Total Sodium (Na)	µg/L	68,000	(3)	21,400	No	No	4,860	No	No
Total Strontium (Sr)	µg/L	2500	(6)	506	No	No	225	No	No
Total Thallium (Tl)	µg/L	0.8	(1)	0.0058	No	No	0.01	No	No
Total Thorium (Th)	µg/L	0.52	(4)	0.013	No	No	0.002	No	No
Total Tin (Sn)	µg/L	73	(3)	0.52	No	No	0.0361	No	No
Total Titanium (Ti)	µg/L	27.2	(4)	19	No	No	1.592	No	No
Total Tungsten (W)	µg/L	30	(2)	0.06	No	No	0.007	No	No
Total Uranium (U)	µg/L	15	(1)	1.48	No	No	0.672	No	No
Total Vanadium (V)	µg/L	120	(8)	2.53	No	No	0.4	No	No
Total Zinc (Zn)	µg/L	7	(1)	3.75	No	No	3.1	No	No
Dissolved Zinc (Zn)	µg/L	7	(1)	2.615	No	No	3.502	No	No
Total Zirconium (Zr)	µg/L	4	(2)	0.19	No	No	0.065	No	No
Other									
Morpholine	µg/L	4	(2)	1	No	No	0	No	No
Bromoform	µg/L	60	(2)	0	No	No	0	No	No
Chloroform	µg/L	1.8	(1)	0	No	No	0	No	No
Bromodichloromethane	µg/L	200	(2)	0	No	No	0	No	No

References:

1. CCME Canadian Water Quality Guidelines for Protection of Aquatic Life. Accessed in July 2020.
2. MOECC: Water management: policies, guidelines, provincial water quality objectives (1994).
3. Suter and Tsao, (1996). Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota: 1996 Revision.
4. Borgmann et al., (2005). Toxicity of Sixty-Three Metals and Metalloids to Hyalella Azteca at Two Levels of Water Hardness.
5. Ecometrix. (2020). Darlington New Nuclear Project Supporting Environment Studies – Environment. Report prepared for OPG. Report No. NK054-REP-01210-0001. May.
6. ECCC (2020). Federal Environmental Quality Guidelines - Strontium. July.
7. Environment Canada (2013). Federal Environmental Quality Guidelines, Vanadium. May.

Notes:

[a] Phosphorus is a nutrient and not a toxicant. Therefore it was not carried forward as a COPC.
[b] E.coli and other coliforms are not of concern of ecological health. They are not carried forward as COPCs.
[c] Although the concentration of total aluminum exceeded the selected screening criteria, its more bioavailable form, dissolved aluminum, did not exceed. Therefore, aluminum was not carried forward as a COPC.
[d] Barium exceeded screening and was retained as a COPC in the 2020 DN ERA. Due to a change in the screening criteria used, barium no longer screens in as a COPC.
[e] Parameter found to exceed screening, but is not carried forward as a COPC. Major ions (Ca, Mg, K) are not considered toxic at environmental concentrations.
[f] Parameters previously assessed as COPCs in the 2020 DN ERA are not carried forward as COPCs for this Addendum, as no new concentrations data is available since the 2020 DN ERA.

Value	Indicates parameter exceeded screening criteria.

Table A-16: Ecological Screening Criteria for Sediment COPCs

Parameter	Units	Sediment Quality Guidelines				Background Values		Lake Ontario Sediment		Pond Sediment	
		PSQG (LEL) (1)	CSQG (2)	Toxicity / Other Benchmark (3-6)	Toxicity / Other Benchmark Reference for Sediment	95th Percentile Background Value, Lake Ontario (7)	Dragun & Chiasson, 1991 (8)	Selected Screening Criteria, Lake Ontario	Reference	Selected Screening Criteria, Pond [c]	Reference
Physical/Conventional Parameters											
Moisture	%	-	-	-	-	-	-	-	-[d]	-	-[d]
Nutrients											
Calculated Total Kjeldahl Nitrogen	mg/kg	550	550	-	-	-	-	550	(1)	550	(1)
Total Organic Carbon	mg/kg	10000	-	-	-	-	-	10,000	(1)	10,000	(1)
Total Phosphorus (P)	mg/kg	600	-	-	-	-	-	600	(1)	600	(1)
Metals											
Total Aluminum (Al)	mg/kg	-	-	58030	(3)	-	-	58,030	(3)	58,030	(3)
Total Antimony (Sb)	mg/kg	-	-	2	(6)	-	-	2	(6)	2	(6)
Total Arsenic (As)	mg/kg	6	5.9	-	-	-	-	5.9	(2)	5.9	(2)
Total Barium (Ba)	mg/kg	-	-	-	-	264.3	10-5000	264.3	(7) [a]	10-5000	(8)
Total Beryllium (Be)	mg/kg	-	-	-	-	1.17	<1.0-15	1.17	(7) [a]	<1.0-15	(8)
Total Bismuth (Bi)	mg/kg	-	-	-	-	<0.5	<10-15	0.5	(7) [a]	<10-15	(8)
Total Boron (B)	mg/kg	-	-	-	-	7.1	<20-300	7.1	(7) [a]	<20-300	(8)
Hot Water Ext. Boron (B)	mg/kg	-	-	-	-	0.5	-	0.5	(7) [b]	-	-
Total Cadmium (Cd)	mg/kg	0.6	0.6	-	-	-	-	0.6	(1)	0.6	(1)
Total Calcium (Ca)	mg/kg	-	-	-	-	107,576	100-320,000	107,576	(7) [a]	100-320,000	(8)
Total Cesium (Cs)	mg/kg	-	-	-	-	0.21	0.25-25	0.21	(7) [a]	0.25-25	(8)
Total Chromium (Cr)	mg/kg	26	37.3	-	-	-	-	26	(1)	26	(1)
Total Cobalt (Co)	mg/kg	-	-	50	(4)	-	-	50	(4)	50	(4)
Total Copper (Cu)	mg/kg	16	35.7	-	-	-	-	16	(1)	16	(1)
Total Iron (Fe)	mg/kg	20000	-	-	-	-	-	20,000	(1)	20,000	(1)
Total Lead (Pb)	mg/kg	31	35	-	-	-	-	31	(1)	31	(1)
Total Lithium (Li)	mg/kg	-	-	-	-	7.2	<5.0-140	7.2	(7) [a]	<5.0-140	(8)
Total Magnesium (Mg)	mg/kg	-	-	-	-	10,501	50->100,000	10,501	(7) [a]	50->100,000	(8)
Total Manganese (Mn)	mg/kg	460	-	-	-	-	-	460	(1)	460	(1)
Total Mercury (Hg)	mg/kg	0.2	0.17	-	-	-	-	0.17	(2)	0.17	(2)
Total Molybdenum (Mo)	mg/kg	-	-	13.8	(5)	-	-	13.8	(5)	13.8	(5)
Total Nickel (Ni)	mg/kg	16	-	-	-	-	-	16	(1)	16	(1)
Total Potassium (K)	mg/kg	-	-	-	-	8,494	50-63,000	8,494	(7) [a]	50-63,000	(8)
Total Selenium (Se)	mg/kg	-	-	1.9	(5)	-	-	1.9	(5)	1.9	(5)
Total Silver (Ag)	mg/kg	-	-	0.5	(4)	-	-	0.5	(4)	0.5	(4)
Total Sodium (Na)	mg/kg	-	-	-	-	9,154	<500-100,000	9,154	(7) [a]	<500-100,000	(8)
Total Strontium (Sr)	mg/kg	-	-	-	-	270	<5-3000	270	(7) [a]	<5-3000	(8)
Total Thallium (Tl)	mg/kg	-	-	-	-	0.17	<0.25-10	0.17	(7) [a]	<0.25-10	(8)
Total Thorium (Th)	mg/kg	-	-	-	-	4.34	2.2-31	4.34	(7) [a]	2.2-31	(8)
Total Tin (Sn)	mg/kg	-	-	-	-	3.01	<0.1-10	3.01	(7) [a]	<0.1-10	(8)
Total Titanium (Ti)	mg/kg	-	-	-	-	3534	70-20,000	3,534	(7) [a]	70-20,000	(8)
Total Tungsten (W)	mg/kg	-	-	-	-	0.58	<100-1000	0.58	(7) [a]	<100-1000	(8)
Total Uranium (U)	mg/kg	-	-	104.4	(5)	-	-	104.4	(5)	104.4	(5)
Total Vanadium (V)	mg/kg	-	-	35.2	(5)	-	-	35.2	(5)	35.2	(5)
Total Zinc (Zn)	mg/kg	120	123	-	-	-	-	120	(1)	120	(1)
Total Zirconium (Zr)	mg/kg	-	-	-	-	122.2	<20-2000	85.68	(7) [a]	<20-2000	(8)
PHCs				-	-	-					
F1 (C6-C10)	mg/kg	-	-	-	-	10	-	10	(7) [a]	-	-
F1 (C6-C10) - BTEX	mg/kg	-	-	-	-	10	-	10	(7) [a]	-	-
F2 (C10-C16 Hydrocarbons)	mg/kg	-	-	-	-	10	-	10	(7) [a]	-	-
F3 (C16-C34 Hydrocarbons)	mg/kg	-	-	-	-	10	-	10	(7) [a]	-	-
F4 (C34-C50 Hydrocarbons)	mg/kg	-	-	-	-	10	-	10	(7) [a]	-	-
F4G-sg (Grav. Heavy Hydrocarbons)	mg/kg	-	-	-	-	10	-	10	(7) [a]	-	-
PAHs				-							
Anthracene	mg/kg	0.22	0.0469	-	-	-	-	0.0469	(2)	0.0469	(2)
Benzo(a)anthracene	mg/kg	0.32	0.317	-	-	-	-	0.317	(2)	0.317	(2)
Benzo(a)pyrene	mg/kg	0.37	0.0319	-	-	-	-	0.0319	(2)	0.0319	(2)
Benzo(g,h,i)perylene	mg/kg	0.17	-	-	-	-	-	0.17	(1)	0.17	(1)
Benzo(k)fluoranthene	mg/kg	0.24	-	-	-	-	-	0.24	(1)	0.24	(1)
Chrysene	mg/kg	0.34	0.0571	-	-	-	-	0.0571	(2)	0.0571	(2)
Dibenzo(a,h)anthracene	mg/kg	0.06	0.00622	-	-	-	-	0.00622	(2)	0.00622	(2)
Fluoranthene	mg/kg	0.75	0.111	-	-	-	-	0.111	(2)	0.111	(2)
Fluorene	mg/kg	0.19	0.0212	-	-	-	-	0.0212	(2)	0.0212	(2)
Indeno(1,2,3-cd)pyrene	mg/kg	0.2	-	-	-	-	-	0.2	(1)	0.2	(1)
Phenanthrene	mg/kg	0.56	0.0419	-	-	-	-	0.0419	(2)	0.0419	(2)
Pyrene	mg/kg	0.49	0.053	-	-	-	-	0.053	(2)	0.053	(2)
Total PAHs	mg/kg	4	-	-	-	-	-	4	(1)	4	(1)
Pesticides and PCBs											
Chlordane (Total)	mg/kg	0.007	0.0045	-	-	-	-	0.0045	(2)	0.0045	(2)
Aldrin	mg/kg	0.0020	-	-	-	-	-	0.002	(1)	0.002	(1)
Total (α-, β-, γ-) BHC	mg/kg	0.003	-	-	-	-	-	0.003	(1)	0.003	(1)
alpha-BHC	mg/kg	0.006	-	-	-	-	-	0.006	(1)	0.006	(1)
beta-BHC	mg/kg	0.005	-	-	-	-	-	0.005	(1)	0.005	(1)
gamma-BHC (Lindane)	mg/kg	0.003	-	-	-	-	-	0.003	(1)	0.003	(1)
Dieldrin	mg/kg	0.002	0.00285	-	-	-	-	0.002	(1)	0.002	(1)
Endrin	mg/kg	0.003	0.00267	-	-	-	-	0.00267	(2)	0.00267	(2)
Hexachlorobenzene	mg/kg	0.02	-	-	-	-	-	0.02	(1)	0.02	(1)
Heptachlor	mg/kg	0.0003	0.0006	-	-	-	-	0.0003	(1)	0.0003	(1)
Heptachlor epoxide	mg/kg	0.005	0.003	-	-	-	-	0.003	(2)	0.003	(2)
Mirex	mg/kg	0.007	-	-	-	-	-	0.007	(1)	0.007	(1)
o,p-DDT + p,p-DDT	mg/kg	0.008	-	-	-	-	-	0.008	(1)	0.008	(1)
p,p-DDD	mg/kg	0.008	-	-	-	-	-	0.008	(1)	0.008	(1)
p,p-DDE	mg/kg	0.005	-	-	-	-	-	0.005	(1)	0.005	(1)
Aroclor 1016	mg/kg	0.007	-	-	-	-	-	0.007	(1)	0.007	(1)
Aroclor 1248	mg/kg	0.03	-	-	-	-	-	0.03	(1)	0.03	(1)
Aroclor 1254	mg/kg	0.06	-	-	-	-	-	0.06	(1)	0.06	(1)
Aroclor 1260	mg/kg	0.005	-	-	-	-	-	0.005	(1)	0.005	(1)
Total PCB	mg/kg	0.07	0.0341	-	-	-	-	0.0341	(2)	0.0341	(2)

References:

1. Ministry of the Environment, Conservation and Parks (2019). Guidelines for identifying, assessing and managing contaminated sediments in Ontario.
2. CCME (1999), Canadian Sediment Quality Guidelines for the Protection of Aquatic Life. Updated 2001.
3. Jones, Suter, (1997). Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment - Associated Biota: 1997 Revision. The probable effect concentration was adopted.
4. MOEE (1993). Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario. Benchmarks were carried forward from the Open Water Disposal Guideline published in 1976.
5. P. A. Thompson, J. Kurias and S. Mihok. 2005. Derivation and use of sediment quality guidelines for ecological risk assessment of metals and radionuclides released to the environment from uranium mining and milling activities in Canada.
6. Long, E. R. and Morgan L. G. (1991), The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program. NOAA. August.
7. OPG (2009). Ecological Risk Assessment and Assessment of Effects on Non-Human Biota Technical Support Document New Nuclear - Darlington Environmental Assessment. Report No. NK054-REP-07730-00022-R000. September.

Notes:

[a] If the 95th percentile of the background value is greater than the detection limit, the background value is selected as the screening criteria. Otherwise, detection limit was selected as the screening criteria.

[b] The concentration of hot water extracted boron collected in the local study area (off-site) in the 2009 ERA was used to screen this parameter.

[c] As the aquatic environment in ponds are very different from Lake Ontario, it is considered not appropriate to use the lake sediment background value to screen pond parameters. For pond sediment, the upper crustal values in the continental USA was used as the background concentration.

[d] The Analyte is not considered of ecological health concern, and therefore no screening benchmark is necessary.

Table A-17: Screening of Lake Ontario Sediment Quality for Ecological Health (no new data since 2020 ERA)

Parameter	Units	Selected Ecological Screening Criteria	Reference	Max Concentration in 2020 ERA	COPC in 2020 ERA?	Exceeds Screening Criteria?	Carried Forward as COPC for Addendum?
Physical/Conventional Parameters							
Moisture	%	-	-	37	-	-	No
Nutrients							
Calculated Total Kjeldahl Nitrogen	mg/kg	550	(1)	**944**	Yes	**Yes**	No [c]
Total Organic Carbon	mg/kg	10,000	(1)	9100	No	No	No
Total Phosphorus (P)	mg/kg	600	(1)	**1010**	Yes	**Yes**	No [c]
Metals							
Total Aluminum (Al)	mg/kg	58,030	(3)	4860	No	No	No
Total Antimony (Sb)	mg/kg	2	(6)	0.15	No	No	No
Total Arsenic (As)	mg/kg	5.9	(2)	1.86	No	No	No
Total Barium (Ba)	mg/kg	264.3	(7)[a]	42.2	No	No	No
Total Beryllium (Be)	mg/kg	1.17	(7)	0.24	No	No	No
Total Bismuth (Bi)	mg/kg	0.5	(7)	0.04438	No	No	No
Total Boron (B)	mg/kg	7.1	(7)	5.4	No	No	No
Hot Water Ext. Boron (B)	mg/kg	0.5	(7)	0.46	No	No	No
Total Cadmium (Cd)	mg/kg	0.6	(1)	0.149	No	No	No
Total Calcium (Ca)	mg/kg	107,576	(7)	**173,000**	No [a]	**Yes**	No [a]
Total Cesium (Cs)	mg/kg	0.21	(7)	**0.39409**	Yes	**Yes**	No [c]
Total Chromium (Cr)	mg/kg	26	(1)	9.5	No	No	No
Total Cobalt (Co)	mg/kg	50	(4)	2.91	No	No	No
Total Copper (Cu)	mg/kg	16	(1)	6.31	No	No	No
Total Iron (Fe)	mg/kg	20,000	(1)	18,100	No	No	No
Total Lead (Pb)	mg/kg	31	(1)	23.6	No	No	No
Total Lithium (Li)	mg/kg	7.2	(7)	5.3	No	No	No
Total Magnesium (Mg)	mg/kg	10,501	(7)	6950	No	No	No
Total Manganese (Mn)	mg/kg	460	(1)	296	No	No	No
Total Mercury (Hg)	mg/kg	0.17	(2)	0.01488	No	No	No
Total Molybdenum (Mo)	mg/kg	13.8	(5)	0.19	No	No	No
Total Nickel (Ni)	mg/kg	16	(1)	6.24	No	No	No
Total Potassium (K)	mg/kg	8,494	(7)	1010	No	No	No
Total Selenium (Se)	mg/kg	1.9	(5)	0.24486	No	No	No
Total Silver (Ag)	mg/kg	0.5	(4)	0.02449	No	No	No
Total Sodium (Na)	mg/kg	9,154	(7)	211	No	No	No
Total Strontium (Sr)	mg/kg	270	(7)	**276**	Yes	**Yes**	No [c]
Total Thallium (Tl)	mg/kg	0.17	(7)	0.064	No	No	No
Total Thorium (Th)	mg/kg	4.34	(7)	3.67	No	No	No
Total Tin (Sn)	mg/kg	3.01	(7)	0.68	No	No	No
Total Titanium (Ti)	mg/kg	3,534	(7)	469	No	No	No
Total Tungsten (W)	mg/kg	0.58	(7)	0.13889	No	No	No
Total Uranium (U)	mg/kg	104.4	(5)	1.05	No	No	No
Total Vanadium (V)	mg/kg	35.2	(5)	33.9	No	No	No
Total Zinc (Zn)	mg/kg	120	(1)	25.9	No	No	No
Total Zirconium (Zr)	mg/kg	85.68	(7)	2.27	No	No	No
PHCs							
F1 (C6-C10)	mg/kg	10	(7)	0	No	No	No
F1 (C6-C10) - BTEX	mg/kg	10	(7)	0	No	No	No
F2 (C10-C16 Hydrocarbons)	mg/kg	10	(7)	0	No	No	No
F3 (C16-C34 Hydrocarbons)	mg/kg	10	(7)	**64**	Yes	**Yes**	No [c]
F4 (C34-C50 Hydrocarbons)	mg/kg	10	(7)	0	No	No	No
PAHs							
Anthracene	mg/kg	0.0469	(2)	0.03	No	No	No
Benzo(a)anthracene	mg/kg	0.317	(2)	0.07	No	No	No
Benzo(a)pyrene	mg/kg	0.0319	(2)	**0.06**	Yes	**Yes**	No [c]
Benzo(g,h,i)perylene	mg/kg	0.17	(1)	0.03	No	No	No
Benzo(k)fluoranthene	mg/kg	0.24	(1)	0.03	No	No	No
Chrysene	mg/kg	0.0571	(2)	**0.06**	Yes	**Yes**	No [c]
Dibenzo(a,h)anthracene	mg/kg	0.00622	(2)	**0.007**	Yes	**Yes**	No [c]
Fluoranthene	mg/kg	0.111	(2)	0.1	No	No	No
Fluorene	mg/kg	0.0212	(2)	0.02	No	No	No
Indeno(1,2,3-cd)pyrene	mg/kg	0.2	(1)	0.04	No	No	No
Phenanthrene	mg/kg	0.0419	(2)	**0.1**	Yes	**Yes**	No [c]
Pyrene	mg/kg	0.053	(2)	0.09	Yes	Yes	No [c]
Total PAHs	mg/kg	4	(1)	0.7	No	No	No
Pesticides and PCBs							
Chlordane (Total)	mg/kg	0.0045	(2)	<0.002	No	No	No
Aldrin	mg/kg	0.002	(1)	<0.002	No	No	No
Total (α-, β-, γ-) BHC	mg/kg	0.003	(1)	<0.002	No	No	No
alpha-BHC	mg/kg	0.006	(1)	<0.002	No	No	No
beta-BHC	mg/kg	0.005	(1)	<0.002	No	No	No
gamma-BHC (Lindane)	mg/kg	0.003	(1)	<0.002	No	No	No
Dieldrin	mg/kg	0.002	(1)	<0.002	No	No	No
Endrin	mg/kg	0.00267	(2)	<0.002	No	No	No
Hexachlorobenzene	mg/kg	0.02	(1)	<0.002	No	No	No
Heptachlor	mg/kg	0.0003	(1)	**<0.002**	No [b]	**Yes**	No [b]
Heptachlor epoxide	mg/kg	0.003	(2)	<0.002	No	No	No
Mirex	mg/kg	0.007	(1)	<0.002	No	No	No
o,p-DDT + p,p-DDT	mg/kg	0.008	(1)	<0.002	No	No	No
p,p-DDD	mg/kg	0.008	(1)	<0.002	No	No	No
p,p-DDE	mg/kg	0.005	(1)	<0.002	No	No	No
Aroclor 1016	mg/kg	0.007	(1)	**<0.05**	No [b]	**Yes**	No [b]
Aroclor 1248	mg/kg	0.03	(1)	**<0.05**	No [b]	**Yes**	No [b]
Aroclor 1254	mg/kg	0.06	(1)	<0.02	No	No	No
Aroclor 1260	mg/kg	0.005	(1)	**<0.02**	No [b]	**Yes**	No [b]
Total PCB	mg/kg	0.0341	(2)	**<0.05**	No [b]	**Yes**	No [b]

References:

1. Ministry of the Environment, Conservation and Parks (2019). Guidelines for identifying, assessing and managing contaminated sediments in Ontario.
2. CCME (1999), Canadian Sediment Quality Guidelines for the Protection of Aquatic Life. Updated 2001.
3. Jones, Suter, (1997). Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment - Associated Biota: 1997 Revision. The probable effect concentration was adopted.
4. MOEE (1993). Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario. Benchmarks were carried forward from the Open Water Disposal Guideline published in 1976.
5. P. A. Thompson, J. Kurias and S. Mihok. 2005. Derivation and use of sediment quality guidelines for ecological risk assessment of metals and radionuclides released to the environment from uranium mining and milling activities in Canada. Environmental Monitoring and Assessment (110): 71-85. Weighted method was adopted in the table.
6. Long, E. R. and Morgan L. G. (1991), The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program. NOAA. August.
7. OPG (2009). Ecological Risk Assessment and Assessment of Effects on Non-Human Biota Technical Support Document New Nuclear - Darlington Environmental Assessment. Report No. NK054-REP-07730-00022-R000. September.

Notes:

[a] Calcium is a natural component in soil, and is an essential nutrient for life. It is not a toxicant for ecological receptors and therefore is not carried forward as a COPC.
[b] All PCB concentrations in the 2018-2019 sampling events were below detection. Also, there is no known source of PCBs at the Darlington site. Therefore, PCBs were not carried forward as COPCs for sediment.
[c] Parameters previously assessed as COPCs in the 2020 DN ERA are not carried forward as COPCs for this Addendum, as no new concentrations data is available since the 2020 DN ERA.

Value	Indicates parameter exceeded screening criteria.

Table A-18: Screening of Pond Sediment Quality for Ecological Health (no new data since 2020 ERA)

Parameter	Units	Selected Screening Criteria	Reference	Coot's Pond			Treefrog Pond		
				2020 ERA Max	COPC in the 2020 ERA?	Carried Forward as COPC for Addendum?	2020 ERA Max	COPC in the 2020 ERA?	Carried Forward as COPC for Addendum?
Physical/Conventional Parameters									
Moisture	%	-	-	68	-	-	85	-	-
Nutrients									
Calculated Total Kjeldahl Nitrogen	mg/kg	550	(1)	**3780**	Yes	No [a]	**21200**	Yes	No [a]
Total Organic Carbon	mg/kg	10,000	(1)	**31,000**	Yes	No [a]	**260,000**	Yes	No [a]
Total Phosphorus (P)	mg/kg	600	(1)	**812**	Yes	No [a]	**1420**	Yes	No [a]
Metals									
Total Aluminum (Al)	mg/kg	58,030	(3)	20,300	No	No	17,900	No	No
Total Antimony (Sb)	mg/kg	2	(6)	0.64	No	No	0.4	No	No
Total Arsenic (As)	mg/kg	5.9	(2)	2.74	No	No	2.46	No	No
Total Beryllium (Be)	mg/kg	<1.0-15	(8)	0.81	No	No	0.77	No	No
Total Bismuth (Bi)	mg/kg	<10-15	(8)	0.15	No	No	0.2	No	No
Total Boron (B)	mg/kg	<20-300	(8)	18.3	No	No	10	No	No
Hot Water Ext. Boron (B)	mg/kg	-	-	1.6	-	-	2.4	-	-
Total Cadmium (Cd)	mg/kg	0.6	(1)	**1.6**	Yes	No [a]	**1.21**	Yes	No [a]
Total Calcium (Ca)	mg/kg	100-320,000	(8)	186,000	No	No	21,800	No	No
Total Cesium (Cs)	mg/kg	0.25-25	(8)	1.4	No	No	0.90	No	No
Total Chromium (Cr)	mg/kg	26	(1)	**30.7**	Yes	No [a]	25.7	No	No
Total Cobalt (Co)	mg/kg	50	(4)	17.3	No	No	6.02	No	No
Total Copper (Cu)	mg/kg	16	(1)	**40.5**	Yes	No [a]	**54.8**	Yes	No [a]
Total Iron (Fe)	mg/kg	20,000	(1)	**23,700**	Yes	No [a]	17,300	No	No
Total Lead (Pb)	mg/kg	31	(1)	13.2	No	No	30	No	No
Total Lithium (Li)	mg/kg	<5.0-140	(8)	21.8	No	No	15.8	No	No
Total Magnesium (Mg)	mg/kg	50->100,000	(8)	12,400	No	No	4,550	No	No
Total Manganese (Mn)	mg/kg	460	(1)	**540**	Yes	No [a]	181	No	No
Total Mercury (Hg)	mg/kg	0.17	(2)	0.065	No	No	0.17	No	No
Total Molybdenum (Mo)	mg/kg	13.8	(5)	5.96	No	No	1.43	No	No
Total Nickel (Ni)	mg/kg	16	(1)	**20.2**	Yes	No [a]	14.2	No	No
Total Potassium (K)	mg/kg	50-63,000	(8)	3,940	No	No	1,980	-	-
Total Selenium (Se)	mg/kg	1.9	(5)	0.36	No	No	**3.07**	Yes	No [a]
Total Silver (Ag)	mg/kg	0.5	(4)	0.06	No	No	0.15	No	No
Total Sodium (Na)	mg/kg	<500-100,000	(8)	550	No	No	167	No	No
Total Strontium (Sr)	mg/kg	<5-3000	(8)	453	No	No	53.5	No	No
Total Thallium (Tl)	mg/kg	<0.25-10	(8)	0.23	No	No	0.16	No	No
Total Thorium (Th)	mg/kg	2.2-31	(8)	3.68	No	No	2.3	No	No
Total Tin (Sn)	mg/kg	<0.1-10	(8)	1.25	No	No	1.31	No	No
Total Titanium (Ti)	mg/kg	70-20,000	(8)	795	No	No	591	No	No
Total Tungsten (W)	mg/kg	<100-1000	(8)	0.23	No	No	0.12	No	No
Total Uranium (U)	mg/kg	104.4	(5)	1.34	No	No	6.96	No	No
Total Vanadium (V)	mg/kg	35.2	(5)	**59.6**	Yes	No [a]	**37.5**	Yes	No [a]
Total Zinc (Zn)	mg/kg	120	(1)	**170**	Yes	No [a]	119	No	No
Total Zirconium (Zr)	mg/kg	<20-2000	(8)	2.11	No	No	3.56	No	No
PHCs									
F1 (C6-C10)	mg/kg	-	-	0	-	No	0	-	No
F1 (C6-C10) - BTEX	mg/kg	-	-	0	-	No	0	-	No
F2 (C10-C16 Hydrocarbons)	mg/kg	-	-	46	-	No	34.07	-	No
F3 (C16-C34 Hydrocarbons)	mg/kg	-	-	460	-	No	410	-	No
F4 (C34-C50 Hydrocarbons)	mg/kg	-	-	160	-	No	147.95	-	No
PAHs									
Anthracene	mg/kg	0.0469	(2)	0	No	No	0	No	No
Benzo(a)anthracene	mg/kg	0.317	(2)	0	No	No	0.018	No	No
Benzo(a)pyrene	mg/kg	0.0319	(2)	0	No	No	0.025	No	No
Benzo(g,h,i)perylene	mg/kg	0.17	(1)	0.014	No	No	0.035	No	No
Benzo(k)fluoranthene	mg/kg	0.24	(1)	0.0040	No	No	0.010	No	No
Chrysene	mg/kg	0.0571	(2)	0.0073	No	No	0.022	No	No
Dibenzo(a,h)anthracene	mg/kg	0.00622	(2)	0	No	No	0	No	No
Fluoranthene	mg/kg	0.111	(2)	0.015	No	No	0.037	No	No
Fluorene	mg/kg	0.0212	(2)	0	No	No	0	No	No
Indeno(1,2,3-cd)pyrene	mg/kg	0.2	(1)	0.0088	No	No	0.027	No	No
Phenanthrene	mg/kg	0.0419	(2)	0.0071	No	No	0.023	No	No
Pyrene	mg/kg	0.053	(2)	0.014	No	No	0.034	No	No

References:

1. Ministry of the Environment, Conservation and Parks (2019). Guidelines for identifying, assessing and managing contaminated sediments in Ontario.
2. CCME (1999), Canadian Sediment Quality Guidelines for the Protection of Aquatic Life. Updated 2001.
3. Jones, Suter, (1997). Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment - Associated Biota: 1997 Revision. The probable effect
4. MOEE (1993). Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario. Benchmarks were carried forward from the Open Water Disposal Guideline published in 1976.
5. P. A. Thompson, J. Kurias and S. Mihok. 2005. Derivation and use of sediment quality guidelines for ecological risk assessment of metals and radionuclides released to the environment
6. Long, E. R. and Morgan L. G. (1991), The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program. NOAA. August.

Notes:

[a] Parameters previously assessed as COPCs in the 2020 DN ERA are not carried forward as COPCs for this Addendum, as no new concentrations data is available since the 2020 DN ERA.

Value	Indicates parameter exceeded screening criteria.

Table A-19: Ecological Screening Criteria for Soil COPCs

Parameter	Units	PSO Component Value (1)[a]	BM Component Value (1)[b]	CCME SQG Agricultural (2)	MOE Table 1 (Residential / Parkland, 1)	Rural Parkland OTR_{98} (1)[c]	Dragun & Chiasson (1991, 3)	Selected Screening Criteria, Plants and Soil Invertebrates	PSO Reference	Selected Screening Criteria, Birds and Mammals	BM Reference
Physical/Conventional Parameters											
Conductivity	µmho/cm	700	-	2000	0.57	-	-	700	(1)	2000	(2)
pH	pH	-	-	6-8	5-9	-	-	5-9	(2)	5-9	(2)
TOC	%	-	-	-	-	-	-	-	-	-	-
Moisture	%	-	-	-	-	-	-	-	-	-	-
Sodium Adsorption Ratio	N/A	5	-	5	2.4	-	-	5	(2)	5	(2)
Metals			-								
Hot Water Ext. Boron (B)	mg/kg	1.5	-	2	-	-	-	1.5	(1)	2	(2)
Total Aluminum (Al)	mg/kg	-	-	-	-	30,000	-	30,000	(1)	30,000	(1)
Total Antimony (Sb)	mg/kg	20	25	20	1.3	-	-	20	(2)	20	(2)
Total Arsenic (As)	mg/kg	20	51	12	18	-	-	12	(2)	12	(2)
Total Barium (Ba)	mg/kg	750	390	750	220	-	-	750	(1)	390	(1)
Total Beryllium (Be)	mg/kg	4	13	4	2.5	-	-	4	(2)	4	(2)
Total Bismuth (Bi)	mg/kg	-	-	-	-	-	<10-15	<10-15	(3)	<10-15	(3)
Total Boron (B)	mg/kg	-	120		36	-	-	36	(1)	120	(1)
Total Cadmium (Cd)	mg/kg	12	1.9	1.4	1.2	-	-	1.4	(2)	1.4	(2)
Total Calcium (Ca)	mg/kg	-	-	-	-	54,000	-	54,000	(1)	54,000	(1)
Total Cesium (Cs)	mg/kg	-	-	-	-	-	0.25-25	0.25-25	(3)	0.25-25	(3)
Total Chromium (Cr)	mg/kg	310	160	64	70	-	-	64	(2)	64	(2)
Total Cobalt (Co)	mg/kg	40	180	40	21	-	-	40	(2)	40	(2)
Total Copper (Cu)	mg/kg	140	770	63	92	-	-	63	(2)	63	(2)
Total Iron (Fe)	mg/kg	-	-	-	-	36,000	-	36,000	(2)	36,000	(2)
Total Lead (Pb)	mg/kg	250	32	70	120	-	-	70	(2)	32	(1)
Total Lithium (Li)	mg/kg	-	-	-	-	-	<5.0-140	<5.0-140	(3)	<5.0-140	(3)
Total Magnesium (Mg)	mg/kg	-	-	-	-	19,000	-	19,000	(1)	19,000	(1)
Total Manganese (Mn)	mg/kg	-	-	-	-	1900	-	1900	(1)	1900	(1)
Total Mercury (Hg)	mg/kg	10	20	6.6	0.27	-	-	6.6	(2)	6.6	(2)
Total Molybdenum (Mo)	mg/kg	40	6.9	5	2	-	-	5	(2)	5	(2)
Total Nickel (Ni)	mg/kg	100	5000	45	82	-	-	45	(2)	45	(2)
Total Potassium (K)	mg/kg	-	-	-	-	6500	-	6500	(1)	6500	(1)
Total Selenium (Se)	mg/kg	10	2.4	1	1.5	-	-	1	(2)	1	(2)
Total Silver (Ag)	mg/kg	20	-	20	0.5	-	-	20	(2)	20	(2)
Total Sodium (Na)	mg/kg	-	-	-	-	690	-	690	(1)	690	(1)
Total Strontium (Sr)	mg/kg	-	-	-	-	63	-	63	(1)	63	(1)
Total Thallium (Tl)	mg/kg	1.4	3.9	1	1	-	-	1	(1)	1	(1)
Total Thorium (Th)	mg/kg	-	-	-	-	-	2.2-31	2.2-31	(3)	2.2-31	(3)
Total Tin (Sn)	mg/kg	-	-	5	-	-	-	5	(2)	5	(2)
Total Titanium (Ti)	mg/kg	-	-	-	-	5500	-	5500	(1)	5500	(1)
Total Tungsten (W)	mg/kg	-	-	-	-	-	<100-1000	<100-1000	(3)	<100-1000	(3)
Total Uranium (U)	mg/kg	500	33	23	2.5	-	-	23	(2)	23	(2)
Total Vanadium (V)	mg/kg	200	18	130	86	86	-	130	(2)	86	(1)[e]
Total Zinc (Zn)	mg/kg	400	340	250	290	-	-	250	(2)	250	(2)
Total Zirconium (Zr)	mg/kg	-	-	-	-	-	<20-2000	<20-2000	(3)	<20-2000	(3)
PHC											
F1 (C6-C10) - BTEX	mg/kg	210	-	210	25	-	-	210	(2)	210	(2)
F1 (C6-C10)	mg/kg	210	-	210	25	-	-	210	(2)	210	(2)
F2 (C10-C16 Hydrocarbons)	mg/kg	150	-	150	10	-	-	150	(2)	150	(2)
F3 (C16-C34 Hydrocarbons)	mg/kg	300	-	300	240	-	-	300	(2)	300	(2)
F4 (C34-C50 Hydrocarbons)	mg/kg	2800	-	2800	120	-	-	2800	(2)	2800	(2)
F4G-sg (Grav. Heavy Hydrocarbons)	mg/kg	2800	-	2800	120	-	-	2800	(2)	2800	(2)
VOC											
1,1,1,2-Tetrachloroethane	mg/kg	-	-	-	0.05	-	-	0.05	(1)	0.05	(1)
1,1-Dichloroethane	mg/kg	8.4	-	0.1	0.05	-	-	0.1	(2)	0.1	(2)
1,1-Dichloroethylene	mg/kg	50	-	0.1	0.05	-	-	0.1	(2)	0.1	(2)
1,2-Dibromoethane (ethylene dibromide)	mg/kg	-	-	-	0.05	-	-	0.05	(1)	0.05	(1)
1,2-Dichlorobenzene	mg/kg	3.4	-	0.1	0.05	-	-	0.1	(2)	0.1	(2)
1,2-Dichloroethane	mg/kg	48	-	0.1	0.05	-	-	0.1	(2)	0.1	(2)
1,2-Dichloropropane	mg/kg	25	-	0.1	0.05	-	-	0.1	(2)	0.1	(2)
1,3-Dichlorobenzene	mg/kg	4.8	-	0.1	0.05	-	-	0.1	(2)	0.1	(2)
1,3-Dichloropropene (cis+trans)	mg/kg	25	-	-	0.05	-	-	25	(1)	0.05	(1)
1,4-Dichlorobenzene	mg/kg	3.6	-	0.1	0.05	-	-	0.1	(2)	0.1	(2)
2-Butanone (Methyl Ethyl Ketone)	mg/kg	35	9900	-	0.5	-	-	35	(1)	9900	(1)
Methyl Isobutyl Ketone	mg/kg	-	-	-	0.5	-	-	0.5	(1)	0.5	(1)
Acetone (2-Propanone)	mg/kg	-	56	-	0.5	-	-	0.5	(1)	56	(1)
Benzene	mg/kg	25	370	0.03	0.02	-	-	0.03	(2)	0.03	(2)
Bromodichloromethane	mg/kg	-	-	-	0.05	-	-	0.05	(1)	0.05	(1)
Bromoform	mg/kg	-	-	-	0.05	0.00027	-	0.05	(1)	0.05	(1)
Bromomethane	mg/kg	-	-	-	0.05	0.0011	-	0.05	(1)	0.05	(1)
Carbon Tetrachloride	mg/kg	5.8	7.6	0.1	0.05	-	-	0.1	(2)	0.1	(2)
Chlorobenzene	mg/kg	6	-	0.1	0.05	-	-	0.1	(2)	0.1	(2)
Chloroform	mg/kg	34	81	0.1	0.05	-	-	0.1	(2)	0.1	(2)
cis-1,2-Dichloroethylene	mg/kg	-	84	-	0.05	-	-	0.05	(1)	84	(1)
cis-1,3-Dichloropropene[d]	mg/kg	25	-	-	0.05	-	-	25	(1)	0.05	(1)
Dibromochloromethane	mg/kg	-	-	-	0.05	0.00019	-	0.05	(1)	0.05	(1)
Dichlorodifluoromethane (FREON 12)	mg/kg	40	-	-	0.05	-	-	40	(1)	0.05	(1)
Ethylbenzene	mg/kg	55	90	0.082	0.05	-	-	0.082	(2)	0.082	(2)
Methyl t-butyl ether (MTBE)	mg/kg	25	-	-	0.05	-	-	25	(1)	0.05	(1)
Methylene Chloride(Dichloromethane)	mg/kg	0.78	350	0.1	-	-	-	0.1	(2)	0.1	(2)
Styrene	mg/kg	17	-	0.1	0.05	-	-	0.1	(2)	0.1	(2)
trans-1,2-Dichloroethylene	mg/kg	-	84	-	0.05	-	-	0.05	(1)	84	(1)
trans-1,3-Dichloropropene[d]	mg/kg	25	-	-	0.05	-	-	25	(1)	0.05	(1)
Trichloroethylene	mg/kg	100	8.1	-	0.05	-	-	100	(1)	8.1	(1)
Trichlorofluoromethane (FREON 11)	mg/kg	16	-	-	0.25	-	-	16	(1)	0.25	(1)
Vinyl Chloride	mg/kg	3.4	12	-	0.25	-	-	3.4	(1)	12	(1)
Total Xylenes	mg/kg	95	96	11	0.05	-	-	11	(2)	11	(2)
Hexane	mg/kg	-	-	0.49	0.05	-	-	0.49	(2)	0.49	(2)
PAHs											
1-Methylnaphthalene	mg/kg	-	-	-	0.59	0.006	-	0.59	(1)	0.59	(1)
2-Methylnaphthalene	mg/kg	-	-	-	0.59	0.006	-	0.59	(1)	0.59	(1)
Acenaphthene	mg/kg	-	6600	-	0.072	-	-	0.072	(1)	6600	(1)
Acenaphthylene	mg/kg	-	-	-	0.093	0.093	-	0.093	(1)	0.093	(1)
Anthracene	mg/kg	2.5	38000	2.5	0.16	-	-	2.5	(2)	2.5	(2)
Benzo(b/j)fluoranthene	mg/kg	-	-	0.1[f]	0.47	-	-	0.1	(2)	0.1	(2)
Benzo(a)anthracene	mg/kg	0.5	-	0.1[f]	0.36	-	-	0.5	(1)	0.1	(2)
Benzo(a)pyrene	mg/kg	20	1600	20	0.3	-	-	20	(2)	20	(2)
Benzo(g,h,i)perylene	mg/kg	6.6	-	-	0.68	-	-	6.6	(1)	0.68	(1)
Benzo(k)fluoranthene	mg/kg	7.6	-	0.1[f]	0.48	-	-	7.6	(1)	0.48	(2)
Chrysene	mg/kg	7	-	-	2.8	-	-	7	(1)	2.8	(1)
Dibenzo(a,h)anthracene	mg/kg	-	-	0.1[f]	0.1	-	-	0.1	(2)	0.1	(2)
Fluoranthene	mg/kg	50	0.69	50	0.56	-	-	50	(1)	0.69	(1)
Fluorene	mg/kg	-	-	-	0.12	0.0094	-	0.12	(1)	0.12	(1)
Indeno(1,2,3-cd)pyrene	mg/kg	0.38	-	0.1[f]	0.23	-	-	0.38	(1)	0.23	(2)
Naphthalene	mg/kg	0.6	380	0.6	0.09	-	-	0.6	(1)	380	(1)
Phenanthrene	mg/kg	6.2	2700	0.1[f]	0.69	-	-	6.2	(1)	2700	(1)
Pyrene	mg/kg	-	4700	0.1[f]	1	-	-	1	(2)	4700	(1)
PCBs											
Polychlorinated Biphenyls	mg/kg	33	1.1	0.5	0.3	-	-	0.5	(2)	1.1	(1)
Other					-						
Cyanide (free)	mg/kg	0.9	0.11	0.9	0.051	-	-	0.9	(2)	0.11	(1)
Total Phosphorus	mg/kg	-	-	-	-	1100	-	1100	(1)	1100	(1)

Reference:

1. Standards Development Branch, Ontario Ministry of the Environment, 2011. Rationale for the Development of Soil and Ground Water Standards for Use at contaminated Sites in Ontario. April.
2. CCME. Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health. Accessed on July 2020.
3. Dragun and Chiasson (1991). Elements in North American Soils.

Notes:

[a] Plant and Soil Organisms (PSO) component values for agricultural/other land use was adopted in this table.
[b] Bird and mammal (BM) component values derived for residential/parkland were adopted in this table.
[c] If there are multiple OTR_{98} values in different sampling regions, values from region 3 (central) was selected considering the DN facility resides in region 3.
[d] Screening Criteria selected to screen 1,3-dichloropropene was also applied to screen cis- and trans-1,3-dichloropropene.
[e] OTR_{98} was selected for vanadium for protection of mammal and birds, considering the background concentration in Ontario is more elevated than the component value. See discussion in Section 4.1.4.3.
[f] Insufficient direct soil contact data available. This value is based on the interim CSQG. Ontario component value, if available, is selected prior to this value.

Table A-20: Screening of Soil Quality for Ecological Health

Parameter	Units	Selected Screening Criteria, Plants and Soil Invertebrates		Selected Screening Criteria, Birds and Mammals		2020 ERA Max Concentrations Within Each Terrestrial Polygon				2021 DNNP Soil Characterization Study	Plants and Soil		Birds and Mammals	
		Screening Criteria	Reference	Screening Criteria	Reference	AB	C	D	E	E	COPC in the 2020 ERA?	Carried Forward as COPC for Addendum?	COPC in the 2020 ERA?	Carried Forward as COPC for Addendum?
Physical/Conventional Parameters														
Conductivity	µmho/cm	700	(1)	2000	(2)	265	230	256	407	530	No	No	No	No
pH	pH	5-9	(2)	5-9	(2)	7.55	7.59	7.55	8.12	6.83 - 8.11	No	No	No	No
TOC	%	-		-	-	2.57	2.43	3.41	2.12	-	No	No	No	No
Moisture	%	-		-	-	33	24	26	42	49	No	No	No	No
Sodium Adsorption Ratio	N/A	5	(2)	5	(2)	0.24	0.3	0.19	0.51	**6.70**	No	**Yes (E)**	No	**Yes (E)**
Metals														
Hot Water Ext. Boron (B)	mg/kg	1.5	(1)	2	(2)	0.65	0.29	0.44	0.75	0.87	No	No	No	No
Total Aluminum (Al)	mg/kg	30000	(1)	30000	(1)	13900	12800	11800	13600	-	No		No	
Total Antimony (Sb)	mg/kg	20	(2)	20	(2)	0.18	0.06972	0.13	15.4	2.00	No	No	No	No
Total Arsenic (As)	mg/kg	12	(2)	12	(2)	6.77	1.8	2	**133**	**20**	Yes (E)	No [b,c]	Yes (E)	No [b,c]
Total Barium (Ba)	mg/kg	750	(1)	390	(1)	104	92.9	107	110	170	No	No	No	No
Total Beryllium (Be)	mg/kg	4	(2)	4	(2)	0.55	0.55	0.48	0.68	0.8	No	No	No	No
Total Bismuth (Bi)	mg/kg	<10-15	(4)	<10-15	(4)	0.075	0.07324	0.0747	0.73	-	No	No	No	No
Total Boron (B)	mg/kg	36	(1)	120	(1)	6.9	6.5	7.7	13.2	14	No	No	No	No
Total Cadmium (Cd)	mg/kg	1.4	(2)	1.4	(2)	0.285	0.129	0.274	**3.75**	0.33	Yes (E)	No [b,c]	Yes (E)	No [b,c]
Total Calcium (Ca)	mg/kg	54,000	(1)	54,000	(1)	**106,000**	**74,500**	**86,000**	**277,000**	-	No[a]	No[a]	No[a]	No[a]
Total Cesium (Cs)	mg/kg	0.25-25	(4)	0.25-25	(4)	0.72709	0.64941	0.76087	0.96806	-	No	No	No	No
Total Chromium (Cr)	mg/kg	64	(2)	64	(2)	22.2	20.9	20.8	**74.8**	30	Yes (E)	No [b,c]	Yes (E)	No [b,c]
Total Cobalt (Co)	mg/kg	40	(2)	40	(2)	7.06	7.1	6.98	**159**	28	Yes (E)	No [b,c]	Yes (E)	No [b,c]
Total Copper (Cu)	mg/kg	63	(2)	63	(2)	16.8	15.2	15.1	**2230**	**370**	Yes (E)	No [b,c]	Yes (E)	No [b,c]
Total Iron (Fe)	mg/kg	36,000	(2)	36,000	(2)	18,500	17,800	17,300	**94,900**	-	Yes (E)	No [b]	Yes (E)	No [b]
Total Lead (Pb)	mg/kg	70	(2)	32	(1)	23.6	8.14	9.83	**589**	**77**	Yes (E)	No [b,c]	Yes (E)	No [b,c]
Total Lithium (Li)	mg/kg	<5.0-140	(4)	<5.0-140	(4)	11	12.6	10.5	11.3	-	No	No	No	No
Total Magnesium (Mg)	mg/kg	19,000	(1)	19,000	(1)	7,660	6,060	7,740	15,900	-	No	No	No	No
Total Manganese (Mn)	mg/kg	1,900	(1)	1,900	(1)	443	408	446	572	-	No	No	No	No
Total Mercury (Hg)	mg/kg	6.6	(2)	6.6	(2)	0.045	0.02441	0.04482	0.03497	0.067	No	No	No	No
Total Molybdenum (Mo)	mg/kg	5	(2)	5	(2)	0.39	0.24	0.95	**42.3**	1.6	Yes (E)	No [b,c]	Yes (E)	No [b,c]
Total Nickel (Ni)	mg/kg	45	(2)	45	(2)	13	15.1	13.7	**129**	24	Yes (E)	No [b,c]	Yes (E)	No [b,c]
Total Potassium (K)	mg/kg	6,500	(1)	6,500	(1)	2,010	2,310	2,770	2,400	-	No	No	No	No
Total Selenium (Se)	mg/kg	1	(2)	1	(2)	0.334	0.12695	0.29382	**6.12**	**1.40**	Yes (E)	No [b,c]	Yes (E)	No [b,c]
Total Silver (Ag)	mg/kg	20	(2)	20	(2)	0.055	0.03906	0.553	1.85	0.26	No	No	No	No
Total Sodium (Na)	mg/kg	690	(1)	690	(1)	205	168	266	**1920**	-	Yes (E)	No [b]	Yes (E)	No [b]
Total Strontium (Sr)	mg/kg	63	(1)	63	(1)	**174**	**122**	**142**	**755**	-	Yes (AB, C, D, E)	No [b]	Yes (AB, C, D, E)	No [b]
Total Thallium (Tl)	mg/kg	1	(1)	1	(1)	0.144	0.137	0.148	0.139	0.2	No	No	No	No
Total Thorium (Th)	mg/kg	2.2-31	(4)	2.2-31	(4)	3.78	3.87	3.56	4.01	-	No	No	No	No
Total Tin (Sn)	mg/kg	5	(2)	5	(2)	0.91	0.58	0.69	**108**	-	Yes (E)	No [b]	Yes (E)	No [b]
Total Titanium (Ti)	mg/kg	5500	(1)	5500	(1)	874	434	639	719	-	No	No	No	No
Total Tungsten (W)	mg/kg	<100-1000	(4)	<100-1000	(4)	0.095	0.08789	7.04	1.91	-	No	No	No	No
Total Uranium (U)	mg/kg	23	(2)	23	(2)	0.642	0.454	0.583	1.16	1.4	No	No	No	No
Total Vanadium (V)	mg/kg	130	(2)	86	(1)	36.7	27.5	30.2	31.2	45	No	No	No	No
Total Zinc (Zn)	mg/kg	250	(2)	250	(2)	63	44	53.5	**9320**	**1200**	Yes (E)	No [b,c]	Yes (E)	No [b,c]
Total Zirconium (Zr)	mg/kg	<20-2000	(4)	<20-2000	(4)	1.85	2.12	1.81	14.5	-	No	No	No	No
PHCs														
F1 (C6-C10) - BTEX	mg/kg	210	(2)	210	(2)	0	0	0	0	-	No	No	No	No
F1 (C6-C10)	mg/kg	210	(2)	210	(2)	0	0	0	0	**270**	No	**Yes (E)**	No	**Yes (E)**
F2 (C10-C16 Hydrocarbons)	mg/kg	150	(2)	150	(2)	0	0	0	12	**460**	No	**Yes (E)**	No	**Yes (E)**
F3 (C16-C34 Hydrocarbons)	mg/kg	300	(2)	300	(2)	30.09146	62	44.34857	250	**1000**	No	**Yes (E)**	No	**Yes (E)**
F4 (C34-C50 Hydrocarbons)	mg/kg	2800	(2)	2800	(2)	0	0	0	750	350	No	No	No	No
F4G-sg (Grav. Heavy Hydrocarbons)	mg/kg	2800	(2)	2800	(2)	0	0	0	**3900**	-	Yes (E)	No [b]	Yes (E)	No [b]
VOCs														
1,1,1,2-Tetrachloroethane	mg/kg	0.05	(1)	0.05	(1)	0	0	0	0	<0.04	No	No	No	No
1,1-Dichloroethane	mg/kg	0.1	(2)	0.1	(2)	0	0	0	0	<0.04	No	No	No	No
1,1-Dichloroethylene	mg/kg	0.1	(2)	0.1	(2)	0	0	0	0	<0.04	No	No	No	No
1,2-Dibromoethane (ethylene dibromide)	mg/kg	0.05	(1)	0.05	(1)	0	0	0	0	<0.04	No	No	No	No
1,2-Dichlorobenzene	mg/kg	0.1	(2)	0.1	(2)	0	0	0	0	<0.04	No	No	No	No
1,2-Dichloroethane	mg/kg	0.1	(2)	0.1	(2)	0	0	0	0	<0.049	No	No	No	No
1,2-Dichloropropane	mg/kg	0.1	(2)	0.1	(2)	0	0	0	0	<0.04	No	No	No	No
1,3-Dichlorobenzene	mg/kg	0.1	(2)	0.1	(2)	0	0	0	0	<0.04	No	No	No	No
1,3-Dichloropropene (cis+trans)	mg/kg	25	(1)	0.05	(1)	0	0	0	0	-	No	No	No	No
1,4-Dichlorobenzene	mg/kg	0.1	(2)	0.1	(2)	0	0	0	0	<0.04	No	No	No	No
2-Butanone (Methyl Ethyl Ketone)	mg/kg	35	(1)	9900	(1)	0	0	0	0	<0.4	No	No	No	No
Methyl Isobutyl Ketone	mg/kg	0.5	(1)	0.5	(1)	0	0	0	0	-	No	No	No	No
Acetone (2-Propanone)	mg/kg	0.5	(1)	56	(1)	0	0	0	0	<0.49	No	No	No	No
Benzene	mg/kg	31	(2)	25	(2)	0	0	0	0	0.21	No	No	No	No
Bromodichloromethane	mg/kg	0.05	(1)	0.05	(1)	0	0	0	0	-	No	No	No	No
Bromoform	mg/kg	0.05	(1)	0.05	(1)	0	0	0	0	-	No	No	No	No
Bromomethane	mg/kg	0.05	(1)	0.05	(1)	0	0	0	0	<0.04	No	No	No	No
Carbon Tetrachloride	mg/kg	0.1	(2)	0.1	(2)	0	0	0	0	<0.04	No	No	No	No
Chlorobenzene	mg/kg	0.1	(2)	0.1	(2)	0	0	0	0	<0.04	No	No	No	No
Chloroform	mg/kg	0.1	(2)	0.1	(2)	0	0	0	0	<0.04	No	No	No	No
cis-1,2-Dichloroethylene	mg/kg	0.05	(1)	84	(1)	0	0	0	0	<0.04	No	No	No	No
cis-1,3-Dichloropropene	mg/kg	25	(1)	0.05	(1)	0	0	0	0	<0.03	No	No	No	No
Dibromochloromethane	mg/kg	0.05	(1)	0.05	(1)	0	0	0	0	-	No	No	No	No
Dichlorodifluoromethane (FREON 12)	mg/kg	40	(1)	0.05	(1)	0	0	0	0	<0.04	No	No	No	No
Ethylbenzene	mg/kg	110	(2)	110	(2)	0	0	0	0	0.56	No	No	No	No
Methyl t-butyl ether (MTBE)	mg/kg	25	(1)	0.05	(1)	0	0	0	0	<0.04	No	No	No	No
Methylene Chloride (Dichloromethane)	mg/kg	0.1	(2)	0.1	(2)	0	0	0	0	<0.049	No	No	No	No
Styrene	mg/kg	0.1	(2)	0.1	(2)	0	0	0	0	<0.04	No	No	No	No
trans-1,2-Dichloroethylene	mg/kg	0.05	(1)	84	(1)	0	0	0	0	<0.04	No	No	No	No
trans-1,3-Dichloropropene	mg/kg	25	(1)	0.05	(1)	0	0	0	0	<0.04	No	No	No	No
Trichloroethylene	mg/kg	100	(1)	8.1	(1)	0	0	0	0	<0.01	No	No	No	No
Trichlorofluoromethane (FREON 11)	mg/kg	16	(1)	0.25	(1)	0	0	0	0	<0.04	No	No	No	No
Vinyl Chloride	mg/kg	3.4	(1)	12	(1)	0	0	0	0	<0.019	No	No	No	No
Total Xylenes	mg/kg	11	(2)	11	(2)	0	0	0	0	5.2	No	No	No	No
Hexane	mg/kg	0.49	(2)	0.49	(2)	0	0	0	0	-	No	No	No	No
PAHs														
1-Methylnaphthalene	mg/kg	0.59	(1)	0.59	(1)	0	0	0.0091	0.0056	0.52	No	No	No	No
2-Methylnaphthalene	mg/kg	0.59	(1)	0.59	(1)	0	0	0.0092	0.0058	**0.62**	No	No [d]	No	No [d]
Acenaphthene	mg/kg	0.072	(1)	6600	(1)	0	0	0	0.041823	0.023	No	No	No	No
Acenaphthylene	mg/kg	0.093	(1)	0.093	(1)	0	0	0	0	0.016	No	No	No	No
Anthracene	mg/kg	2.5	(2)	2.5	(2)	0	0	0	0.048847	0.077	No	No	No	No
Benzo(b/j)fluoranthene	mg/kg	0.1	(2)	0.1	(2)	0.01	0.004163	0.0089	0.1	0.078	No	No	No	No
Benzo(a)anthracene	mg/kg	0.5	(1)	0.1	(2)	0.0052	0	0.004761	0.086	0.045	No	No	No	No
Benzo(a)pyrene	mg/kg	20	(2)	20	(2)	0.0067	0	0.0064	0.081	0.039	No	No	No	No
Benzo(g,h,i)perylene	mg/kg	6.6	(1)	0.68	(1)	0.0071	0.0058	0.0075	0.083	0.061	No	No	No	No
Benzo(k)fluoranthene	mg/kg	7.6	(1)	0.48	(1)	0.002909	0	0	0.034582	0.023	No	No	No	No
Chrysene	mg/kg	7	(1)	2.8	(1)	0.0054	0	0.0061	0.077	0.051	No	No	No	No
Dibenz(a,h)anthracene	mg/kg	0.1	(2)	0.1	(2)	0	0	0	0.01	0.0078	No	No	No	No
Fluoranthene	mg/kg	50	(1)	0.69	(1)	0.011	0.003637	0.0092	0.26	0.13	No	No	No	No
Fluorene	mg/kg	0.12	(1)	0.12	(1)	0	0	0	0.041499	0.023	No	No	No	No
Indeno(1,2,3-cd)pyrene	mg/kg	0.38	(1)	0.23	(1)	0.0064	0	0.004912	0.061	0.048	No	No	No	No
Naphthalene	mg/kg	0.6	(1)	380	(1)	0	0	0.004408	0.007	0.12	No	No	No	No
Phenanthrene	mg/kg	6.2	(1)	2700	(1)	0.0057	0	0.0082	0.26	0.27	No	No	No	No
Pyrene	mg/kg	1	(1)	4700	(1)	0.02	0	0.0086	0.18	0.092	No	No	No	No
PCBs														
Polychlorinated Biphenyls	mg/kg	0.5	(2)	1.1	(1)	-	-	-	-	<0.04	No	No	No	No
Other														
Cyanide (free)	mg/kg	0.9	(2)	0.11	(1)	0.07	0.05	0.01	0.33	-	No	No	Yes (E)	No [b]
Total Phosphorus	mg/kg	1100	(1)	1100	(1)	751	661	782	672	-	No	No	No	No

Reference:

1. Standards Development Branch, Ontario Ministry of the Environment, 2011. Rationale for the Development of Soil and Ground Water Standards for Use at contaminated Sites in Ontario. April.
2. CCME. Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health. Accessed on November 2023.
3. CCME (1991). Interim Canadian Environmental Quality Criteria for Contaminated Sites. September.
4. Dragun and Chiasson (1991). Elements in North American Soils.

Notes

[a] Calcium is a natural component in soil, and is an essential nutrient for life. It is not a toxicant for ecological receptors and therefore is not carried forward as a COPC.
[b] Parameters previously assessed as COPCs in the 2020 DN ERA are not carried forward as COPCs for this Addendum, as no new concentrations data is available since the 2020 DN ERA.
[c] New maximum concentration from 2021 DNNP soil characterization study less than previous maximum concentration used in 2020 DN ERA.
[d] Refer to Section 4.1.3.4 of the Addendum for further discussion regarding 2-methylnaphthalene screening.

Value	Indicates parameter exceeded screening criteria.

Appendix B Soil Characterization Data Summary Table

Table B-1: Soil Summary Statistics

Parameter	Summary Statistics								
	N	N > DL	Units	DL	Min	25th-%	50th-%	75th-%	Max
Physical/Conventional Parameters									
Conductivity	106	106	mS/cm	<0.082	<0.082	0.13	0.15	0.22	0.53
Cyanide (Weak Acid Dissociable)	106	15	mg/kg	<0.01	<0.01	0.01	0.01	0.01	0.04
pH	107	107	Unitless	<6.83	<6.84	7.5	7.71	7.89	8.11
Sodium Adsorption Ratio	106	106	Unitless	<0.19	<0.20	0.26	0.295	0.375	6.7
Moisture	157	156	%	<1	<1	7.2	9.9	15	49
Metals									
Antimony	106	10	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2	2
Arsenic	106	78	mg/kg	<1	<1	<1	1.3	1.7	20
Barium	106	106	mg/kg	<10	<10	30.25	39.5	66.25	170
Beryllium	106	70	mg/kg	<0.2	<0.2	<0.2	0.23	0.390	0.8
Boron	106	45	mg/kg	<5	<5	<5	<5	6.2	14
Boron (Hot Water Soluble)	106	91	mg/kg	<0.05	<0.05	0.073	0.12	0.21	0.87
Cadmium	106	45	mg/kg	<0.1	<0.1	<0.1	<0.1	0.138	0.33
Chromium	106	106	mg/kg	<5.3	<5.3	8.325	10	14.75	30
Chromium (VI)	106	0	mg/kg	<0.18	<0.18	<0.18	<0.18	<0.18	<0.18
Cobalt	106	106	mg/kg	<1.4	<1.4	2.7	3.4	4.6	28
Copper	106	106	mg/kg	<1.6	<1.6	5.325	8.4	13	370
Lead	106	106	mg/kg	<1.4	<1.4	3.325	4.8	7.78	77
Mercury	106	3	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	0.067
Molybdenum	106	22	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5	1.6
Nickel	106	106	mg/kg	<2.6	<2.6	5.325	7.4	11	24
Selenium	106	3	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5	1.4
Silver	106	1	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2	0.26
Thallium	106	79	mg/kg	<0.05	<0.05	<0.05	0.067	0.095	0.2
Uranium	106	106	mg/kg	<0.32	<0.32	0.4325	0.485	0.57	1.4
Vanadium	106	106	mg/kg	<11	<11	15.25	18	24	45
Zinc	106	106	mg/kg	<6.9	<6.9	26	35.5	50	1200
Petroleum Hydrocarbons (PHCs) & BTEX									
Petroleum Hydrocarbons - F1 (C6-C10)	151	16	mg/kg	<10	<10	<10	<10	<10	270
Petroleum Hydrocarbons - F2 (C10-C16)	151	28	mg/kg	<10	<10	<10	<10	<10	460
Petroleum Hydrocarbons - F3 (C16-C34)	151	37	mg/kg	<50	<50	<50	<50	51	1000
Petroleum Hydrocarbons - F4 (C34-C50)	151	18	mg/kg	<50	<50	<50	<50	<50	350
Benzene	151	9	mg/kg	<0.02	<0.02	<0.02	<0.02	<0.02	0.21
Toluene	151	10	mg/kg	<0.02	<0.02	<0.02	<0.02	<0.02	0.45
Ethylbenzene	151	13	mg/kg	<0.02	<0.02	<0.02	<0.02	<0.02	0.56
Xylenes, Total	151	17	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	5.2
Volatile Organic Compounds (VOCs)									

Table B-1: Soil Summary Statistics

Parameter	Summary Statistics								
	N	N > DL	Units	DL	Min	25th-%	50th-%	75th-%	Max
2-Chlorophenol	10	0	mg/kg	<0.08	<0.08	<0.08	<0.08	<0.08	<0.2
2,4-Dichlorophenol	10	0	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2
Pentachlorophenol	10	0	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2
2,4,5-Trichlorophenol	10	0	mg/kg	<0.08	<0.08	<0.08	<0.08	<0.08	<0.2
2,4,6-Trichlorophenol	10	0	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2
Acetone	3	0	mg/kg	<0.49	<0.49	<0.49	<0.49	<0.49	<0.49
trans-1,3-Dichloropropene	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
cis-1,3-Dichloropropene	3	0	mg/kg	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Bromomethane	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
1,2-Dibromoethane	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Carbon Tetrachloride	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
n-Hexane	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Chlorobenzene	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
2-Butanone	3	0	mg/kg	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Chloroform	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
4-Methyl-2-pentanone	3	0	mg/kg	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
1,2-Dichlorobenzene	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Methyl tert-Butyl Ether	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
1,3-Dichlorobenzene	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Methylene Chloride	3	0	mg/kg	<0.049	<0.049	<0.049	<0.049	<0.049	<0.049
1,4-Dichlorobenzene	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Styrene	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Dichlorodifluoromethane	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Tetrachloroethene	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
1,1-Dichloroethane	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
1,1,1,2-Tetrachloroethane	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
1,2-Dichloroethane	3	0	mg/kg	<0.049	<0.049	<0.049	<0.049	<0.049	<0.049
1,1,2,2-Tetrachloroethane	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
1,1-Dichloroethene	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
1,1,1-Trichloroethane	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
trans-1,2-Dichloroethene	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
1,1,2-Trichloroethane	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
cis-1,2-Dichloroethene	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Trichloroethene	3	0	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Table B-1: Soil Summary Statistics

Parameter	Summary Statistics								
	N	N > DL	Units	DL	Min	25th-%	50th-%	75th-%	Max
1,2-Dichloropropane	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Trichlorofluoromethane	3	0	mg/kg	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Vinyl Chloride	3	0	mg/kg	<0.019	<0.019	<0.019	<0.019	<0.019	<0.019
Polycyclic Aromatic Hydrocarbons (PAHs)									
Acenaphthene	88	1	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005	0.4
Benzo[g,h,i]perylene	88	19	mg/kg	<0.005	<0.005	<0.005	<0.005	0.008	0.2
Indeno[1,2,3-cd]pyrene	88	9	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005	0.2
Acenaphthylene	88	2	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005	0.1
Benzo[k]fluoranthene	88	3	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005	0.06
1- & 2-Methylnaphthalene	88	22	mg/kg	<0.0071	<0.0071	<0.0071	<0.0071	0.031	1.1
Anthracene	88	9	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005	0.077
Chrysene	88	18	mg/kg	<0.005	<0.005	<0.005	<0.005	0.010	0.1
Naphthalene	88	8	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005	0.12
Benzo[a]anthracene	88	5	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005	0.1
Dibenzo[a,h]anthracene	88	2	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005	0.1
Phenanthrene	88	27	mg/kg	<0.005	<0.005	<0.005	<0.005	0.015	0.27
Benzo[a]pyrene	88	10	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005	0.1
Fluoranthene	88	14	mg/kg	<0.005	<0.005	<0.005	<0.005	0.010	0.13
Pyrene	88	15	mg/kg	<0.005	<0.005	<0.005	<0.005	0.009	0.1
Fluorene	88	1	mg/kg	<0.005	<0.005	<0.005	<0.005	<0.005	0.07
Polychlorinated Biphenyls (PCBs)									
Polychlorinated Biphenyls (PCBs)	81	0	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.015	<0.04

Notes:
N = Total count
N > DL = Total count of samples above the laboratory detection limit
DL = Laboratory detection limit. If multiple DLs were reported, the lowest is presented.
Min = Minimum concentration
25th-% = 25th-percentile concentration
50th-% = 50th-percentile concentration
75th-% = 75th-percentile concentration
Max = Maximum concentration

Appendix C Modelled Concentrations for Ecological Receptors

Table C.1: Modelled Radiation Concentration for Aquatic Biota for Polygon Lake Ontario

Receptor	Unit	Carbon-14		Cobalt-60		Cesium-134		Cesium-137		Tritium		Iodine-131		OBT	
		Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM
Lake Trout	Bq/kg (fw)	1.31E+03	1.78E+02	1.70E+01	1.87E+00	2.01E+03	3.29E+02	2.54E+03	4.97E+02	1.16E+01	1.29E+00	6.60E+00	2.46E+00	2.16E+00	2.41E-01
American Eel	Bq/kg (fw)	1.31E+03	1.78E+02	1.70E+01	1.87E+00	2.01E+03	3.29E+02	2.54E+03	4.97E+02	1.16E+01	1.29E+00	6.60E+00	2.46E+00	2.16E+00	2.41E-01
Bufflehead	Bq/kg (fw)	4.17E+01	3.84E+01	2.21E-01	2.06E-01	6.52E-01	5.83E-01	6.75E-01	5.90E-01	1.58E+01	9.92E+00	1.91E-01	1.91E-01	1.41E+00	7.60E-01
Mallard	Bq/kg (fw)	4.17E+01	3.84E+01	2.08E-01	1.94E-01	6.14E-01	5.48E-01	6.36E-01	5.55E-01	1.58E+01	9.92E+00	1.80E-01	1.79E-01	1.41E+00	7.60E-01

Table C.2: Modelled Radiation Concentration for Media and Ecological Receptors for Polygon AB

Receptor	Unit	Carbon-14		Cobalt-60		Cesium-134		Cesium-137		Tritium		Iodine-131		OBT	
		Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM
Loam Pore Water	Bq/L	1.17E-01	1.17E-01	0.00E+00	0.00E+00	5.40E-04	5.40E-04	1.49E-02	1.49E-02	7.50E+02	4.38E+02	1.22E-01	1.22E-01	0.00E+00	0.00E+00
Turtles	Bq/kg (fw)	3.99E+02	3.51E+02	6.43E+00	4.88E+00	5.11E+02	5.11E+02	7.32E+02	6.83E+02	3.51E+01	3.04E+01	2.31E+01	1.39E+01	6.55E+00	5.67E+00
Frogs	Bq/kg (fw)	3.99E+02	3.51E+02	6.43E+00	4.88E+00	5.11E+02	5.11E+02	7.32E+02	6.83E+02	3.51E+01	3.04E+01	2.31E+01	13.86	6.55E+00	5.67E+00
Aquatic Plants	Bq/kg (fw)	3.89E+01	3.51E+01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	4.30E+01	4.16E+01	2.00E+00	2.00E+00	6.31E+00	6.10E+00
Benthic Invertebrates	Bq/kg (fw)	3.64E+02	3.20E+02	1.31E+01	9.93E+00	1.45E+01	1.45E+01	2.07E+01	1.93E+01	3.51E+01	3.04E+01	3.70E+01	2.22E+01	6.55E+00	5.67E+00
Bufflehead	Bq/kg (fw)	3.64E+02	3.20E+02	2.44E+00	1.86E+00	7.50E+00	7.50E+00	1.07E+01	1.00E+01	2.23E+01	0.00E+00	6.33E-02	3.81E-02	0.00E+00	0.00E+00
Mallard	Bq/kg (fw)	3.10E+02	2.73E+02	1.95E+00	1.49E+00	5.97E+00	5.97E+00	8.49E+00	7.93E+00	2.26E+01	0.00E+00	5.04E-02	3.06E-02	0.00E+00	0.00E+00
Muskrat	Bq/kg (fw)	6.25E+01	5.64E+01	1.69E-02	1.67E-02	8.73E-01	8.73E-01	8.99E-01	8.95E-01	4.54E+01	3.78E+01	8.26E-01	6.99E-01	3.09E+00	2.26E+00
Green Heron	Bq/kg (fw)	3.50E+01	3.19E+01	2.33E-01	2.31E-01	6.53E-01	6.53E-01	6.66E-01	6.64E-01	3.47E+01	2.96E+01	6.47E-01	6.46E-01	1.26E+00	8.49E-01
American Robin	Bq/kg (fw)	3.28E+01	3.20E+01	5.26E-01	5.24E-01	1.47E+00	1.47E+00	1.58E+00	1.58E+00	2.38E+01	2.00E+01	2.44E-02	2.36E-02	1.84E+00	1.42E+00
Bank Swallow	Bq/kg (fw)	3.67E+01	3.18E+01	4.32E-01	4.30E-01	1.21E+00	1.21E+00	1.28E+00	1.27E+00	2.59E+01	2.17E+01	2.36E-02	2.25E-02	1.94E+00	1.50E+00
Song Sparrow	Bq/kg (fw)	4.81E+01	4.68E+01	1.05E+00	1.05E+00	2.94E+00	2.94E+00	3.04E+00	3.03E+00	5.11E+01	4.50E+01	2.42E-02	2.28E-02	3.55E+00	2.88E+00
Yellow Warbler	Bq/kg (fw)	3.62E+01	3.16E+01	4.67E-01	4.65E-01	1.31E+00	1.31E+00	1.37E+00	1.37E+00	2.63E+01	2.22E+01	2.36E-02	2.27E-02	1.96E+00	1.52E+00
Eastern Cottontail	Bq/kg (fw)	5.79E+01	5.63E+01	1.88E-02	1.86E-02	9.71E-01	9.71E-01	1.05E+00	1.05E+00	2.37E+02	1.54E+02	4.74E+00	4.61E+00	1.26E+01	8.32E+00
Meadow Vole	Bq/kg (fw)	5.79E+01	5.63E+01	7.61E-03	7.52E-03	3.94E-01	3.94E-01	4.13E-01	4.11E-01	2.37E+02	1.54E+02	1.95E+00	1.87E+00	1.26E+01	8.32E+00
White-tailed Deer	Bq/kg (fw)	5.79E+01	5.63E+01	2.64E-02	2.61E-02	1.36E+00	1.36E+00	1.43E+00	1.42E+00	2.65E+02	1.70E+02	6.73E+00	6.48E+00	1.36E+01	8.89E+00
Common Shrew	Bq/kg (fw)	6.05E+01	5.23E+01	2.64E-02	2.63E-02	1.35E+00	1.35E+00	1.39E+00	1.38E+00	4.76E+01	4.01E+01	2.38E+00	2.32E+00	4.08E+00	3.22E+00
Raccoon	Bq/kg (fw)	4.84E+01	4.42E+01	4.55E-02	3.87E-02	2.53E+00	2.53E+00	3.34E+00	3.18E+00	9.47E+01	0.00E+00	3.81E+00	3.16E+00	0.00E+00	0.00E+00
Red Fox	Bq/kg (fw)	1.20E+02	1.09E+02	5.34E-03	4.34E-03	7.45E-01	7.45E-01	1.02E+00	9.59E-01	1.17E+02	0.00E+00	8.03E-01	6.43E-01	0.00E+00	0.00E+00
Short-tailed Weasel	Bq/kg (fw)	5.79E+01	5.63E+01	5.55E-04	4.40E-04	2.44E-01	2.44E-01	3.08E-01	3.04E-01	1.42E+02	9.38E+01	5.64E-01	4.56E-01	4.25E+00	3.02E+00

Table C.3: Modelled Radiation Concentration for Media and Ecological Receptors for Polygon C

Receptor	Unit	Carbon-14		Cobalt-60		Cesium-134		Cesium-137		Tritium		Iodine-131		OBT	
		Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM
Loam Pore Water	Bq/L	3.33E-02	3.33E-02	0.00E+00	0.00E+00	2.70E-04	2.70E-04	1.89E-03	1.89E-03	5.28E+02	3.08E+02	1.33E-01	1.33E-01	0.00E+00	0.00E+00
American Robin	Bq/kg (fw)	3.66E+01	3.66E+01	5.19E-01	5.19E-01	1.45E+00	1.45E+00	1.46E+00	1.46E+00	6.93E+01	5.01E+01	2.07E-02	2.07E-02	6.16E+00	4.04E+00
Song Sparrow	Bq/kg (fw)	5.61E+01	5.61E+01	1.04E+00	1.04E+00	2.89E+00	2.89E+00	2.90E+00	2.90E+00	1.38E+02	1.07E+02	2.25E-02	2.25E-02	1.11E+01	7.72E+00
Yellow Warbler	Bq/kg (fw)	5.58E+01	5.58E+01	4.58E-01	4.58E-01	1.28E+00	1.28E+00	1.28E+00	1.28E+00	9.58E+01	7.66E+01	2.81E-02	2.81E-02	7.40E+00	5.28E+00
Eastern Cottontail	Bq/kg (fw)	1.16E+02	1.16E+02	1.82E-02	1.82E-02	9.30E-01	9.30E-01	9.38E-01	9.38E-01	2.75E+02	2.08E+02	3.65E+00	3.65E+00	2.45E+01	1.64E+01
Meadow Vole	Bq/kg (fw)	1.16E+02	1.16E+02	7.24E-03	7.24E-03	3.70E-01	3.70E-01	3.72E-01	3.72E-01	2.75E+02	2.08E+02	1.46E+00	1.46E+00	2.45E+01	1.64E+01
White-tailed Deer	Bq/kg (fw)	1.16E+02	1.16E+02	2.51E-02	2.51E-02	1.28E+00	1.28E+00	1.29E+00	1.29E+00	2.61E+02	2.06E+02	5.05E+00	5.05E+00	2.15E+01	1.50E+01
Common Shrew	Bq/kg (fw)	9.45E+01	9.45E+01	2.61E-02	2.61E-02	1.34E+00	1.34E+00	1.34E+00	1.34E+00	2.37E+02	1.70E+02	2.99E+00	2.99E+00	2.28E+01	1.47E+01
Raccoon	Bq/kg (fw)	9.26E+01	9.26E+01	2.04E-02	2.04E-02	1.09E+00	1.09E+00	1.10E+00	1.10E+00	2.47E+02	1.76E+02	2.60E+00	2.60E+00	0.00E+00	0.00E+00
Red Fox	Bq/kg (fw)	1.09E+02	1.09E+02	1.15E-03	1.15E-03	2.07E-01	2.07E-01	2.10E-01	2.10E-01	2.85E+02	1.92E+02	4.14E-01	4.14E-01	0.00E+00	0.00E+00
Short-tailed Weasel	Bq/kg (fw)	1.16E+02	1.16E+02	7.63E-05	7.63E-05	2.01E-01	2.01E-01	2.06E-01	2.06E-01	2.96E+02	1.96E+02	2.53E-01	2.53E-01	2.16E+01	1.28E+01

Table C.4: Modelled Radiation Concentration for Media and Ecological Receptors for Polygon D

Receptor	Unit	Carbon-14		Cobalt-60		Cesium-134		Cesium-137		Tritium		Iodine-131		OBT	
		Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM	Maximum	UCLM
Loam Pore Water	Bq/L	3.57E-01	3.57E-01	0.00E+00	0.00E+00	5.40E-04	5.40E-04	1.70E-02	1.70E-02	4.74E+02	2.76E+02	1.66E-02	1.66E-02	0.00E+00	0.00E+00
Turtles	Bq/kg (fw)	5.07E+02	5.07E+02	3.00E+00	3.00E+00	2.49E+02	2.49E+02	2.34E+02	2.34E+02	4.35E+01	4.35E+01	1.33E+00	1.33E+00	8.12E+00	8.12E+00
Aquatic Plants	Bq/kg (fw)	5.75E+01	5.75E+01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	5.80E+01	5.80E+01	3.00E+00	3.00E+00	8.51E+00	8.51E+00
American Robin	Bq/kg (fw)	3.91E+01	3.87E+01	5.22E-01	5.22E-01	1.46E+00	1.46E+00	1.57E+00	1.57E+00	2.32E+01	2.05E+01	2.57E-02	2.57E-02	1.68E+00	1.42E+00
Song Sparrow	Bq/kg (fw)	5.76E+01	5.65E+01	1.04E+00	1.04E+00	2.91E+00	2.91E+00	3.01E+00	3.01E+00	5.29E+01	4.79E+01	1.90E-02	1.90E-02	3.42E+00	2.98E+00
Yellow Warbler	Bq/kg (fw)	3.86E+01	3.86E+01	4.62E-01	4.62E-01	1.29E+00	1.29E+00	1.35E+00	1.35E+00	3.44E+01	3.22E+01	1.45E-02	1.45E-02	2.20E+00	1.97E+00
Eastern Cottontail	Bq/kg (fw)	1.14E+02	9.79E+01	1.85E-02	1.85E-02	9.50E-01	9.50E-01	1.02E+00	1.02E+00	4.80E+01	3.94E+01	5.99E+00	5.99E+00	4.00E+00	3.37E+00
Meadow Vole	Bq/kg (fw)	1.14E+02	9.79E+01	7.41E-03	7.41E-03	3.82E-01	3.82E-01	3.92E-01	3.92E-01	4.80E+01	3.94E+01	2.39E+00	2.39E+00	4.00E+00	3.37E+00
White-tailed Deer	Bq/kg (fw)	1.14E+02	9.79E+01	2.57E-02	2.57E-02	1.32E+00	1.32E+00	1.35E+00	1.35E+00	4.80E+01	3.87E+01	8.29E+00	8.29E+00	3.74E+00	3.08E+00
Common Shrew	Bq/kg (fw)	6.39E+01	6.39E+01	2.62E-02	2.62E-02	1.34E+00	1.34E+00	1.37E+00	1.37E+00	6.24E+01	5.92E+01	1.50E+00	1.50E+00	4.64E+00	4.26E+00
Raccoon	Bq/kg (fw)	7.81E+01	7.18E+01	2.07E-02	2.07E-02	1.11E+00	1.11E+00	1.23E+00	1.23E+00	5.41E+01	4.88E+01	2.71E+00	2.71E+00	0.00E+00	0.00E+00
Red Fox	Bq/kg (fw)	1.08E+02	9.23E+01	1.51E-03	1.51E-03	2.35E-01	2.35E-01	2.56E-01	2.56E-01	2.99E+01	2.25E+01	6.78E-01	6.78E-01	0.00E+00	0.00E+00
Short-tailed Weasel	Bq/kg (fw)	1.14E+02	9.79E+01	3.00E-04	3.00E-04	2.22E-01	2.22E-01	2.74E-01	2.74E-01	4.80E+01	4.06E+01	4.07E-01	4.07E-01	3.31E+00	2.86E+00

Appendix D Sample Calculations

Table D.1: Sample Calculation for Oshawa Urban Resident (Adult) Drinking Water Exposure and Risk to Hydrazine with Decay (t½ =1.3 days)

Parameter Description	Parameter Symbol	Hydrazine		
Environmental Media Concentration		**Value**	**Unit**	**Source**
Maximum Effluent Water Concentration	A	7.60E-03	mg/L	Table 3-8
Dilution Factor (Oshawa WSP)	B	35.6	unitless	Table 3-8
Half-life hydrazine (t½)	C	1.3	days	Section 3.2.6.1
Hydrazine Decay Constant (λ)	D=ln(2)/C	0.53	unitless	Calculation
Distance to Oshawa WSP	E	7800	m	2020 DN ERA (Ecometrix, 2022a)
Current Velocity to the West	F	0.085	m/s	2020 DN ERA (Ecometrix, 2022a)
Travel Time	G=E/F/(60sec*60min*24hr)	1.06	days	Calculation
Hydrazine Decayed Concentration t½ =1.3 days	H=A*EXP(-D*G)	4.31E-03	mg/L	Calculation
Degradation of hydrazine during water treatment	I	0.1	fraction	Section 3.2.6.2.1
Estimated at Oshawa WSP (mg/L)	J=(H*I)/B	1.21E-05	mg/L	Calculation
Human Exposure Factors (Adult)				
Drinking Water Intake	K	1.5	L/d	Table 3-5
Days per Week/7 (D2)	L	1	d/d	Table 3-5
Weeks per Year/52 (D3)	M	1	wk/wk	Table 3-5
Years Exposed (D4)	N	30	years	Table 3-5
Fraction of Water Obtained from WSP	O	0.834	unitless	Table 3-6
Body Weight	P	70.7	kg	Table 3-5
Life Expectancy	Q	70	years	Table 3-5
RAF_{GITi}	R	1	unitless	Table 3-5
TRV (Oral Slope Factor)	S	3	$(mg/kg\ d)^{-1}$	Section 3.3.1
Human Dose and ILCR				
Ingestion Dose	T = (J*K*L*R*M*N*O)/(P*Q)	9.19E-08	mg/kg d	Calculation
ILCR	U = S*T	3E-07	unitless	Calculation

Table D.2: Sample Calculation for Sport Fisher Fish Consumption Exposure and Risk to Hydrazine

Parameter Description	Parameter Symbol	Hydrazine		
Environmental Media Concentration		**Value**	**Unit**	**Source**
Maximum Outfall Water Concentration	A	1.09E-03	mg/L	Table 3-11
Fish Concentration				
Bioaccumulation Factor (BAF)	B	3.16	L/kg fw	Table 3-11
Tissue Concentration	C=A*B	3.4E-03	mg/kg fw	Calculation
Human Exposure Factors (Adult)				
Fish Ingestion	D	0.111	kg/d	Table 3-5
Years Exposed (D4)	E	30	a	Table 3-5
D_{fish} (days in which consumption occurs)	F	365	d/a	Table 3-5
Fraction of Fish in Diet Obtained from Outfall	G	1	unitless	Table 3-6
Body Weight	H	70.7	kg	Table 3-5
Life Expectancy	I	70	years	Table 3-5
RAF_{GITi}	J	1	unitless	Table 3-5
TRV (Oral Slope Factor)	K	3	$(mg/kg\ d)^{-1}$	Section 3.3.1
Human Dose and ILCR				
Ingestion Dose	L = (C*D*F*G*J*E)/(H*365*I)	2.32E-06	mg/kg d	Calculation
ILCR	M = K*L	7E-06	unitless	Calculation

Summary of Regulatory Commitments, Regulatory Obligations and Regulatory Management Actions Made/Concurrence Requested

CD# NK38-CORR-00531-25312 P

Submission Title: **Darlington NGS – 2024 Environmental Risk Assessment Addendum for the Darlington Nuclear Site**

Regulatory Commitments (REGC):

No.	Description	Date to be Completed
	None	

Regulatory Management Action (REGM):

No.	Description	Date to be Completed
	None	

Regulatory Obligation Action (REGO):

No.	Description	Date to be Completed
	None	

Concurrence Requested: None.

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Darlington NGS Probabilistic Safety Assessment Report

Darlington NGS Probabilistic Safety Assessment Report

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Revision Summary

Revision Number	Date	Comments
R000	May 2012	Initial Issue
R001	July 2015	Revised for 2015 DARA update
R002	March 2021	Revised for 2020 DARA update

Executive Summary

The objective of Probabilistic Safety Assessment (PSA) at Ontario Power Generation (OPG) Nuclear is to provide an integrated review of the adequacy of the safety of the current station design and operation for each nuclear power station. The station PSAs are required to comply with the Canadian Nuclear Safety Commission (CNSC) Regulatory Document REGDOC-2.4.2 [R-1].

A nuclear PSA identifies the various event sequences that lead to radioactive releases, assigns them to different categories of consequences, and calculates their frequencies of occurrence. Additionally, the PSA is used to identify the sources of risk and assess the magnitude of radiological risks to the public from potential accidents due to the operation of nuclear reactors while at power as well as during outages. Furthermore, the PSA is used to assess the magnitude of radiological risks to the public from potential accidents due to the operation of the non-reactor facilities that contain sources of radioactivity. The PSA is a comprehensive model of the plant that incorporates knowledge about plant design, operation, maintenance, testing and response to abnormal events. To the extent possible, the PSA is intended to be a realistic model of the plant.

The Darlington Nuclear Generating Station (NGS) PSA followed a quality assurance plan consistent with Canadian Standards Association standard CSA N286-12, Management System Requirements for Nuclear Power Plants [R-2]. The PSA used computer programs consistent with Canadian Standards Association standard CSA N286.7-16, Quality Assurance of Analytical, Scientific and Design Computer Programs for Nuclear Power Plants [R-3].

The PSA was prepared following methodologies consistent with industry good practices. The OPG PSA Methodologies have been accepted by the CNSC under compliance with REGDOC-2.4.2.

The baseline Darlington NGS PSAs are documented in several reports:

- A hazard screening assessment identifies the hazards that require assessment in a PSA model.
- The Level-1 and Level-2 internal events at-power PSA assesses the risk of severe core damage and radioactive releases from internal events occurring while the reactor is at power; i.e., it considers the challenges to reactor core cooling from accident sequences covering Design Basis Accidents and Beyond Design Basis Accidents including Severe Accidents while the reactor is at full power.
- The internal events outage PSA assesses the risk of severe core damage from internal events occurring while the reactor is in the Guaranteed Shutdown State (GSS); i.e., it considers the challenges to reactor core cooling from accident sequences during unit outages, including loss of shutdown heat sinks. It also provides an estimate of the risk of large release in GSS.
- The seismic PSA assesses the risk of severe core damage from seismic events occurring while the reactor is at full power, and provides an estimate of the risk of large release as a result of seismic events.
- The internal fire PSA assesses the risk of severe core damage and large release from internal fires occurring while the reactor is at full power.

- The internal flooding PSA assesses the risk of severe core damage from internal floods occurring while the reactor is at full power, and a bounding estimate of large release as a result of internal floods.

- The high wind PSA assesses the risk of severe core damage from high wind occurring while the reactor is at full power, and an estimate of large release as a result of high wind events.

- The non-reactor source PSA assesses the risk of radioactive releases from sources other than the reactor core.

The completion of the Darlington PSA shows that the severe core damage frequency and large release frequency for each hazard are less than OPG's safety goals.

1.0 INTRODUCTION

The objective of Probabilistic Safety Assessment (PSA) at Ontario Power Generation (OPG) Nuclear is to provide an integrated review of the adequacy of the safety of the current station design and operation for each nuclear power station. The station PSAs are required to comply with the Canadian Nuclear Safety Commission (CNSC) Regulatory Document REGDOC-2.4.2 [R-1].

A nuclear PSA identifies the various event sequences that lead to radioactive releases, assigns them to different categories of consequences, and calculates their frequencies of occurrence. Additionally, the PSA is used to identify the major sources of risk and assess the magnitude of radiological risks to the public from accidents due to the operation of nuclear reactors while at power as well as during outage. The PSA is a comprehensive model of the plant that incorporates knowledge about plant design, operation, maintenance, testing and response to abnormal events. To the extent possible, the PSA is intended to be a realistic model of the plant.

The PSA for the Darlington Nuclear Generating Station (NGS) or Darlington Risk Assessment is referred to as DARA. The DARA studies provide an estimate of the station risk in its current configuration and are required for compliance with REGDOC-2.4.2. The PSA reflects the current station design and operation, is consistent with the OPG PSA methodology, and is consistent with industry good practices. The OPG PSA Methodologies have been accepted by the CNSC under REGDOC-2.4.2. A separate hazard screening assessment for internal and external events has been completed to confirm that no other identified hazards require detailed assessment in a PSA.

Development of the Darlington NGS PSA followed a quality assurance plan consistent with Canadian Standards Association standard CSA N286-12, Management System Requirements for Nuclear Power Plants [R-2]. The PSA used computer programs consistent with Canadian Standards Association standard CSA N286.7-16, Quality Assurance of Analytical, Scientific and Design Computer Programs for Nuclear Power Plants [R-3].

Ontario Power Generation has safety goals for Severe Core Damage[1] Frequency (SCDF) and Large Release[2] Frequency (LRF), Reference [R-4], as shown in Table 1. The intent of these goals is to ensure that the radiological risks arising from nuclear accidents associated with the operation of Ontario Power Generation’s nuclear power reactors are low in comparison to risks to which the public is normally exposed. The baseline DARA studies show that the risk from the operation of Darlington NGS is low.

The first Darlington NGS PSA studies for S-294 [R-5] compliance were completed in 2011 and the previous update was completed in 2015. All of the Darlington PSA studies were revised in 2020 as part of the regular update cycle under REGDOC-2.4.2 compliance. The updates included:

[1] Severe Core Damage is the loss of core structural integrity.
[2] Large Release is a release greater than 1E14 Bq of Cs-137

- Station design, operation, and analysis information up to the study freeze date of December 31, 2018;
- A number of model and documentation enhancements;
- The incorporation of changes in Emergency Mitigating Equipment (EME) design since 2013;
- The incorporation of several Safety Improvement Opportunities (SIOs), which were implemented as part of Darlington NGS refurbishment; and
- The credit of Severe Accident Management Guidelines (SAMG) in the Level 2 PSA.

The current report summarizes the probabilistic safety assessments of the Darlington NGS described above and compares the results with Ontario Power Generation's safety goals as documented in Reference [R-4].

1.1 Objectives

The principal objectives of the DARA Studies are:

(1) To provide an integrated review of the adequacy of the safety of the current station design and operation;

(2) To prepare a risk model in a form that can be used to assist in safety-related decision making; and

(3) To assess risk results and ensure that they are acceptably low.

1.2 Scope

The baseline DARA probabilistic safety assessments are documented in eight separate reports - one hazard screening and seven PSA models, as follows:

(1) A hazard screening assessment for internal and external events, which identifies the hazards that require further detailed analysis in a PSA.

(2) A Level-1 internal events at-power PSA, which studies the risk of severe core damage from internal events (e.g., loss of coolant accidents, steam line breaks) occurring while the reactor is at full power; i.e., it considers the challenges to reactor core cooling from accident sequences covering Design Basis Accidents and Beyond Design Basis Accidents while the reactor is at full power. This report is referred to as DARA-L1P.

(3) A Level-2 internal events at-power PSA (DARA-L2P), which studies the frequency and composition of releases to the environment from severe core damage occurring due to events occurring within the station (e.g., loss of coolant accidents, steam line breaks) while the reactor is at full power. This PSA is the extension of the Level-1 PSA described in Item 2.

(4) An internal events outage PSA (DARA-L1O), which studies the risk of severe core damage from internal events occurring while the reactor is in the GSS; i.e., it considers the challenges to reactor core cooling from accident sequences during unit outages, including loss of shutdown heat sinks; and it provides an estimate of large release frequency as a result of internal events during GSS.

(5) A seismic PSA (DARA-SEISMIC), which studies the risk of severe core damage from seismic events occurring while the reactor is at full power, and provides an estimate of the risk of large release as a result of seismic events (i.e., earthquakes).

(6) An internal fire PSA (DARA-FIRE), which studies the risk of severe core damage and large release as a result of internal fire events (e.g., fires caused by station electrical equipment) occurring while the reactor is at full power.

(7) An internal flooding PSA (DARA-FLOOD), which studies the risk of severe core damage from internal floods (e.g., pipe breaks of plant systems) occurring while the reactor is at full power, and provides a bounding estimate of large release frequency as a result of internal flooding.

(8) A high wind PSA (DARA-WIND), which studies the risk of severe core damage from high wind events (e.g., severe thunderstorms, tornadoes) occurring while the reactor is at full power, and provides an estimate of large release frequency as a result of high wind events.

(9) A non-reactor source PSA, which studies the risk of releases to the environment from non-reactor sources of radioactivity.

The Darlington PSA models (reports 2-9 above) do not cover the following potential sources of risk:

- Hazards from chemical materials used and stored at the plant;
- Other external initiating events (IEs) such as external floods, airplane crashes, train derailment, etc.; and
- Other internal initiating events such as turbine missiles

These types of hazards are instead addressed through other screening or deterministic hazard studies, see Section 4.0. Consistent with industry practice, wilful acts (e.g., sabotage) are not modelled in the OPG PSAs.

The response of all Darlington NGS units to various initiating events is essentially identical, and it is generally only necessary to model a single unit, with this unit considered representative of all other units despite slight differences in design. Unit 2 was selected as the reference unit.

1.3 Organization of Summary Report

In addition to the general information presented in this introductory section, the Summary Report provides the following:

(a) A short description of the Darlington NGS station and units (Section 2.0);

(b) An overview of hazard screening method and the internal/external hazard screening assessment (Section 4.0);

(c) An overview of PSA methods and the Level 1 and Level 2 PSA (Section 3.0) and the methods used for Level 1 Analysis (Section 5.0) and Level 2 Analysis (Section 6.0);

(d) A discussion of the main results of the DARA studies (Section 7.0).

Appendix A contains a list of the abbreviations and acronyms used in this summary report.

2.0 PLANT DESCRIPTION

The following subsections provide a short description of the Darlington site and plant.

2.1 Site Arrangement

The Darlington NGS facility consists of four CANDU pressurized heavy water reactor units. The station was designed and constructed in the 1980s to early 1990s, with in-service dates ranging between October 1990 and June 1993. The station has four nuclear reactors, four turbine generators, and associated equipment, services and facilities, shown in Figure 1 and Figure 2. At full power each unit produces 2776 MW(th), generating a net output of 881 MW(e). The electrical output from each reactor-turbine generator set is generated at 22 kV, 60Hz and 0.85 power factor and delivered to the 500 kV switchyard. The turbine-generator set can operate for sustained periods if the reactor power is greater than 30% full power.

Each unit was originally designed and evaluated for a 30-year lifetime. OPG is currently working towards refurbishment of Darlington, which will extend the life of the station to 2055.

Each unit comprises a power source capable of operating independently of the other units with reliance on certain common services. The power generating equipment of each unit is a conventionally steam-driven turbine generator. The associated heat source is a heavy water (D_2O) moderated, pressurized heavy water cooled, natural uranium dioxide fuelled, horizontal pressure tube reactor. This type of nuclear steam supply is used in all electrical nuclear power stations built in the province of Ontario.

2.2 Buildings and Structures

The Darlington NGS contains the following buildings and structures:

(a) Four reactor building structures;

(b) Four reactor auxiliary bays;

(c) A powerhouse comprising four turbine halls, four turbine auxiliary bays, and a central service area;

(d) A vacuum structure;

(e) Four combined cooling and service water pumphouses;

(f) An emergency electrical power and water supply complex, consisting of an Emergency Service Water (ESW) pumphouse, emergency power supply generator sets buildings, emergency power supply fuel management structures, and emergency electrical rooms and associated tunnels;

(g) Two administrative buildings;

(h) A Water Treatment Building;

(i) Two Fuelling Facilities Auxiliary Areas (FFAAs), including two Irradiated Fuel Bays (IFBs);

(j) Two standby generator areas;

(k) A Heavy Water Management Building;

(l) Tritium Removal Facility;

(m) Flammable Material Storage Building;

(n) High-Pressure Gas Cylinder Storage Building;

(o) Sewage Treatment Plant;

(p) Emergency Response Team Facility;

(q) Hazardous Material and D_2O Storage Building;

(r) A Main Security Building and an Auxiliary Security Building;

(s) Darlington Waste Management Facility (DWMF); and

(t) Auxiliary Heating Steam Boiler House.

The general arrangement of the station is shown in Figure 2. The four units at the station are each numbered and referred to as Unit 1, Unit 2, etc. The common equipment is referred to as Unit 0.

The Reactor Building, Figure 3, is a rectangular reinforced-concrete building, which serves as a support and an enclosure for the reactor and some of its associated equipment. The portion of the Reactor Building, which forms part of the containment envelope, is called the reactor vault.

The fuelling duct, which is connected to each of the reactor vaults, runs the length of the station under the vaults. It serves as a connection between the reactor and the Fuelling Facilities Auxiliary Areas at each end of the duct. A provision for future plant extension has been provided in the end wall of the fuelling duct in the Fuelling Facilities Area (east). A pressure relief duct connects the fuelling duct to the vacuum structure.

The containment envelope comprises the four reactor vaults, the fuelling duct, the pressure relief duct, the pressure relief valve manifold, the vacuum structure, the fuelling machine head removal area, and a fuel handling and service area at each end of the fuelling duct.

Each reactor vault is surrounded by a Reactor Auxiliary Bay. This building contains reactor auxiliaries and secondary circuits of low temperature, pressure, and generally of low radioactivity level. The Reactor Auxiliary Bay consists of a basement with concrete floors below elevation 100 m, and a conventional steel-frame structure with concrete floor slabs above elevation 100 m.

The Central Service Area is divided into the Central Service Area-Nuclear and the Central Service Area-Conventional. The Central Service Area serves the entire station. The Central Service Area-Nuclear contains facilities for fuelling machine head removal, treatment and storage of heavy water, spent ion exchange resins, and active wastes. It is located below grade in the south portion of the Central Service Area and is of reinforced-concrete construction. The Central Service Area-Conventional contains stores, laboratories, electrical, air conditioning equipment and the central control area. For the most part, it is of steel-frame construction with concrete floors. The central control area is located above the Central Service Area-Nuclear and is enclosed on all four sides by reinforced-concrete walls. The control area also has a reinforced-concrete roof.

Column Line 11 between turbine auxiliary building and reactor auxiliary building from elevation 100.0 m to 115.0 m is credited as a steam and flood protection barrier in the event of a secondary side or feed water line break. The wall and door between the RAB and the West FFAA on column line A, between elevations 107.5 m and 115 m are credited as a barrier to prevent steam and water released from a feed water break at 107.5 m el. (south of column line 11) from spilling into the West FFAA at elevations 100 m and 105.7 m.

The emergency electrical power and water supply complex is of reinforced-concrete construction throughout. The other buildings listed are of conventional steel-frame construction on reinforced-concrete foundations.

2.3 Reactor

The reactor consists of a cylindrical, horizontal, single-walled stainless steel vessel called the calandria. It provides containment for the heavy water moderator and reflector. It is axially penetrated by 480 calandria tubes. These tubes surround the pressure tubes, which contain the fuel and heavy water coolant. The calandria, the two end shields, and the shield tank form an integral, multi-compartment structure which contains the heavy water moderator and reflector, and the light water shielding. The end shields and shield tank (filled with light water) provide part of the building operational shielding, as well as full shielding between the calandria and the reactor vault when the reactor is shutdown (see Figure 3).

2.3.1 Primary Heat Transport System

The primary Heat Transport System (HTS) consists of two identical loops, one for the north half of the reactor and one for the south half. Each loop consists of fuel channels filled with natural uranium fuel bundles surrounded by pressurized heavy water, steam generators, circulation pumps and associated piping and valves. The coolant in the fuel channels removes the heat generated by the fuel. During normal operation the heat from the fuel is generated via the nuclear fission; following shutdown heat is generated from the fuel via fission product decay. The circulating coolant transports this heat to the four steam generators. This is the primary heat sink for the reactor; thus, the system is often referred to as the primary heat transport system.

The heat transport system interfaces with a number of systems: the shutdown cooling system, which removes decay heat when the reactor is shut down; the feed and bleed system, which provides pressure and inventory control for the coolant; the D_2O recovery system, which recovers heavy water from leaks; and the Emergency Coolant Injection System (ECIS), which adds light water after the occurrence of a loss of coolant accident beyond the capacity of the D_2O recovery system.

2.3.2 Steam and Feedwater System

The main role of the primary heat transport system is to transport the heat generated in the fuel channels to the steam generators. The role of the steam generators is to transfer this heat and boil the light water on the secondary side. The steam generated is then used to drive the turbine generators to convert the thermal energy to electrical power. After passing through the turbine the steam condenses. The condensate is returned via the feedwater (FW) system to the steam generators to continue the process.

2.3.3 Inter-Unit Feedwater Tie System

After an accident, if the normal feedwater supply to the steam generators is unavailable, the Inter-Unit Feedwater Tie (IUFT) system can provide a short-term source of water to the accident-unit steam generators. Along with the safety relief valves, the IUFT can be used to cool the heat transport system. The water is supplied by the feedwater system of an adjacent unit using a header that runs the length of the station. Feedwater supply to IUFT can come from the auxiliary feed pumps in any of the units. The IUFT system is automatically started when the water level in a steam generator drops below a set level.

2.3.4 Steam Generator Emergency Cooling System

The Steam Generator Emergency Cooling System (SGECS) provides an interim water supply to the steam generators following a postulated steam line or nozzle rupture and/or loss of feedwater supply. The automatic injection of SGECS water will maintain the steam generators as effective heat sinks for the heat transport system until such time as the ESW system is available.

SGECS comprises two water tanks and two air accumulators, with associated valves and piping. Each water tank is pressurized by one of the air accumulators and supplies water to two steam generators. The water tanks are filled with demineralized water from the feedwater system.

2.3.5 Steam Relief System

The steam relief system protects the steam generators from overpressure and is also used for rapid cooling of the primary heat transport system when needed. Three types of valves can be used to reject steam from the steam generators: the Atmospheric Steam Discharge Valves (ASDVs), the Condenser Steam Discharge Valves (CSDVs), and the Instrumented Steam Relief Valves (ISRVs). The ASDVs and ISRVs discharge steam into the atmosphere. The CSDVs discharge steam into the condenser, where the steam is condensed and returns to the feed cycle.

2.3.6 Shutdown Cooling System

The Shutdown Cooling (SDC) system provides an alternative method to remove decay heat from the primary heat transport coolant when the reactor is shutdown. The system consists of a set of pumps and heat exchangers (HXs) that are normally isolated from the primary heat transport circuit, but can be connected when needed. The shutdown cooling system has a much smaller capacity to remove heat than the steam generators, as the reactor produces significantly less heat in the shutdown state. The shutdown cooling system is the preferred heat sink when the unit is in the Guaranteed Shutdown State (GSS).

2.3.7 Moderator System

During normal plant operation the moderator system is used to slow the neutrons produced by fission in order to sustain the chain reaction and maintain criticality. Heat is generated in the moderator by the neutrons as they slow down, and energy is transferred to the moderator from the calandria tubes, shell, tubesheets and, reactivity mechanisms. Additionally, a small fraction of the heat produced by the fuel is transferred to the moderator during normal at-power operation. The moderator heat is removed by the Moderator Circulation System that incorporates heat exchangers. After an accident, the moderator can be used as an additional heat sink to remove decay heat from the reactor. This additional heat sink is an important, unique feature of the CANDU reactor design.

2.3.8 Unit Control System

Each unit is operated and controlled independently by a dual Digital Control Computer (DCC) system. Important process variables and devices controlled by the dual computer system include:

(a) Reactivity control devices, which includes the liquid zone control valves, the adjuster, absorber and shut-off rods, and gadolinium poison addition into the moderator;

(b) Primary heat transport pressure and inventory control components such as the D_2O liquid feed and bleed valves, the D_2O steam bleed valves, and the pressurizer heaters;

(c) Steam generator level control system components such as the two large and one small level control valves per steam generator;

(d) Steam generator pressure control components such as the turbine governor valves, the CSDVs and the ASDVs; and

(e) Moderator temperature control system components such as the three temperature control valves in the service water side of the moderator heat exchangers.

2.3.9 Powerhouse Steam Venting System

The Powerhouse Steam Venting System (PSVS) is designed to vent steam from the powerhouse in the event of the secondary side piping failure, minimizing the effect of harsh environment on the equipment located in the powerhouse. The system consists of wall mounted, air and spring operated dampers of louvers located at a lower elevation on the powerhouse north wall and at a high elevation on the Reactor Auxiliary Bay walls, and dampers of gravity ventilators located on the roof of the Turbine Hall. The dampers of the louvers and gravity ventilators open automatically on a high temperature signal. The open flow areas at high elevations provide an escape route for steam, while the make-up air is supplied by the open dampers at the lower elevation.

2.3.10 Special Safety Systems

Four special safety systems are incorporated into the plant design to limit radioactive releases to the public following any abnormal event:

(a) Shutdown System No. 1 (SDS1);

(b) Shutdown System No. 2 (SDS2);

(c) Emergency Coolant Injection System (ECIS); and

(d) Negative Pressure Containment (NPC) System.

2.3.11 Shutdown System No. 1

The primary method of quickly terminating reactor operation is the release of 32 gravity-drop, spring-assisted, neutron-absorbing shut-off rods. The shut-off rods are housed in 32 assemblies positioned vertically through the reactor core, with the rods themselves above the core during high power operation. The SDS1 system employs an independent, triplicated system which senses the requirement for reactor trip and de-energizes direct current clutches to release all of the shut-off rods into the reactor core.

2.3.12 Shutdown System No. 2

The second method of quickly terminating reactor operation is the rapid injection of neutron-absorbing gadolinium nitrate solution into the bulk moderator through eight horizontal nozzles. The SDS2 employs an independent, triplicated system which senses the requirement for this rapid shutdown and opens fast-acting helium injection valves to force the gadolinium nitrate poison into the moderator.

The gadolinium nitrate solution is stored in eight tanks, connected to a horizontal injection nozzle in the calandria by stainless steel piping. Helium under pressure is stored in a tank that is isolated from the gadolinium nitrate tanks by a duplicated set of quick-opening valves. Opening of the valves causes the helium to pressurize the poison tanks, forcing the gadolinium nitrate solution through the injection nozzles and into the moderator.

2.3.13 Emergency Coolant Injection System

The Emergency Coolant Injection System (ECIS) automatically provides make-up cooling water to the heat transport system following a postulated Loss-Of-Coolant Accident (LOCA). The system also provides one of the long-term heat sinks for emergency core cooling. The ECIS, with most of its major equipment centralized in the central service area, is designed to serve all four units.

The ECIS does not operate during normal plant operation, but is in a poised standby mode.

For the initial high-pressure Emergency Coolant Injection (ECI) injection, light water coolant is drawn from the injection water storage tank and pumped to the affected unit. Upon depletion of the water stored in the injection water storage tank, a recovery mode (long-term injection) is established manually. During this long-term injection phase, a mixture of light (ECI) water and heavy (heat transport) water is drawn from the recovery sump in the pressure relief duct and is recirculated to the affected heat transport system. The Post-Accident Water Cooling System (PAWCS) can be used to cool the recirculated water, providing a long term heat sink.

2.3.14 Containment Systems

The containment system is a special safety system that forms an envelope around the nuclear components of the reactor and the reactor coolant system. It is composed of a number of systems and subsystems whose collective purpose is to prevent a significant release of radioactive material, which may be present in the containment atmosphere following certain postulated accident conditions, to the outside environment. The physical barrier, which minimizes the outflow of radioactive material, is called the containment envelope, and the system whose main purpose is to prevent the design pressure of the containment envelope from being exceeded following an accident is called the containment system. The containment system includes provisions for controlling and maintaining a negative pressure within the containment envelope before and after accidents. The containment system quickly reduces the containment pressure to a subatmospheric level following a large energy release within containment and, hence, minimizes uncontrolled releases to the outside environment. Containment includes an Emergency Filtered Air Discharge System (EFADS) to maintain containment at a sub-atmospheric pressure in the long term following a design basis accident, while providing a filtered discharge path to minimize long-term radioactive releases to the environment. Containment also includes a Containment Filtered Venting System (CFVS) which provides protection of containment against the potential of slow over-pressurization failure and reduces radioactive release to the atmosphere in the event of a Beyond Design Basis Accident (BDBA) or severe accident.

2.3.15 Support Systems

Support systems are considered in the PSA as they provide common services to the systems described above. Failure of the support systems can result in failure of the mitigating systems credited to remove heat after an initiating event. The following systems are modelled as support systems in the PSA.

2.3.15.1 Electrical Power Systems

The electrical system of the Darlington NGS is designed to satisfy the high reliability requirements of nuclear systems. The design features dual (odd and even) bus arrangements for both unit and common systems, high capacity standby power supplies, and ample redundancy in equipment. There are four distinct classes of power (Classes IV, III, II, and I), as well as the Emergency Power System (EPS).

Class IV power is the main site electrical power supplied from a combination of the provincial electrical grid and the station generating unit transformers; Class III power is typically supplied by Class IV power, but has backup supplies and includes four standby generators; Class II is an AC power system to supply control and monitoring systems and is supplied by Class I power via inverters; Class I is a DC power system to supply control and monitoring system. Class I has battery backup supplies.

EPS is a separate power system consisting of its own on-site power generation (three Emergency Power Generators (EPGs)) and AC and DC distribution systems whose normal supply is from the Class III power system. The purpose of the EPS system is to provide power to selected safety-related loads following events postulated to impact the normal Class IV / III / II / I power distribution, including events that impact more than one unit.

2.3.15.2 Service Water Systems

The service water systems provide cooling water for various loads. The service water systems for Darlington NGS consist of:

(a) Low Pressure Service Water System: Each unit has a Low Pressure Service Water (LPSW) system taking untreated lake water from the forebay. This water is used to cool loads at low elevations. After passing through the various loads, the water is returned to the lake via the condenser cooling water discharge duct.

(b) Powerhouse Upper Level Service Water system: The Powerhouse Upper Level Service Water (PULSW) system supplies tempered water of 10°C in winter and untempered lake water in summer from the LPSW system to various continuously used equipment. This system serves all loads where potential heavy water freezing is a problem, as well as loads located at high elevations in the reactor building that are beyond the maximum pressure available from the LPSW system.

(c) Recirculated Cooling Water System: The Recirculated Cooling Water (RCW) system is a unitized closed loop system which supplies demineralized water to continuously used equipment. This system supplies cooling water to certain vital equipment requiring treated water, at a temperature above the freezing point of heavy water, at a pressure sufficiently high to prevent localized boiling in certain heat exchangers, and of a quality sufficiently high to minimize corrosion, fouling, and activation by radiation.

(d) Emergency Service Water System: The Emergency Service Water (ESW) system is independent and physically separated from the normal water systems. It is primarily used to supply cooling water to essential safety-related loads when normal service water supplies are unavailable. One ESW system supplies the required loads for all four units. In order for this system to not remain dormant for long periods of time, it is used to supply the normal requirements of the IFB heat exchangers, secondary control areas (Group 2 ventilation), the Auxiliary Service Water System, and the fire water supply.

(e) Circulating Water System: The circulating water system is an open loop system to supply cooling water to the condensers to maintain the design backpressure of the turbine exhaust during full load operation. The circulating water is discharged back to the lake through the discharge duct.

(f) Auxiliary Service Water System: The auxiliary service water system supplies water for cooling purposes in the Central Service Area and other common areas. The system is supplied from the ESW system.

(g) Demineralized Water System: This system supplies make-up water to systems using demineralized water including RCW and the condensate make-up system.

(h) Domestic Water System: This system supplies hot and cold potable water to domestic fixtures in the station including the drinking fountains, showers, washrooms, and kitchens.

Failures of the auxiliary service water system, the demineralized water system and the domestic water system are not analyzed in detail as part of the PSA assessment.

2.3.15.3 Instrument Air Systems

The instrument air (IA) supply is a support system providing filtered and dry compressed air. This compressed air is used for various plant activities including operating valves and inflating airlock seals. Each unit has its own air supply, with certain key loads supplied by backup air from bottles, to ensure operability in the event of failure of the normal supply. On loss of unit instrument air, instrument air supply from another donor unit can be valved in manually via an inter-unit tie.

In addition, the station has a common instrument air system to supply the central service area, FFAAs, vacuum structure, pumphouses, water treatment building, heavy water management building, and ESW pumphouse.

The service air system supplies compressed air to all areas in the station including the service area and other buildings. In addition, the service air system supplies the air requirements of the common instrument air system.

2.3.15.4 Powerhouse Ventilation System

The powerhouse ventilation system provides heating and cooling to the station buildings. Failures of this system are studied for the steam protected rooms in the powerhouse, reactor auxiliary bay and reactor building. Failure of the cooling and ventilation in these rooms may result in equipment failures in the support or mitigating systems.

2.3.15.5 Emergency Mitigating Equipment

As a result of the Fukushima event, OPG has implemented Emergency Mitigating Equipment (EME) for Darlington NGS. The EME was designed to cope with a total loss of heat sink caused by an extended loss of all AC power. EME also provides an additional potential mitigating function for a variety of accident sequences considered in the DARA studies that involve a total loss of heat sinks due to other causes.

The intent of EME is to restore selected reactor cooling and monitoring functions as much as possible using temporarily installed and portable equipment.

EME response is provided in two phases:

- Phase 1 via on-site rapidly deployable mobile equipment to restore selected reactor cooling and monitoring functions and to protect containment.
- Phase 2 via three 4 kV portable diesel driven generators stored at Pickering NGS to energize one Unit 0 4 kV EPS bus to restore specified Unit 0 and Unit EPS loads and to provide additional methods to protect containment.

Phase 1 EME consists of:

(a) EME Generator: A 150 kW 600V diesel generator.

(b) 2 large diesel pumps, each with suction, discharge hose and manifold to supply:

  (1) Steam generators;

  (2) Moderator.

  (3) Heat transport system;

  (4) End shield cooling; and

  (5) Irradiated fuel bays.

(c) Portable Uninterruptable Power Supplies (PUPSs): provided for each unit to power instruments for essential EME parameters if EPS and Class I batteries fail before connection of the Phase 1 EME diesel generator.

(d) Portable Instrumentation: Pressure Gauges (PGs) and associated connection fittings to allow monitoring of EME parameters if for any reason the normally installed instrumentation is unavailable (power cannot be restored, instruments failed, etc.).

(e) Portable Compressors: Two portable diesel driven compressors to provide a means of maintaining airlock seal integrity in the event of extended loss of AC power (loss of Class III and Class IV power where EPS is unable to restore power) by tying into the emergency backup bottle and airlock distribution panel locations for the airlock seals via quick connect fittings.

(f) Telecommunications Trailers: Specialized telecommunication equipment and satellite telephones dedicated for use during an emergency on site are distributed at key locations throughout the station.

The portable Phase 1 EME equipment would be moved from its storage location on site to pre-determined locations in the plant and connected to the designated tie-in points.

Phase 2 EME consists of:

(a) Three 4 kV portable diesel driven Generators deployed from Pickering NGS and staged on the Darlington site within 12 hours of the initiating event.

    (1) The Generators are connected in parallel for tie in to the EPS buses.

    (2) The Unit 0 4 kV bus will energize specified Unit 0 and Unit EPS 600 V and low voltage AC and DC buses. The loads will include one ESW pump, one Low Pressure Emergency Coolant Injection (LPECI) pump, EFADS, Vault Coolers, and a limited set of Unit 0 and Unit Group 2 equipment.

    (3) Each Generator has a maximum capacity of 1.4 MW and the parallel connected Generator Set has a nominal rated capacity of 3 MW. The Generator Set digital controller has full synchronizing and load sharing capability.

After transition to Phase 2 EME power, station ESW will supply steam generator and moderator makeup, vault cooling, and PAWCS as required. The Phase I EME diesel driven pumps will continue to supply End Shield Cooling (ESC), IFB, and primary Heat Transport System makeup as required (unless primary HTS makeup via LPECI has been established).

2.4 Two-Group Separation

The Darlington NGS design uses group separation to minimize the possible consequences of events that could cause widespread damage, and to provide defence in depth. Each group contains equipment to shut down the reactor, remove decay heat, and monitor the reactor status. The Group 1 and Group 2 systems are physically separated.

The following systems are Group 1:

- SDS1: Shutdown System No. 1

- SDC: Shutdown Cooling
- IUFT: Interunit Feedwater Tie
- FW: Feedwater
- Class IV, III, II, I Electrical Power
- Instrument air (normal distribution)

The Group 1 control functions are performed from the Main Control Room (MCR).

The following systems are Group 2:

- SDS2: Shutdown System No. 2
- ISRVs: Instrumented Steam Relief Valves
- EPS: Emergency Power Supply
- SGECS: Steam Generator Emergency Cooling System
- ESW: Emergency Service Water
- ECI, PAWCS: Emergency Coolant Injection and Post-Accident Water Cooling System
- Containment
- EFADS: Emergency Filtered Air Discharge System
- CFVS: Containment Filtered Venting System

The Group 2 systems are seismically qualified to withstand a Design Basis Earthquake (DBE) and designed to withstand the severe atmospheric conditions created by the design basis tornado. The Group 2 control functions are performed from secondary control areas.

3.0 OVERVIEW OF PSA METHODS

Probabilistic safety assessment is based on the idea that the product of the frequency of occurrence of an event and the consequence of the event represents a useful and meaningful quantity. This product is defined to be the risk from the event and is expressed in units of consequence per unit of time. For example, consider a residential sump pump that fails on average once every four years. If the consequence of the pump failing is $1000 in property damage, then the average risk from failure of the pump is $250 per year.

Risk provides a means of quantifying the degree of safety inherent in a potentially hazardous activity as well as a common basis for comparing the relative safety of dissimilar types of activities and industrial processes. One of the principles of the probabilistic safety assessment process is that the larger the numerical value of risk for a particular event or combination of events, the more important the event is to safety. Thus, measures to reduce calculated risk improve the level of safety. Probabilistic Safety Assessment represents the process by which risk is quantified, leading to the identification of the dominant contributors to risk. If necessary, the dominant contributors can be used to create strategies to reduce risk and improve safety.

For a nuclear generating plant, the events studied are those leading to damage to fuel both in the core and out of core or releases of radioisotopes into the environment. Consistent with the requirements of REGDOC-2.4.2 [R-1], Ontario Power Generation has completed hazard screening, Level 1 and Level 2 PSA to assess the risk from Darlington NGS:

- A hazard screening assessment was performed to confirm which hazards can be screened out from probabilistic safety assessment, and identify which hazards need to be assessed by a PSA.
- Level 1 of the PSA assesses the frequency of varying degrees of fuel failures, which lead to release of radioactivity into containment.
- Level 2 of the PSA assesses the frequency and magnitude of the release of this radioactivity from containment to the outside environment.

OPG's safety goals in Table 1 for PSA correspond to the Level 1 and Level 2 PSA results.

Level 1 probabilistic safety assessments have been prepared for full reactor power operation for the following types of initiating events based on the hazard screening results:

- Internal initiating events (e.g., steam line break, loss of coolant accidents);
- Seismic events;
- Internal Fire (fires initiated by in plant sources, e.g., electrical equipment);
- Internal flooding (floods originating from water sources internal to the plant); and
- High winds (including both straight line winds and tornadoes).

An assessment of risk while a single unit is in GSS was prepared for internal initiating events. Outage PSAs have not been prepared for seismic events, high winds, fire, and internal flooding for the reasons described below:

An outage seismic PSA was not performed as the risk from a seismic event while a single unit is shutdown is bounded by the risk from seismic event while all units are at high power. The accident progression is slower when the unit is in outage, giving more time for operator action; and the time at risk while the unit is in outage is small compared to the time at-power. Thus, the risk is smaller for outage.

An outage high wind PSA was not performed as the risk from a high wind while a single unit is shutdown is bounded by the risk from high wind event while all units are at high power. The accident progression is slower when the unit is in outage, giving more time for operator action;

and the time at risk while the unit is in outage is small compared to the time at-power. Thus, the risk is smaller for outage.

An outage internal fire PSA was not performed as the overall risk of severe core damage due to fire while the unit is at-power is low; the time at risk during an outage is small; and the risk management controls during outage limit the risk of an internal fire.

An outage internal flood PSA was not done as the overall risk of Severe Core Damage (SCD) due to flooding is low. The low risk of SCD due to flooding is due to the low initiating event frequency, the physical separation of the Group 1 and Group 2 systems and the separation of odd and even equipment. As these factors are the same from both at-power and outage operation, a low at-power risk of SCD implies the outage risk will also be low.

The full scope Level 2 PSA has been prepared for at-power internal events. Reduced scope Level 2 assessments have been prepared for seismic events, outage internal events, internal fires, internal flooding, and high winds as follows:

- The Level 2 assessment for seismic events considers the likelihood of consequential failure of containment due to an earthquake, and then provides a bounding assessment of large release frequency due to seismic failure modes of containment following severe core damage caused by a seismic event.

- The Level 2 assessment of outage internal events reviews the potential for unique containment challenges or bypass pathways in the outage state caused by severe core damage from an internal initiating event occurring while the reactor is in the GSS.

- For the Level 2 assessment of fire events, a Level 2 fire PSA model was developed based on the Level 2 internal events and quantified to provide an estimate of large release frequency.

- Level 2 assessment for internal flooding considered flooding events inside and outside containment involving a single unit, flooding events involving 2 units and more than 2 units that will lead to SCD. Based on this assessment, a large release frequency estimate can be produced.

- The Level 2 high wind assessment considered the potential failure of containment systems due to wind impacts. Large release frequency is then estimated based on the Level 2 model which has been updated to include the impacts of the wind hazards.

Additionally, bounding assessments for non-reactor sources (IFB and used fuel dry storage) were performed.

In the following sections, the methods used for hazard screening, Level 1 PSA, Level 2 PSA and non-reactor source PSA are described.

4.0 HAZARD SCREENING METHODS

A hazard is an event or natural phenomenon that has the potential to pose some risk to facility. Hazards can be divided into two groups: external and internal. External hazards include events such as flooding and fires external to the plant, tornadoes, earthquakes, and aircraft crashes. Internal hazards include events such as equipment failures, operator induced events, flooding and fires internal to the plant. The purpose of hazard screening analysis is to determine which hazards can be screened out from probabilistic safety assessment, and identify which hazards need to be assessed by a PSA. Both reactor sources and non-reactor sources were considered.

4.1 External Hazards Screening for Reactor Sources

External hazards are defined as hazards that are initiated outside the OPG exclusion zone or are hazards that are outside the plant's direct control. These hazards could be in the form of natural hazards (ice-storms, flood, etc.) or man-made hazards (chlorine leak from a rail-car derailment, aircraft crash, etc.).

4.1.1 Overview of External Hazards Screening Method

The external hazards screening method involves three main steps:

(1) Identify all the external hazards applicable to the site.

(2) Determine consequences of hazards and accident scenarios. Screen-out events qualitatively, based on the consequence of events.

(3) Determine likelihood of event occurring. Screen-out events quantitatively, based on the likelihood of event occurring.

The hazard screening flow diagram of steps is shown in Figure 4. A generic list of the hazards is developed based on a literature review and is reviewed and rationalized by a group of risk assessment experts to come up with a refined master list. Once the hazards are identified, the screening process begins with qualitative assessment of hazards impact and consequences of events, followed by quantitative assessments.

The qualitative screening steps QL1 to QL7 discussed below are the criteria for qualitative screening.

[QL1] The first qualitative criterion is if the event is of equal or lesser damage potential than similar events for which the plant has been designed.

After the hazards are identified and determined their impact could be beyond the design basis of the plant, the scenarios need to be defined for each hazard, and it needs to be determined how far from the station they take place and how they can potentially impact the plant's operation.

[QL2] For each scenario, it has to be determined if there are other bounding events. If the hazard imposes lower risk (frequency and consequence) than another hazard, it can be screened out.

[QL3] Once the hazard distance is determined, it can be assessed whether it can be screened based on the distance from the plant.

For screening purposes, a Screening Distance Value (SDV) is defined by the International Atomic Energy Association (IAEA), which is the distance from a facility beyond which, potential sources of a particular type of external event can be ignored. The SDV is different for different hazards. Generally, the safe distance is a distance beyond which a hazard source is too weak to impact nuclear safety.

[QL4] If the event is included in the definition of another event or bounded by other event, it can be screened out from any further assessment.

[QL5] Events that progress slowly and it can be demonstrated that there is sufficient time to eliminate the source of the threat or provide an adequate response, can be screened out.

[QL6] If the event does not cause an initiating event (or the need to shutdown), and does not result in loss of a safety system, it can be screened out.

[QL7] If the hazard does not result in actuation of a front-line system (i.e., a system that directly performs accident mitigating functions), then it is not necessary to evaluate the consequences of the hazard, and it can be screened out.

At this stage of the screening, all qualitative criteria are examined and if the hazard still has not been screened out by any of the seven deterministic criteria, quantitative screening would be required. The OPG PSA Guide for External Hazard Screening recommends using the criteria for quantitatively screening of external events, as shown in Table 2.

Once a hazard has been subject to all qualitative and quantitative criteria, and it is not screened out, then a more detailed assessment using PSA is recommended.

4.1.2 Human-Induced External Hazards

All human-induced external hazards identified for the Darlington NGS were reviewed and examined against the methodology described in Section 4.1.1. All human-induced hazards are screened out, and do not require a PSA. A list of the human-induced external hazards assessed is presented in Table 3.

4.1.3 Natural External Hazards

A Review Level Condition (RLC) needs to be defined for each natural hazard during screening assessment and is used to assess the impact on the nuclear safety. The RLCs are normally defined for a beyond-design-basis event, as the natural hazards within the design basis should not have any significant impact on the plant’s operation and safety. The concept of RLC implies a particular level of hazard which challenges the systems, structures and components (SSCs) on the site. Selection of RLC is based on:

(a) Canadian and International regulations and standards, and

(b) Information on credible hazards at the plant site.

(c) Or alternatively, the RLC can be established for the corresponding screening frequency.

PSA screening analysis for natural external hazards was conducted in accordance with the methodology described in Section 4.1.1. A set of RLCs were defined and used in the screening analysis. Among the twenty-two natural hazards assessed, all of them were screened out, except earthquake, tornado, and high wind as they may cause some potential damages to certain SSCs, which may have impact on Group 2 systems. A list of the natural external hazards considered is presented in Table 4. Seismic and high wind (including straight-line winds and tornados) PSA assessments were performed; see details in Section 5.5 and Section 5.6, respectively. In addition, the hazards ice-storms, extreme temperatures and geomagnetic storms and solar flares are already accounted for in the internal events PSA (see Section 5.1).

4.1.4 Combined External Hazards

Combinations of external hazards may have a significant impact on diverse safety systems at the same time. Therefore, evaluation of the combination events is an essential part of the external hazards screening for PSA to ensure the consequences of combinations are not disproportionate. Combined external hazards include combinations of human-induced hazards with natural hazards, human-induced hazards with other human-induced hazards, as well as combinations of natural hazards. In particular, some combinations of natural hazards can be correlated (e.g., high winds and flooding can both occur in summer storms) and could potentially produce the most severe impacts challenging the safe operations of the nuclear plants. Review of the international practices shows that combinations of external hazards are considered only if the hazards are correlated and dependent. Independent combinations of beyond design basis hazards usually have an extremely low likelihood of occurrence. The objective of the assessment was to ensure the combinations would not have significant impacts on diverse safety systems at the same time, and do not impose disproportional risks to the station’s safe operation. The combined hazard assessment did not identify any hazard combination that requires a PSA assessment.

4.2 External Hazards Screening for Non-Reactor Sources - IFB

Screening assessments for the hazards for the IFB is based on the following considerations and insights;

- Loss of IFB heat sink
- Loss of IFB water Inventory

The above hazard conditions can adversely impact the ability to prevent IFB fuel uncovery, as follows:

- Reduced IFB water level can result in increased radiation fields in and near the IFB with the potential to inhibit corrective operator field actions such as equipment repair and IFB inventory make-up.

- Boiling of IFB water can result in harsh environment with the potential to cause IFB equipment failure and inhibit corrective operator field actions.

- IFB inventory leakage events (e.g., pipe break) can cause IFB equipment failure and inhibit corrective operator field actions

4.2.1 Human-Induced External Hazards

The methodology used for screening the human-induced external hazards for IFB is the same as described in Section 4.1.1. All human-induced hazards are screened out, and do not require a PSA. A list of the human-induced external hazards assessed is presented in Table 5.

4.2.2 Natural External Hazards

A list of natural external hazards were assessed through a hazard screening assessment to determine if they are applicable to the IFB at the Darlington NGS.

Similar to Section 4.1.3, the RLCs defined for the reactor units are considered applicable to the IFB because the reactor units and IFB are at the same site. The list of natural External Hazard can be found in Table 6.

The hazards that were not screened out were addressed in the non-reactor source PSA (see Section 6.13).

4.2.3 Combined External Hazards

Specific combinations of external hazards are not explicitly reviewed. Instead, it is judged that the effect of any combination of hazards (correlated, consequential, and coincidental) would be bounded by the IFB Loss of Heat Sink scenario.

4.3 External Hazards Screening for Non-Reactor Sources - UFDS

Once the fuel has resided in the irradiated fuel bays for a minimum of ten years, the residual decay heat is sufficiently low to allow this fuel to be moved to dry storage. The Used Fuel Dry Storage (UFDS) process operations can be broken down into six parts, which are:

- Receipt of empty Dry Storage Containers (DSCs);

- Prepare empty DSC for loading;

- Transfer operation;

- Fuel loading operation at Fuelling Facilities Auxiliary Areas (FFAAs);

- DSC processing operations at the DWMF; and
- Interim storage of DSCs in the storage buildings.

In order to release Cs-137, which is the radionuclide of concern for the Large Release Frequency (LRF) in a PSA, the fuel would need to be melted. The fuel in the DSCs no longer generates enough heat to require active cooling. The hazard screening for the UFDS therefore makes use of this condition, i.e. if the hazard cannot raise the temperature of the dry fuel, then the hazard can be screened out.

4.3.1 Human-Induced External Hazards

Table 7 has been developed to align the listing of the human induced external hazards for the UFDS with those for the reactor in Section 4.1.2, All human-induced external hazards with a potential to impact UFDS are screened out, and do not require a PSA.

4.3.2 Natural External Hazards

Table 8 lists the natural external hazards and provides their screening analysis based on the approach adopted for the analysis of the human-induced hazards in Section 4.2.2. All natural external hazards are screened out, and do not require a PSA.

4.3.3 Combined External Hazards

Given that individual external hazards do not involve the high temperatures required for a large release of Cs-137 from the UFDS, the combinations of external hazards do not need to be assessed for the UFDS.

4.4 Internal Hazards Screening for Reactor Sources

4.4.1 Overview of Internal Hazards Screening Method

The internal hazards screening method is similar to the external hazards screening method and involves three main steps:

(1) Identify all the internal hazards applicable to the site.

(2) Determine consequences of hazards and accident scenarios. Screen-out events qualitatively, based on the consequence of events.

(3) Determine likelihood of event occurring. Screen-out events quantitatively, based on the likelihood of event occurring.

The screening flow diagram of steps is the same as for the external events as shown in Figure 4. A preliminary list of the hazards is developed based on a literature review, as well as a site walk down to review vulnerable areas within the powerhouse to identify any additional hazards. As many internal hazards have already been assessed in detail by the different Darlington PSA studies, the hazard screening only considered internal hazards not already assessed in DARA.

For each of the hazards identified, one or more parameters are selected that define the internal hazard and/or its potential impact, and for which discrete and quantifiable criteria can be developed. The qualitative criteria are the same as those for the external events as described in Section 4.1.1. If all qualitative criteria have been examined and the hazard has not been screened out by the seven deterministic criteria, the quantitative screening is required as per Table 2.

4.4.2 Internal Hazards Screening Results

The internal hazards identification included mechanical, chemical, electrical hazards, initiated from the inside of the plant (such as turbine missiles, load drops, accidental release of chemicals, and electromagnetic interferences). The internal hazards identified are listed below:

- Mechanical missile impact;
- Explosions within the generating station main buildings;
- Release of oxidizing, toxic, radioactive or corrosive gases and liquids from onsite storage;
- Release of stored energy;
- Dropped or impacting loads
- Transportation impact (e.g., vehicles, movement of toxic on-site goods);
- Electromagnetic interference; and
- Static electricity.

The above internal hazards were assessed and all of them were screened out, some based on the consequences (qualitatively) and some based on their extremely low probability of occurrence (quantitatively). Internal hazards for which a PSA already exists were not considered. As a result of the screening assessment, no new internal hazard was identified to be included in the Darlington PSA.

4.5 Internal Hazards Screening for Non-Reactor Sources - IFB

Identification of internal hazards for IFB is based on the OPG PSA Guide for Internal Hazard Screening which classifies all the internal hazards as leading to the following bounding consequences:

- Loss of IFB Heat Sink (resulting from, e.g., random IFB cooling and support system failures, human errors, internal IFB fires, internal IFB flooding, reactor hazards that may impact IFB cooling system equipment operation); or

- Rapid/Slow Loss of IFB Inventory (resulting from, e.g., random IFB piping breaks, loss of inventory make-up, damage due to heavy load drops). In principle the same hazard types are considered as for the existing reactor PSAs.

The internal hazards are identified as follows:

- Loss of heat sink:
  - Random IFB cooling system failures (e.g., pumps, flow path, valving, control logic, etc.);
  - Random IFB support systems failures (e.g., power, air, water supply failure);
  - Human errors (e.g., due to maintenance and testing);
  - Internal IFB fires;
  - Internal IFB flooding;
  - Loss of IFB water Inventory
- Loss of IFB water inventory
  - Rapid loss of IFB water inventory;
  - Slow loss of IFB water inventory;
  - Damage due to heavy load drops from craning accidents.
- Loss of IFB make-up water
- Turbine generated missile
- Criticality
- Reactor events, e.g., secondary side line break (SSLBs) and LOCAs outside containment
- Reactor events leading to core damage
- Reactor events leading to containment failure causing a large release

The internal hazards that were not screened out were assessed further as part of the non-reactor PSA (see Section 6.13).

4.6 Internal Hazards Screening for Non-Reactor Sources – UFDS

The hazard screening assessment for internal hazard is similar to the assessment conducted for UFDS for external hazards (see Section 4.3).

The internal hazards are identified as follows:

- Mechanical missile impact;
- Explosions within the generating station main buildings;
- Release of oxidizing, toxic, radioactive or corrosive gases and liquids from onsite storage;
- Release of stored energy;
- Dropped or impacting loads
- Transportation impact (e.g., vehicles, movement of toxic on-site goods);
- Criticality
- Loss of support services to the UFDS (e.g. Electrical Power, Service Air, Heat, Ventilation and Air Conditioning (HVAC), etc.)
- Fires
- Electromagnetic interference; and
- Static electricity.

All internal hazards with the potential to impact UFDS have been screened out and do not require a PSA.

5.0 LEVEL 1 PSA METHODS

The goal of a Level 1 PSA is to identify occurrences at the plant that can cause a transient that would challenge fuel cooling, identify what systems can be credited to mitigate the event, assess what the impact of the transient may be on the mitigating systems, and to determine and quantify the degree of fuel damage that would occur if the mitigating systems fail.

Typically, the first PSA study for a station will be a Level 1 At-Power internal events PSA. Much of the effort of this study is in constructing models of what mitigating systems can be credited for a given transient, and how the mitigating systems can fail. In PSAs for other types of initiating events, e.g., internal fire, internal flood, seismic events, and high winds, much of the effort is associated with determining the impact these events have on the mitigating systems. The descriptions of the methodology for the various Level 1 studies in the following subsections reflect different requirements for the different studies.

The Level 1 and Level 2 At-Power PSA models were used to aid in the development and quantification of the internal events outage, seismic, fire, internal flooding, and high wind PSAs.

5.1 Level 1 At-Power Internal Events

The Level 1 At-Power Internal Events PSA for Darlington NGS has been developed following the methodology for preparation of a Level-1 At-Power PSA as described in the Internal Events At-Power PSA Guide.

The major activities of a Level 1 Internal Events PSA are listed below:

(a) Identification of initiating events based on a review of station operating experience and knowledge gained from previous probabilistic safety assessment studies. The identification of initiating events is discussed in Section 5.1.1.

(b) Development of a scheme to group sequences into a manageable number of consequence categories based on degree of fuel damage, as discussed in Section 5.1.2.

(c) Development of event trees. Event trees (ETs) are a tool that establishes what consequences can occur from a particular initiating event, given success or failure of the systems credited with mitigating the initiating event. Development of the DARA event trees is discussed in Section 5.1.3.

(d) Development of system level fault trees (FTs) needed to quantify the probability of failure of the mitigating systems credited in the event trees (including support systems that interface with the mitigating systems). The development of the fault trees is discussed in Section 5.1.4.

(e) Development of a component reliability database with, to the extent possible, information specific to Darlington NGS. The reliability database is needed to support the fault tree analysis mentioned above. The sources for the data in the component reliability database are discussed in Section 5.1.4.

(f) Assessment of the effect of human error on system performance using Human Reliability Analysis (HRA). The potential for human errors must be incorporated along with hardware failures in the system level fault trees and event trees, and the human error probabilities systematically estimated and assigned. Human errors are referred to as “human interactions” in DARA. The HRA is discussed in Section 5.1.5.

(g) Integration of event trees with the system fault trees, and risk quantification. This step combines the accident sequences described in the event trees with the system logic contained in the system fault trees to produce integrated fault trees representing each of the fuel damage categories. The integration process is described in Section 5.1.6.

Although the above listed tasks are carried out in the indicated order, the process is iterative in nature and entails re-assessing the results of a previous task based on insights gained from a subsequent one.

The major activities of the Level-1 At-Power methodology are summarized in the subsections below.

5.1.1 Initiating Events Identification and Quantification

An initiating event (IE) is a disturbance at the plant that challenges reactor operation or fuel integrity either by itself or in conjunction with other failures. Identifying and quantifying the initiating events is the first step in the Level 1 PSA process.

In DARA-L1P, consistent with the above definition, the initiating events under consideration are primarily those plant failures that could lead directly, or in combination with other failures, to damage to fuel in the reactor. The list of DARA initiating events includes events leading to a hostile environment in the powerhouse, i.e., steam line breaks and feedwater line breaks.

Although DARA-L1P is an internal events PSA, it does include events associated with loss of off-site power (loss of the bulk electrical system) and events leading to failures in the service water intake. This is consistent with standard practice in PSA for nuclear power plants.

The objective of the initiating event selection task was to obtain as complete coverage as possible of credible initiating events. To create the initiating event list, past Ontario Power Generation probabilistic safety assessments were reviewed, as were the plant operating experience and station condition records, and other published PSAs. In addition, insight from the fault tree modelling, discussed in Section 5.1.4, identified other initiating events.

The complete list of initiating events considered in DARA-L1P is provided in Table 9.

The initiating events are quantified primarily using Bayes' Theorem. In a Bayesian approach, an assessment is made of generic (prior) experience that is then updated by station-specific experience. This technique allows general experience and knowledge about a given event to be combined with actual operating experience gained with the station under study. It is especially useful for quantifying the frequency of events unlikely to be experienced within the lifetime of a single station. This is the industry standard method.

5.1.2 Fuel Damage Categorization Scheme

Each sequence of initiating event and failure of mitigating systems may potentially result in a different end state at the plant. The plant end states will vary in terms of the severity and timing of fuel damage. Fuel damage categorisation is carried out to simplify the subsequent evaluation of consequence and risk. Each Fuel Damage Category (FDC) represents a collection of event sequences judged to result in a similar degree of potential fuel damage. The FDCs are used as end-states in the Level 1 event trees discussed in Section 5.1.3. In addition, groupings of the fuel damage categories are used to transition from the Level 1 PSA to the Level 2 PSA (see Section 6.1).

The range of events or event sequences covered by the FDCs is defined by the scope of DARA. From the event tree analysis described in Section 5.1.3, general types of accident sequences can be identified. They are in general order of decreasing severity of fuel damage:

(a) Sequences with the potential for loss of core structural integrity (severe core damage).

(b) Loss of fuel cooling requiring the moderator as a heat sink.

(c) Prolonged loss of heat sink.

(d) Inadequate cooling to fuel in one or more core passes following a large loss-of-coolant accident with successful Emergency Cooling Injection System initiation.

(e) Sequences leading to fuel damage in one channel with and without an accompanying automatic containment isolation.

(f) Loss of Heat Transport System integrity followed by successful ECI initiation with no significant fuel damage.

The lower consequence threshold for significance is deemed to be the occurrence of a loss of heat transport system integrity resulting in ECI initiation. Although fuel damage is not likely, the event is considered to have the potential for significant economic consequence due to the downgrading of heavy water, and the loss of revenue due to prolonged shutdown of the accident unit. At the other extreme are the unlikely events that have the potential for severe consequences involving the loss of core structural integrity. Table 10 presents the FDCs used in DARA. These FDCs are also used to calculate the frequency of severe core damage, used for comparison to the relevant Ontario Power Generation safety goal. Severe core damage is defined to be the sum of the FDC1 and FDC2 frequencies.

5.1.3 Event Tree Analysis

The potential for accidental release of fission products contained in nuclear fuel constitutes the main risk from a nuclear power plant. In the Level 1 analysis, event trees are used to systematically review the possible ways that radioisotopes can be released from the fuel and to distinguish between varying levels of fuel damage and isotope release resulting from different accidents.

Since a nuclear plant is a complex system, the search for accident sequences must be conducted in a systematic and structured manner. This analysis requires both a thorough understanding of the plant design, operation, maintenance and testing, and the ability to translate that understanding into a model of the plant that captures the logic of the sequences leading to fuel damage.

These sequences are constructed using inductive logic. The graphical representation of this inductive logic is called an event tree. The start of this inductive method is the initiating event, usually a plant malfunction. Following the identification of the initiating events, the next step is to consider what systems are required to mitigate the event and show how the accident could progress if failures of the mitigating systems were also to occur, until a previously defined end state is reached.

Event tree analysis requires the following to be predefined:

(a) A list of initiating events to be considered.

(b) Definition of sequence end states.

(c) Definition of mitigating systems and corresponding ET branch point labels.

Figure 5 shows a generic event tree for a large loss-of-coolant accident at a CANDU plant. A LOCA is typically a pipe break in the heat transport system. Following a large LOCA, three systems are postulated to mitigate releases of radioisotopes: the shutdown systems, ECI and the heat sink function of the moderator system. The potential plant state must be assessed if one or more of these systems fail. These three systems form the branch points in the event tree. The event tree is read from the left, starting at the initiating event IE-LOCA. The first systems credited with preventing fuel damage are the shutdown systems. Failure of both SDS1 and SDS2 is represented by the event tree branch point “SD”. SDS1 and SDS2 are fast acting, diverse and independent systems. The convention used to interpret an event tree is that success of the system is the top path and failure is the lower. If the shutdown systems fail, rapid loss of core structural integrity is expected. FDC1 is assumed to occur. If reactor shutdown is successful, the decay heat from the fuel must still be removed to prevent fuel damage. Two systems are credited for this function: automatic ECI injection and the moderator as a heat sink. If ECI fails, represented by the event tree branch point “ECI”, then the moderator is credited to prevent severe core damage. However, if the moderator system fails, a slow loss of structural integrity is expected. Then the end state is FDC2, one of the fuel damage categories included in the definition of severe core damage. If the moderator system is successful, the less severe FDC3 category is assigned.

If both shutdown and ECI are successful, the end state FDC9 is reached. This category represents no significant fuel damage, and no release to the public, but has significant economic consequences.

Once the Level 1 event trees have been created, the systems that have been identified as mitigating systems in the event tree analysis require fault tree modelling to calculate the probability of failure of the mitigating function. Fault tree analysis is described in the next section.

5.1.4 Fault Tree Analysis

A fault tree (FT) is a logic diagram that models the possible causes of a particular fault, usually a system failure, and is used to calculate the probability that the fault occurs. In DARA, fault trees are used to quantify the probability of the failure of the mitigating systems that appear in the event trees discussed in Section 5.1.3, and for the support systems. Table 11 lists the systems modelled by fault trees in the DARA-L1P study. Figure 6 depicts the relationship between the event trees and fault trees. System fault tree analysis is used to calculate the probability of an event tree branch point given a specific set of events that fail the system.

Each fault tree is a logic diagram developed for a failure mode of interest, and is based on the understanding of system design and operation. At the top of the diagram the event itself is noted and termed the “top event”. The process of fault tree analysis is a deductive, systematic way of failure analysis whereby an undesired state of a system is specified (i.e., top event), and the system is analyzed in context of its environment and operation to find all credible ways in which the undesired state can occur. Thus, through this process, the contributors to the top event are identified.

The “CAFTA” software code is used for developing and quantifying the fault tree [R-6].

For example, consider emergency make-up water to the steam generators. For this system, the failure mode of interest might be “fails to supply adequate water to the steam generator when required”. Figure 7 shows a partially completed fault tree with this event at the top. Starting from this top event, the fault tree analyst poses the question “How can this event occur?”. The answers to this question become the inputs to this top event. For example, Figure 7 shows that ESW to the steam generators can fail if the piping fails due to water hammer, or if there is no flow from check valve NV42. For each of these contributors, the process of examining how they can occur is repeated, until no further insights can be obtained about the behaviour of the system. Typically, the fault tree is developed either to predefined system boundaries, or to the individual system components.

In constructing a fault tree model, a number of design and operational features are assessed.

(a) System capability: For example, how much water flow is required for the steam generator to be a successful heat sink?

(b) Fault detection: For example, if a component has failed, when and how can its failure be detected?

(c) Common cause failures: For example, if a pump has failed due to any number of causes will any of the remaining redundant pumps fail to operate due to the same cause of failure as the first?

(d) Failure criteria: For example, what fundamental failure modes lead to failure of ESW to the steam generators?

(e) Fault tolerance: For example, if the electrical systems have failed, what is the impact on the system?

The basis for system capability and the failure criteria is based on analysis from a variety of sources, including the safety analysis contained in the Darlington NGS Safety Report, Operational Safety Requirements (OSR), Abnormal Incidents Manuals (AIMs), and assessments and regulatory submissions.

In principle, the fault tree analysis technique is straightforward. An undesired event is postulated and then, deductively, its contributors are identified. However, this process requires a detailed understanding of the system design and function, and how it behaves under fault conditions.

Once the fault tree is constructed, it is linked with the system reliability database, a database containing the information to calculate the probability of each event in the fault tree. In DARA, failure rate, test and maintenance data are assigned to the fault tree primary events from a central type code table that is linked to the system reliability databases. This type code table defines failure rates for the various components at the Darlington NGS. The use of the CAFTA compatible reliability database and a central type code table ensures that the same type of component is assigned the same failure rate for the same failure mode in all system fault trees.

The nuclear industry has adopted a Bayesian approach for obtaining component failure rates. The Bayesian approach is based on the use of both the "prior knowledge" and the plant-specific data in deriving the failure rates. Three industry sources, U.S. Nuclear Regulatory Commission (NRC) [R-7], T-book [R-8], and Westinghouse Savannah River Company [R-9], were used for obtaining generic data. The DARA component reliability database is based on a Bayesian calculation of the equipment failure rates reflecting Darlington operational data from 1999 to 2018 inclusive.

The reliability database also contains information on human errors modelled in the fault tree and event trees. The analysis of human errors and their quantification is discussed in the next section.

5.1.5 Human Reliability Analysis

Human errors can affect the performance of systems, and in some cases be significant contributors to risk. Thus, human reliability analysis (HRA) is an important part of DARA. The potential for human errors must be incorporated along with hardware failures in the system level fault trees, and human error probabilities systematically identified and assigned.

The overall objective is to include all human interactions that can potentially lead to a significant increase in the probability of component or system failure and that are not already reflected in the plant failure rate database.

In principle, every piece of equipment or system in the plant is susceptible to failure because of human error; however, human errors that contribute directly to the failure of individual components are included in the equipment reliability database (i.e., reflected in the component failure rate) and need not be identified in fault trees. The human errors of interest to the fault tree analyst arise under five sets of circumstances:

(a) Where an otherwise operable component, subsystem or system can be disabled (i.e., prevented from performing its design function) prior to an initiating event;

(b) Where an annunciated equipment or system failure occurs but this failure is not responded to by the operator prior to an initiating event;

(c) Where an operator action or a closely related series of actions can cause more than one piece of equipment in parallel or redundant pathways to fail or become disabled simultaneously prior to an initiating event;

(d) Where an operator can fail to respond appropriately to bring the plant to a stable state following an initiating event (by not taking any action at all or taking the required action but in an inappropriate way); and

(e) Where an operator can plausibly interfere with correct responses by inhibiting or activating a system.

A human interaction in a fault tree identifies an opportunity for a human to make an error. Only those opportunities that arise in carrying out established plant operating practice are included; specifically, errors made during maintenance, testing, normal plant control, and post-initiating event control and recovery activities. In most cases, these errors would be made while carrying out formal procedures. Random, spurious, wilful, or vengeful actions are not included.

In order to systematically quantify the human interactions in DARA, Ontario Power Generation uses a human interaction taxonomy. This taxonomy classifies the human interactions in DARA-L1P into three parts: Part 1 contains the simple interactions that, by definition, occur prior to an initiating event; Part 2 contains complex human interactions that occur prior to initiating events; and Part 3 contains the complex interactions that occur after an initiating event.

Simple human interactions have the following characteristics:

(a) They are based on written or learned procedures (as opposed to cognitive or creative tasks).

(b) They involve directly manipulated components (e.g., a valve handwheel or a handswitch) or directly viewed main control room display devices.

(c) They occur prior to an initiating event.

The task of assigning preliminary (screening) human error probabilities for the simple human interactions is made easier and faster using a simple method requiring only selection of an unmodified basic Human Error Probability (HEP) and predefined modifying factors. This method quantifies the human interaction based on the type of task, the location where the task is performed, whether the error can be detected in the main control room, and if any annunciations or inspections can detect the error. The simple human interactions are reviewed by the Human Reliability Assessment (HRA) Specialist. In some cases, the probability is requantified using the Technique for Human Error Rate Prediction (THERP) described in Reference [R-10].

For the complex human interactions that occur prior to initiating events, the same process may be followed to obtain a preliminary (screening) quantification. These human interactions are complex because they include system-level functions that involve more than just direct physical manipulation of a component, such as the setting of computer control program parameters or modes. The preliminary quantifications are then reviewed by the HRA Specialist on a case-by-case basis and if required are requantified using THERP methodology described in Reference [R-10].

Post-initiating event complex human interactions usually occur during abnormal conditions and are, therefore, more difficult to identify, analyze, and quantify. Additionally, interactions involved in handling unit upsets are also unlike other interactions as they may take place in dynamic and uncertain situations. Such actions depend upon the cognitive functions of diagnosis and decision-making. These actions are knowledge-based; they are based on fundamental principles of process and safety system operation and on understanding of the interactions amongst these systems.

For the post-initiating event complex human interactions, the preliminary (screening) human error probabilities are assigned based on three criteria: whether the task is straightforward, of average complexity, or very complex; the time available; and the quality of indication available in the main control room to indicate that action is required. The preliminary quantifications are then reviewed by the HRA Specialist. Like the pre-initiating event complex human interactions, in some cases these probabilities are requantified using THERP methodology described in Reference [R-10].

5.1.6 Fault Tree Integration and Evaluation

The fault tree and associated failure rate data contain the information necessary to calculate the top event probability and identify the dominant contributors to failure for the individual system. Integration is the process of merging the system fault trees with the event trees to create logic for the fuel damage (i.e., Level 1) and release categories (i.e., Level 2). The end goal of the integration step is to develop a model that can be used to calculate the frequency of occurrence for each of the end states, i.e., the fuel damage categories and release categories. Combining this information in one model allows dependencies between systems to be identified and quantified correctly.

The information required to quantify the fuel damage categories is stored in the fault trees and event trees. In order to combine the two, the event tree logic is converted into fault tree logic with a top event for each FDC. These fault trees are referred to as the high level logic. The events in the high level logic are the initiating events and the branch points from the event trees. The high level logic is then integrated with the mitigating system event trees; the top events in the mitigating system fault trees are inserted where the mitigating system branch point labels exist in the high level logic model. Finally, the support systems are added to the integrated high level logic fault tree. Figure 8 illustrates this process.

The CAFTA software stores and evaluates the fault trees [R-6]. The CAFTA program was developed by Electric Power Research Institute (EPRI). The FTREX program is used to quantify the results [R-11].

The solution of a fault tree is a listing of the combination of an initiating event, equipment failures, and human errors that leads to the occurrence of the fault tree top event, with each combination containing the minimum number of failures that have to occur to cause the top event. Such combinations are also called minimal cutsets.

The solution of the fault tree calculated using CAFTA is truncated. That is to say, contributors below a certain frequency are not included in the solution. Truncation is necessary because of computational limits. The truncation level selected should be low enough that all significant contributors are captured. The Level 1 At-Power PSA Guide recommends that the solution of the integrated fault tree for each FDC be truncated at either 4 orders of magnitude below the most likely minimal cutset in that FDC or at 1E-12 occ/yr, whichever is the highest. For FDC2, the top cutset frequency is in the 3E-08 occ/yr range, so a truncation of approximately 3E-12 occ/yr is used.

Following the development of the baseline PSA results, an additional understanding of the station risk is obtained by supplementing the baseline solution with the following:

- Importance analysis to identify systems and components that are important to the FDC results;

- Parametric uncertainty analysis to determine the lower and upper limits of the two-sided 90% confidence interval for the frequency of each FDC; and

- Sensitivity analysis used to evaluate the impact on the results of a number of assumptions made in the event tree analysis and fault tree analysis, as well as assumptions impacting the quantification of initiating events, undeveloped events, and human error events.

Recall from Section 3.0 that risk has two components: the frequency of occurrence and the consequences. Section 5.1.1 to 5.1.6 describe the methods used to quantify the frequency of occurrence of the fuel damage categories. The Level 1 analysis is used as an input to the Level 2 analysis (see Section 6.0). The remaining subsections in Section 5.0 describe the differences in methodology for Level 1 assessment for the outage state, for internal fire, internal flood, seismic, and high wind initiating events.

5.2 Outage Internal Events

DARA-L1P considers internal events occurring at 100% full power operation. However, the Darlington NGS has periods of planned outage to perform routine maintenance and testing that cannot be done during full power operation. Typically, a unit has a planned outage for less than 10% of the operating cycle. The reactor power continues to decrease exponentially after reactor trip. Reactor power is typically around 0.6% full power on the first day of an outage.

The 2020 DARA-L1O assessment was developed following the methodology for preparation of a Level-1 Outage PSA as described in the OPG Outage PSA Guide. The 2011 model and the 2015 model were used as the basis for developing the 2020 bounding assessment described in Section 5.2.8.

The Outage PSA uses many of the same techniques as used in the At-Power PSA. The PSA process for outage uses initiating events, event tree analysis and fault tree analysis, like the At-Power PSA. However, different initiating events can occur in the outage state, and the event tree and fault tree must reflect the plant configurations during the outage (e.g. HTS pressurized or depressurized). The plant configurations modelled as part of the outage PSA are typically described as plant operational states (POS).

Determining the possible plant configurations is a major part of the outage probabilistic safety assessment and is described in the next section.

5.2.1 Plant Operational State (POS) Identification and Analysis

The purpose of Plant Operational State analysis is to define the various outage plant scenarios and group them into fewer, representative and bounding states for which the plant status, configurations and system failure criteria are considered sufficiently stable. During unit shutdown, plant system configurations and parameters are dynamic, changing with respect to time. The dynamic nature of shutdown, specifically system configurations, process parameters and varying system failure mechanisms, result in an excessively large number of unique plant scenarios to be analyzed. In the definition of the POSs, only normally planned plant configurations are considered.

Firstly, Pre-Plant Operational States (Pre-POSs) are identified; Pre-POSs are defined as unique outage plant configurations wherein all parameters of interest (system configuration and parameters, e.g., heat transport system pressure, primary heat sink, HTS pressure) are considered stable for the duration of the state. Pre-POSs are the highest resolution of the outage states. The Pre-POSs are grouped into POSs. For DARA-L1O, eight pre-POSs were identified and have been grouped into three representative POSs. The three POSs are used in other aspects of the Outage PSA, including accident sequence analysis using event trees. Table 12 provides a summary of the final POSs used in the DARA-L1O model. The parameters used to define the POSs are listed in the leftmost column.

5.2.2 Initiating Event Identification and Quantification

The development of a Level-1 Outage PSA requires the identification, grouping and quantification of a set of outage initiating events that could occur during the identified outage POSs. An outage initiating event (IE) is defined as a malfunction that can, either independently or in conjunction with other plant conditions or configurations, lead to fuel damage when the unit is in the guaranteed shutdown state.

The process described below was used to identify, group and quantify outage state initiating events:

- The outage IE identification process uses a number of different steps and different sources of information, so that the basis for the Outage PSA is as comprehensive as possible.

- The identified IEs are grouped on the basis of similar mitigation requirements, in order to simplify the accident sequence analysis.

- The frequency of occurrence of each initiating event (or IE group) is estimated, so that the overall risk of core damage can be calculated.

Table 13 presents the list of outage initiating events for the Darlington NGS Level 1 Outage PSA, and which POS each initiating event can occur in. Some initiating events can occur only in specific plant configurations. For example, ice-plugs are used during some maintenance activities on the HTS, but can only be used while the HTS is depressurized. So the ice-plug failure initiating event can only occur during the POSs with a depressurized HTS (POSC and POSD).

5.2.3 Outage Event Tree Analysis and Fuel Damage Category (FDC) Analysis

The event tree process for the internal outage events trees is similar to that used for the at-power event trees described in Section 5.1.3.

The overall process followed to develop the ETs for DARA-L1O is as follows:

(1) For each unique IE/POS combination, identify the mitigating systems credited for the IE based on a review of the accident analysis and plant operating procedures.

(2) Determine the end states of interest in the ET analysis. For DARA-L1O, these are the outage fuel damage categories as shown in Table 14.

(3) Develop the accident sequence logic depending on the success and failure of the mitigating functions credited for the IE.

(4) Add the branch point label for each mitigating system failure as the logic is being developed on the failure branch of the ET.

(5) Assign a FDC to each ET sequence end state.

5.2.4 Outage System Fault Tree Analysis

The fault tree analysis process for the internal outage PSA is the same as for the at-power PSA. However, the fault tree models are significantly different to reflect the outage configurations of the system.

The system FT models are specific to the outage PSA. Each fault tree includes a brief overview of the system analyzed, top event definitions, assumptions, failure criteria, FT diagram, data table, results expressed as minimal cutsets, system failure probability and importance indices. Table 11 lists the systems modelled by fault trees in DARA-L1O.

5.2.5 Reliability Data Analysis

The objective of reliability data analysis is to derive the reliability data assigned to the primary events modelled in the DARA-L1O system fault trees. Primary events include basic events (e.g., component hardware failures), conditioning events (i.e., events used to specify a condition or restriction that applies to the fault tree logic), developed events (i.e., specific fault events related to external interfaces which are typically developed in separate fault tree models), and undeveloped events (i.e., specific fault events not amenable to further development and so quantified using specialized methods).

Like in the at-power PSA, a Bayesian approach is used for obtaining component failure rates. Conditioning events, developed events, and undeveloped events, for which component failure rates are not applicable, are also quantified using one of the following methods:

- Operational events are quantified from observation of operating experience;

- Analytical events have a probability of occurrence that is determined from the results of analytical models outside of the fault tree, engineering judgement, or both.

5.2.6 Human Reliability Analysis

The possibility of component or system failure due to human error is recognized by the inclusion of human interactions in the FTs and ETs. The scope of the HRA includes inadvertent errors by plant operators or maintainers that may contribute to the failure of systems or components but excludes consideration of arbitrary or wilful actions. Ultimately, the human error probabilities are combined with equipment failures in the system FT to provide the overall probability of the top event. In the ETs, the human error probabilities are combined with system and/or equipment failures in the ET to provide accident sequence frequencies.

While the methodology for quantifying human interactions in the Outage PSA is generally the same as in the At-Power model (see Section 5.1.5), the effort required to identify, quantify and model human interactions in Outage PSA is not trivial. The human interactions during outage states require the consideration of the many testing and maintenance activities, procedures, and manual initiation of certain mitigating systems. The HRA specialist considers the outage POSs and system configurations to better understand required operator actions, recall actions, and possible testing and maintenance activities during a given POS.

5.2.7 Model Integration, Quantification, and Additional Analyses

Once the event trees and fault trees are developed, they are linked to determine the frequencies with which various fuel damage consequence categories can occur. Categories, here, are groupings of sequences with similar consequences. As the linked models can be of large size, computer aided methods are used to carry out the computations. The results are expressed in terms of the expected number of occurrences of the consequence category per unit time (i.e., frequency). Only those failure combinations that have frequencies greater than a certain cut-off value are listed. The frequency of the consequence category is obtained by summing the frequency of each sequence belonging to that category.

For each consequence category, the magnitude of the associated consequence needs to be calculated. The product of frequency and consequence is calculated for each category and summed to obtain an overall estimate of risk. These are used in absolute terms to assess the overall safety design adequacy, and in relative terms to identify the dominant risk contributors. The acceptability of the Darlington NGS risk estimates is judged based on comparison with the safety goals established by OPG [R-4].

Similar to the At-Power PSA, additional elements (see Section 5.1.6) supplement the baseline solution in order to gain an additional understanding of the station risk.

5.2.8 DARA-L1O 2020 Bounding Assessment

The 2020 DARA-L1O update is a bounding assessment, undertaken in accordance with the principle in REGDOC-2.4.2 that the level of detail in a PSA should be consistent with the level of risk. It was prepared in accordance with the OPG Level 1 Outage PSA Guide.

The overall objective of 2020 DARA-L1O analysis was to provide an updated severe core damage frequency (SCDF) estimate for 2020 reflecting the current Darlington design and operation to the extent practical for a limited scope bounding assessment. This has been accomplished as follows:

(1) A full scope quantitative update was completed for the outage Plant Operational State (POS) parameters (as described in Section 5.2.1), outage initiating event (IE) frequencies (as described in Section 5.2.2), component failure rates, and frequencies of planned test and maintenance procedures (described in Section 5.2.3), based on the incorporation of recent Darlington NGS experience up to the study freeze date of December 31, 2018.

(2) The potential impact of event tree and fault tree model changes from the 2020 DARA-L1P study was reviewed, with applicable changes made to the Level 1 Outage event trees and fault trees.

(3) The integrated DARA-L1O model was constructed from the updated outage event trees and fault trees.

(4) The integrated DARA-L1O model has been requantified in order to obtain a revised set of baseline cutsets for severe core damage.

5.3 At-Power Internal Fire

The 2020 DARA-FIRE assessment was developed following the methodology for preparation of an Internal Fire PSA as described in the OPG Fire PSA Guide. The 2020 model and analysis are significantly altered from the 2015 DARA-Fire, with fire damage consequence assessments performed using explicitly selected equipment and cable routing information.

The OPG Fire PSA Guide has been developed based on NUREG/CR-6850 [R-12]. The major activities of the Fire PSA methodology and its application in the development of the DARA-FIRE assessment are summarized in the subsections below.

An internal fire PSA is built from the internal events PSA for the corresponding plant operational state. The scope of the DARA-FIRE model is limited to internal fires initiated with the analysis unit at power with the potential to cause severe core damage. Internal fires considered are those resulting from ignition events within fixed equipment (e.g., electrical panels, pumps, etc.) as well as transient ignition events resulting from human activities in the plant (e.g., combustible material storage, hot work, etc.).

The DARA-FIRE model considers sequences that result in severe core damage. Severe core damage is defined as the sum of the FDC1 and FDC2 frequencies. Severe core damage at Darlington is dominated by the FDC2 frequency. In the fire PSA, FDC1 sequences (failure to shutdown the reactor) represents a very small portion of the sequences leading to SCD due to the low frequency in the internal events model. The fail-safe design of the two shutdown systems (SDS1 and SDS2) and the physical separation of SDS1 and SDS2 make it unlikely that a fire could impact both systems. This limited the number of fire scenarios with the potential to impact more than one channel of one SDS and reduced the probability of a fire-induced failure to trip.

The DARA-FIRE analysis used the Darlington NGS Fire Safe Shutdown Analysis (FSSA) as a starting point to select the components required for safe shutdown following a fire.

5.3.1 Phased Approach to Fire PSA

The Fire PSA Guide prescribes a phased evaluation of internal fire risks. In each phase, appropriate technical bases and methods are applied; the difference is in the degree to which simplifying assumptions are made as the significant contributors to risk are addressed.

The fire PSA logic is based on the internal events PSA logic. As the fire PSA is developed based on the internal events PSA, the major tasks in the fire PSA are associated with identifying possible fire scenarios, the zones the fires can impact, affected equipment and cables, and selection of representative internal events sequences and quantifying the consequences of the fire scenarios.

The Fire PSA methodology is broken down into 18 tasks:

- Task 1 – Plant Boundary Definition and Partitioning
- Task 2 – Fire PSA Component Selection
- Task 3 – Fire PSA Cable Selection
- Task 4 – Qualitative Screening
- Task 5 – Fire-Induced Risk Model
- Task 6 – Fire Ignition Frequencies
- Task 7 – Quantitative Screening
- Task 8 – Scoping Fire Modelling
- Task 9 – Detailed Circuit Failure Analysis
- Task 10 – Circuit Failure Mode Likelihood Analysis
- Task 11 – Detailed Fire Modelling
- Task 12 – Post-Fire Human Reliability Analysis
- Task 13 – Seismic-Fire Interactions Assessment (outside the scope of the Darlington NGS Fire PSA; a seismically-induced internal fire and internal flood risk evaluation is undertaken as part of the Darlington NGS Seismic PSA)
- Task 14 – Fire PSA Level 1 Quantification
- Task 15 – Uncertainty and Sensitivity Analysis
- Task 16 – Fire PSA Documentation
- Task 17 – Fire PSA Level 2 Quantification
- Task 18 – Alternate Unit Assessment

The integration of these tasks is shown in Figure 9. The methods prescribed in the Fire PSA Guide are iterative. Several of the tasks listed above involve calculation of severe core damage frequency due to fires in various plant locations. With each subsequent calculation, the methods used to assess the risk for the various scenarios are refined. This iterative approach is used to identify high risk areas and to focus the detailed fire analysis on these areas. A brief summary of the methodology used for DARA-FIRE is provided in the following sections.

5.3.2 Plant Partitioning

This first task in the fire PSA involves the division of the plant into discrete areas called Physical Analysis Units (PAUs). This requires defining the overall analysis boundary to ensure that those plant locations where a postulated fire could impact the PSA are included in the analysis. Once the overall analysis boundary is defined, the buildings that are within the boundary are examined for potential sub-division into PAUs. The PAUs used in the DARA-FIRE assessment are based on those identified in the Darlington NGS Fire Protection Program documented in the Fire Hazard Assessment (FHA). This approach allows the fire PSA to rely on the existing programmatic controls and design requirements for maintaining the integrity of the associated compartment boundaries.

5.3.3 Fire PSA Component and Cable Selection

The development of a fire PSA requires identifying components necessary for safe shutdown and long-term decay heat removal following a fire. A fire can affect the equipment credited for safe shutdown by either being in the same area as the credited equipment or by being in the same area as the cables related to the credited equipment. For example, a fire in the same area as the power cables for a pump could result in failure of the pump, even if the pump itself was remote from the fire.

The purpose of this task is to identify the equipment to be explicitly credited in the fire PSA, and determine where in the plant the equipment and cables necessary for their credited function are located.

The set of components selected for explicit credit in the Fire PSA following a fire includes the systems credited in the Darlington FSSA. In addition, Group 2 functions not credited in the FSSA are selected, such as ESW to the moderator and ESW to the Primary Heat Transport (PHT) system. A subset of Group 1 systems powered by Class III power was also selected, including Auxiliary Feedwater, the IUFT, Shutdown Cooling and the Moderator System. To support these front-line systems, support functions such as power supply from the standby generators, LPSW, instrument air and room HVAC were all considered and included in the selected component set as required. EME make-up to the steam generators, HTS and calandria are also credited, including all electrically or pneumatically controlled valves in the injection pathways that can be misaligned by fire, as well as the availability of an interim heat sink from SGECS or gravity fed flow from the Deaerator Storage Tank to provide time for the deployment of the EME.

In addition to the explicit selection of mitigating systems, the impact of fire-induced Multiple Spurious Operation (MSO) has been addressed in this 2020 update of DARA-Fire as part of this task. The MSO assessment started with the list of unscreened scenarios identified for Darlington NGS and each scenario was either further dispositioned, or resulted in the selection of components for which control and/or power cables were traced in order to identify fire scenarios which can initiate the MSO scenario.

Once the equipment to be explicitly credited following a fire event had been identified, the locations and routing of all cables that impact this equipment were identified. This was completed through a simplified circuit analysis process that identified wires with the potential to impact the credited component function, and identification of the cables containing these wires. The route through the plant, including the PAUs in which the cables appear, was established for each cable through a review of the cable tray route sequence against cable tray layout drawings. The cable routing information was compiled in a database and used to determine the fire PSA components potentially affected by postulated fires at different plant locations.

5.3.4 Qualitative Screening

The PAUs, described in Section 5.3.2, may be screened to eliminate those PAUs where the contribution of fire risk to severe core damage is expected to be relatively low or nonexistent compared to other PAUs. The screening criteria considered the following:

- The type of equipment in the PAU;
- The types of ignition sources in the PAU, and the ability to introduce transient ignition sources into the area;
- Impact of the ignition sources on mitigating systems.

Due to specifics of the Darlington NGS design and the analysis approach, this specific task has been excluded from the 2020 DARA-Fire update and instead, quantification of SCDF for all scenarios were performed as described in Section 5.3.12.

5.3.5 Fire-Induced Risk Model

This task involves the development of a logic model that reflects plant response following a fire. This includes modelling the plant response to fire-induced events and modifying the internal events PSA to reflect postulated equipment failures.

The DARA-L2P model was modified and manipulated to produce a fire-induced risk model capable of quantifying both the SCDF and LRF based on the gate selected for quantification. This included incorporating the modified human error event probabilities as described in Section 5.3.11, and incorporating model logic changes specific to the fire analysis such as the addition of fire specific failure modes (e.g., hot shorts). It also included the identification of events in the fire model to be set to “failed” to represent the unavailability of the equipment should they be failed in the fire scenarios.

5.3.6 Fire Ignition Frequencies

To calculate the risk due to an internal fire, the Fire Ignition Frequencies (FIFs) for each PAU must be assessed. The frequencies were calculated based on generic data in NUREG-2169 [R-13] and the plant populations of fixed ignition sources (e.g., pumps, electrical equipment), as well as information regarding plant operations affecting transient ignition sources (e.g., transient material storage, staff occupancy) identified by plant walkdowns and other appropriate means.

The Darlington NGS fire PSA project is limited to Unit 0 and Unit 2. The calculation of FIFs for Unit 0 and Unit 2, however, required calculation of FIFs for all of the PAUs that are within analysis boundary. This was accomplished by:

(1) Conducting Fixed Ignition Sources (FISs) counting walkdowns of Unit 0 and Unit 2 PAUs;

(2) Conducting a 2019 walkdown to confirm additions or removal of Unit 0 and Unit 2 FISs identified through the review of Darlington NGS engineering design changes for the five year period 2014 – 2018;

(3) Conducting a 2019 walkdown of risk-significant Unit 0 and Unit 2 PAUs (as identified in the 2015 DARA-Fire) to identify any other changes to the FIS inventory occurring since the initial 2011 walkdowns; and

(4) Assuming that Unit 2 is spatially representative of the other three operating units, replicating the Unit 2 FISs walkdown data for PAUs in Units 1, 3 and 4.

The Darlington NGS fire experience data was reviewed to determine the applicability of using the NUREG-2169 generic data [R-13]. The qualitative review of CANDU operating experience with fire events found the use of US experience documented in NUREG-2169 [R-13] would result in under-estimating the fire frequency for some types of ignition sources. Therefore, the US generic ignition frequencies were updated using a Bayesian approach to incorporate the Darlington NGS fire experience.

The 2020 DARA-Fire also incorporated consideration of the impact of refurbishment activities on the potential for transient fires in the operating units and adjusted the transient ignition frequencies accordingly in affected areas.

The FISs fire frequency, the transient ignition sources fire frequency and the total FIF were calculated for each PAU.

5.3.7 Quantitative Screening

The development of a fire PSA allows for a quantitative screening of PAUs based on contribution to SCD for a given PAU. This task estimates SCD frequency for each compartment as well as the cumulative risk associated with the screened compartments (i.e., those not retained for detailed analysis). With the information from the fire model and FIFs (described in Sections 5.3.5 and 5.3.6), the contribution to severe core damage by PAU can be calculated. Based on the severe core damage contribution of each PAU, the areas of the plant are further screened, using industry standard screening criteria from Reference [R-12].

Due to specifics of the Darlington NGS design and the analysis approach, this specific task has been excluded from the 2020 DARA-Fire update and instead, quantification of SCDF for all scenarios were performed as described in Section 5.3.12.

5.3.8 Scoping Fire Modelling

The scoping fire modelling refines the initial frequency results obtained in the quantitative screening process. The scoping fire modelling is used to develop explicit fire scenarios within the PAUs. This task involves the use of generic fire models for various fire ignition sources so that simple rules can be used to define and screen fire ignition sources (and therefore fire scenarios) in an unscreened fire compartment. Fire scoping models are developed for all fire areas.

This task has two main objectives:

- To screen out those FISs that do not pose a threat to the targets within a specific fire compartment; and,
- To assign severity factors to unscreened FISs.

To accomplish these goals, the scoping fire modelling refines the calculation of SCD frequency for each PAU.

5.3.9 Detailed Circuit Failure and Failure Mode Likelihood Analysis

The development of a fire PSA requires detailed circuit failure analysis and circuit failure mode and likelihood analysis. Detailed circuit failure analysis involves identifying how the failure of specific cables impacts the components credited in the Fire PSA. For example, not only can a fire result in failure of equipment, the fire may also result in spurious actuation of equipment, due to possible failure mode of the cables and control logic associated with the equipment.

Circuit failure mode and likelihood analysis task involves the evaluation of the relative likelihood of various circuit failure modes (e.g. failure to operate when required, spurious operation). This added level of resolution applies to those fire scenarios that are significant contributors to the risk.

Circuit analysis was not performed for cables required in the FSSA, because the cable information is already assessed as part of the FSSA. The scope of DARA-FIRE circuit analysis included cable failure mode and failure mode likelihood analysis of components added to the scope of credited safe shutdown equipment credited in the fire PSA, see Section 5.3.3. This task includes, for risk significant components, analysis of circuit operation and functionality to determine whether the cable's fire induced failure could result in undesirable equipment operation. In such cases, a probabilistic assessment of the likelihood that a fire induced failure causes a spurious operation is performed. Given that fire induced cable damage occurs, an appropriate conditional probability is assigned.

5.3.10 Detailed Fire Modelling

Detailed fire modelling was used to perform fire ignition source (scenario) specific fire modelling to address risk significant scenarios in cases where (1) the scoping fire modelling described in Section 5.3.8 produced overly conservative results, or (2) to address the potential fire scenarios not readily addressed by scoping fire modelling. The detailed fire modelling included:

- Explicit treatment of fires in the MCR complex to address fire induced MCR abandonment;
- Explicit analysis of the potential for the formation of damaging hot gas layer from ignition sources in risk-significant PAUs;
- Explicit analysis of multi-compartment scenarios.

The abandonment times for operators in the Darlington NGS Main Control Room (MCR) envelope were assessed for electronic equipment fires and for transient combustible fires within the MCR envelope.

The purpose of the hot gas layer analysis is to determine the probability that a fire originating from a given ignition source in a PAU can generate a layer of hot gases in the PAU that is sufficient to damage all equipment in the PAU, rather than only the equipment within its original zone of influence.

The purpose of multi-compartment analysis is to calculate the probability of compartment interaction caused by a hot gas layer propagation between compartments. The calculation is the product of multiplying the probability of a hot gas layer in the PAU (i.e., the probability that the fire creates a hot gas layer) by the PAU barrier failure probability (i.e., failure of fire doors, dampers and penetrations). The multi-compartment analysis used the hot gas layer development timing defined in Reference [R-14].

5.3.11 Post-Fire Human Reliability Analysis

A review of DARA-L1P was performed to identify the post-initiator operator actions modelled as human failure events along with their associated HEP; pre-initiator operator actions and operator actions associated with non-fire induced events were excluded from consideration.

For each fire-related basic event that represents a post-initiator operator action modelled as human failure, HEP multipliers were developed for fire PSA adjustments. The method to apply the HEP adjustment considered the following factors:

- Location (either inside the MCR actions or outside the MCR actions);
- Time available (based on DARA-L1P HRA documentation);
- Availability of indications and controls necessary to diagnose and execute the action;
- Availability of path to the equipment for field actions

Based on the factors above, the baseline HRA value from the PSA may be retained, the HRA value may be multiplied by a factor in the range of 2 to 30, or no credit for the operator action may be taken (failure of operator action assigned a probability of 1).

The 2020 DARA-Fire has also introduced new fire-specific human actions that were not contained in the DARA-L1P model, and has included a fire-specific analysis of the HEP for EME deployment following a fire event.

5.3.12 Fire Level 1 PSA Quantification

The development of a fire PSA requires the integration of the fire ignition frequencies with the damage consequences assessed for each scenario. The damage consequences are imposed on the risk model to quantify a conditional core damage probability (CCDP) given the occurrence of the initiating fire. The combination of the scenario ignition frequency and CCDP defines the SCDF for the scenario. The DARA-Fire SCDF quantification has been performed using the EPRI code FRANX 4.4 [R-15] which incorporates the output of all the previous fire tasks. The integrated SCDF for all scenarios is used to determine the total fire risk.

The development of the fire risk quantification is typically an iterative process. As various analysis refinement strategies are developed, they are incorporated into the fire risk model.

The scoping fire modelling (Section 5.3.8) provided a conservative and simplified means to develop an initial risk estimate. Additional model quantifications to calculate the severe core damage frequency are performed iteratively as additional analysis refinements are incorporated. This includes information gathered during walkdowns conducted for scoping modelling (Section 5.3.8) and additional analysis of other Darlington NGS design inputs (e.g., equipment and cable tray layout drawings) to refine treatment of PAUs that had high estimated SCDFs. This refinement typically divided risk significant PAUs into multiple fire initiating events (scenarios) to represent the individual fire ignition sources. In some cases, multiple fire ignition sources in a PAU were grouped and treated as a single fire initiating event so long as such grouping did not result in overly conservative risk estimates.

5.3.13 Assessment of Unit-to-Unit Differences

The scope of work resulted in specific numerical results for the Unit 2 PAUs and other site PAUs that are common to all four units. Quantification of separate SCDFs and release frequencies for Units 1, 3, and 4 are not specifically included. Because fire risk characterization is needed for the entire plant site, the anticipated symmetry / consistency in the design and construction of the entire four unit site is relied upon to support the applicability of the risk results for the analyzed unit to the other units.

A side-by-side comparison of the Unit 1, 3 and 4 PAUs to the analyzed Unit 2 PAUs was created using fire zone information from the FSSA and the FHA. Equipment layout drawings and general arrangement drawings were also consulted. A walkdown was performed to assess the differences between the units. The walkdown confirmed the physical differences between the units are relatively minor. Although ongoing refurbishment introduces more significant differences in design, it is recognized that it is a temporary condition. All units will be similar in design post-refurbishment. The top contributing scenarios are not impacted by any of the identified differences and no new scenarios were identified that would be expected to contribute significantly to fire-induced risk.

5.3.14 DARA-FIRE 2020

The 2020 DARA-FIRE assessment was prepared according to the OPG Fire PSA Guide. The overall objective of the 2020 DARA-FIRE report was to provide the risk of SCDF due to internal fire events. This has been accomplished as follows:

(1) Update of PAUs to reflect the fire zone definitions in the updated FHA and FSSA.

(2) Update of the FIFs to include use of the latest U.S. industry guidance [R-16] and generic ignition frequency data [R-13], including a conservative treatment of the impact of Darlington NGS-specific fire experience.

(3) The CCDPs for the fire scenarios are quantified using a fire-induced risk model derived from the latest 2020 DARA-L1P model, described in Section 5.1. The updated 2020 DARA-L1P model includes all relevant engineering and operational changes up to the study freeze date of December 31, 2018, including credit of Phase 1 EME.

(4) The explicit selection of equipment and cable tracing to perform the consequence assessment.

(5) The integration of the ignition frequency, and damage consequence for each fire scenario to generate scenario SCDFs.

5.4 At-Power Internal Flood

The OPG Internal Flooding PSA Guide describes the methodology used to quantify the risk due to internal flooding. Similar to the Fire PSA, the guide prescribes using a two phased approach. If the results of the first phase are satisfactory, then only the first phase is implemented. For Darlington, a Phase 2 Flood PSA was not required.

The 2020 DARA-FLOOD assessment was developed following the methodology for preparation of an Internal Flood PSA as described in the OPG Flood PSA Guide. The 2015 model and analysis were used as the basis for developing the 2020 assessment described in Section 5.4.7.

Like the fire PSA described in Section 5.3, the impacts of internal flooding events are related to the physical location of equipment in the plant. The station must be divided into areas, and the potential initiators in each area assessed, and the impacts of the initiators determined.

The flooding analysis is focused on two primary objectives: areas of the plant that contain equipment from both Group 1 and Group 2 systems (referred to as “pinch points”), or areas which might completely disable all of Group 1 or Group 2, as these areas represent the highest potential for degradation of the plant mitigation capability; and conservative estimation of risks associated with the other areas of the plant. A major input into the Internal Flooding PSA is the At-Power Internal Events PSA (DARA-L1P). The At-Power Internal Events PSA is used to determine which components need to be evaluated for flooding impacts, and is also used as the basis for the quantification of the internal flooding severe core damage frequency.

The construction of the Internal Flood PSA requires the following steps:

(1) Identification of Flood Areas and Systems Structures and Components (SSCs).

(2) Identification of Flood Sources.

(3) Internal Flood Qualitative Screening.

(4) Potential Flood Scenario Characterization.

(5) Internal Flooding Initiating Event Frequency Estimation.

(6) Flood Consequence Analysis.

(7) Evaluate Flood Mitigation Strategies.

(8) PSA Modelling of Flood Scenarios

(9) Internal Flooding Level 1 PSA Quantification.

(10) Sensitivity and Uncertainty Analysis.

(11) Support Task – Plant Walkdowns.

Figure 10 shows the tasks for the flooding PSA.

The flooding PSA focuses on sequences that lead to severe core damage (FDC1 and FDC2) caused by an internal flood. Failure to shutdown sequences (FDC1) are not quantified as the frequency of FDC1 is several orders of magnitude lower than FDC2 in the DARA-L1P model (see Table 19) and the potential for flooding events to adversely affect the shutdown systems, which fail safe on loss of power or loss of actuation inputs, is minimal.

5.4.1 Identification of Flood Areas, SSC and Flood Sources

Like the fire PSA, the first step of the flooding PSA is to partition the plant into the flood areas that will form the basis of the analysis. As part of this task the flood areas are defined based on physical barriers, mitigation features, and propagation pathways. The flood areas were defined based on the partitions in the FSSA.

Once the flood areas are defined, the SSCs in each flood area modelled by the internal event PSA are identified.

For the DARA-FLOOD model, once the flood areas were identified, they were screened using qualitative arguments as described in the following section. After the initial screening, those unscreened areas were reviewed for the impact on equipment credited in the PSA, and the possible flood sources in the area.

5.4.2 Internal Flood Qualitative Screening

This step performs a qualitative screening considering the sources of flooding, the flood propagation pathways and the consequences of the flood. The objective is to qualitatively screen out many low risk internal flood scenarios.

The following rules were used when screening

- The area is outside of Unit 2 (the reference unit) or Unit 0 (common unit);
- The area is evaluated as a Screen 1 in the FSSA (see Section 5.3.4);
- The area contains no Group 1 equipment affecting FDC2;
- The area contains no Group 2 equipment affecting FDC2;
- The area contains no credible flood source, or credible flooding propagation paths into the area of the collocation.

The unscreened areas are the pinch-point areas for the flooding assessment

5.4.3 Potential Flood Scenario Characterization and Consequence

This step identifies and characterizes the potential flood scenarios to be included in the analysis. This task characterizes the consequences for each flood-induced initiating event by considering the following factors:

- Type of flood source, including the type of pressure boundary failures (e.g., spray, large leak, major structural failure), capacity of the flood source (e.g., unbounded lake source, closed tank);
- Through-wall flow rate or spill rate;
- Flood location;
- Time to reach the critical flood volume (e.g., to submerge equipment, or lead to propagation into another area);
- The impact on the SSCs modelled in the PSA.

5.4.4 Internal Flooding Initiating Event Frequency Estimation

This step identifies flooding induced initiating events and estimates their frequency of occurrence. The flooding failure rates are based on generic EPRI data from Reference [R-17].

5.4.5 Flood Mitigation Strategies

This step is to identify and evaluate the strategies that can be employed by plant operators to mitigate the consequences of the flood. These actions can include terminating the source of the flood by isolating the break, or stopping the pumps that supply the flood source, or open doors to divert water away from sensitive equipment.

The evaluation of human failure events in the internal flood scenarios differs from the internal events PSA. Specifically, the appropriate scenario-specific impacts on Performance Shaping Factors (PSFs) were considered for both control room and ex-control room actions based on the following items:

- Additional workload and stress (above that for similar sequences not caused by internal floods);
- Availability of indications;
- Effect of flood on mitigation, required response, timing, and recovery activities (e.g., accessibility restrictions, possibility of physical harm);
- Flooding-specific job aids and training (e.g., procedures, training exercises).

5.4.6 Internal Flooding Accident Sequence and Level 1 PSA Quantification

This step includes the finalization of flood scenario development and completing internal flood accident sequence models based on modifying the internal events PSA model. The 2020 DARA-FLOOD followed a quantification methodology more in line with the Internal Events PSA methodology where all scenarios are captured in a single-top model and the quantification did not use CCDP as in the previous assessment. A generalized simplified flood scenario event tree was used as the basis for developing flood scenarios. For the scenarios developed as part of the previous assessment, the event trees and associated CCDP have been used as the basis for developing the flood specific fault tree logic. The failure or successful isolation of breaks, as modelled in the simplified flood scenario event trees, along with the respective CCDP cases define the combinations of events that need to be added to mitigating system fault trees for the single-top model used in the 2020 DARA FLOOD.

Qualitative sensitivity and uncertainly analyses were included as part of the quantification of the 2020 DARA-FLOOD model.

5.4.7 DARA-FLOOD 2020

The 2020 DARA-FLOOD assessment was prepared according to the OPG Flood PSA Guide. The overall objective of the 2020 DARA-FLOOD report was to provide the 2020 DARA-FLOOD results. This has been accomplished as follows:

(1) Update of the piping rupture frequencies with the latest EPRI data [R-18].

(2) Assessment of postulated flooding scenarios impact on deployment of the EME, including accessibility of the deployment locations and the associated HEPs. Generally, the flooding scenarios credit EME for preventing severe core damage using the same logic modelled in DARA-L1P.

(3) Re-quantification of Severe Core Damage Frequency (SCDF) for all postulated flood scenarios.

(4) The qualitative screening, flood area identification, and flood source identification are based on the FSSA.

5.5 At-Power Seismic

The DARA-SEISMIC assessment has been developed following the methodology for preparation of a seismic PSA as described in the OPG Seismic PSA Guide. The major activities of the Seismic PSA methodology and its application in the development of the DARA-SEISMIC assessment are summarized in the subsections below.

The primary steps in developing the seismic PSA are identifying the seismic hazard at the site, constructing an event tree and fault tree model of the plant to represent the credited heat sinks following a seismic event, and creating new equipment failure modes based on the likelihood of equipment failure due to the seismic event. The seismic PSA was created based on the internal events At-Power PSA, DARA-L1P.

The DARA-SEISMIC model considers sequences that result in severe core damage (i.e., end states FDC1 and FDC2). Accident sequences that postulate a failure to shutdown the reactor (i.e., end state FDC1) are not explicitly assessed following a seismic event. Failure to shutdown following a seismic event is highly unlikely as SDS1 and SDS2 are diverse, highly reliable, have a fail-safe design, and are seismically robust.

Similar to the Fire and Flood studies, the Seismic PSA Guide also outlines a Phased approach, with two phases defined:

- **Phase 1 - PSA-Based Seismic Margin Assessment (SMA)** - In Phase 1, a PSA-based SMA is performed based on the methodology described in Reference [R-19]. This focused approach uses a plant model based on DARA-L1P with the addition of new seismic failure modes; the new seismic failure events are developed from a seismic margin approach with generic variabilities and the seismic risk is calculated based on a point estimate format that does not include a full uncertainty analysis.

- **Phase 2 - Seismic PSA (SPSA)** – In Phase 2, the Phase 1 results are used to identify the most effective approach to convert the Phase 1 risk-based seismic margin study into a SPSA. Uncertainty in the seismic hazard and seismic fragilities are included, propagated, and displayed in the final quantification of risk estimates of the plant for significant risk contributors.

For Darlington, a Phase 2 Seismic PSA study was performed.

Major elements of the Darlington NGS SPSA consist of the following tasks:

- Task 1 - Seismic Hazard Characterization
- Task 2 - Plant Logic Model and Seismic Equipment List Development
- Task 3 - Seismic Response Characterization
- Task 4 - Plant Walkdown and Screening Reviews
- Task 5 - Seismic Fragility Development

- Task 6 - Seismic Level 1 PSA Quantification
- Task 7 - Level 2 Evaluation (see Section 6.11)
- Task 8 - Alternate Unit Analysis
- Task 9 - Seismic PSA Documentation

The integration of these tasks is shown in Figure 11.

5.5.1 Seismic Hazard Characterization

The first step in the seismic PSA is to model the site-specific seismic hazard. The seismic hazard is representation of the possible earthquakes and seismic activity that can be experienced at the site. The seismic hazard is a plot of the peak ground acceleration versus the annual frequency that the ground acceleration will be exceeded (typically described as the frequency of exceedance). Figure 12 shows a typical seismic hazard curve. The curve shows that very small ground accelerations are more likely than very large ground accelerations.

The site-specific seismic hazard curve is used to define the earthquake characteristics used in the PSA analysis

5.5.2 Plant Logic Model Development

This task involves two related but separate sub-tasks: development of the accident progression logic for the risk quantification model, and development of the Seismic Equipment List (SEL), which lists the structures, systems and components credited in the seismic PSA. This task relies upon the internal events PSA and other safe shutdown analyses to define the functions, systems, and components required to mitigate seismic initiating events. The seismic model was updated to credit systems and equipment modified or replaced since the last PSA update (e.g., new EME design, CFVS).

A starting point for the SEL is the fire safe shutdown equipment list. The SEL credits systems that are seismically qualified (e.g., SDS2, ESW, ECI, EPS, EPGs, and required support systems), or seismically assessed (e.g., EME) with preventing SCD over the entire seismic hazard range. Since at lower magnitude earthquakes it is likely that the majority of DNGS systems are still fully operational and capable of performing their SCD mitigating function, selected non-seismically qualified DNGS systems are credited in the lower portion of the seismic hazard.

The SSCs in the reference unit (i.e., Unit 2) and the common systems (i.e., Unit 0) are modelled in the SPSA model, are assessed in later SPSA tasks (e.g., fragility development).

5.5.3 Seismic Response Characterization

The next step in the seismic PSA is to characterize how the station buildings respond to a seismic event. The response of the building will not be the same on each elevation. For example, the small earthquakes occasionally experienced in southern Ontario are typically undetectable to people in the basement or lower floors of buildings, but can be easily detected by people in the higher floors of tall buildings.

The ground oscillation of any seismic event can be described by a combination of frequencies. This is called the spectrum of the seismic event. Each potential seismic event may have a different spectrum. The different frequencies in an earthquake’s spectrum will be transferred to the building in different ways. The response of site buildings determines how the earthquake will affect the credited equipment in the seismic PSA and is used to calculate the probability of equipment failure due to a seismic event.

In Phase 1, a generalized scaling approach is used to calculate the structural response of the site buildings. This method is based on the existing DBE seismic response analyses for the site buildings, prepared as part of the design for the Darlington NGS, with updates to reflect the shapes of the new seismic hazard curves. In addition to characterizing the overall building response, this task defines the local accelerations for the credited equipment. In Phase 2, seismic responses analyses were performed for selected site structures, considering soil-structure interaction (SSI) and ground motion incoherence (GMI) analysis. Insights from the SSI/GMI analyses of these structures were used to refine the response of these structures to the seismic event. The potential for seismically induced soil liquefaction was considered.

5.5.4 Plant Walkdown and Screening Reviews

Plant walkdowns were required to assess the relative vulnerability of equipment to seismic challenges. The walkdowns were performed by fragility experts in order to document the basis for screening equipment in, based on susceptibility, or out, based on ruggedness, of the SPSA. The plant walkdowns included reviews of the SEL items in one unit and the items in the systems common to all four units. The 2020 DARA-SEISMIC update included a walk down to assess SEL SSCs including:

- Group 2 SSCs;
- Spatial interactions;
- Seismically Induced Internal Fires and Floods (SIIFF) sources that were not screened in the previous SIIFF studies;
- EME storage building and deployment paths;
- MCR access paths;
- Group 1 SSCs that can be credited with a magnitude up to 0.1g; and
- SSCs installed due to refurbishment activities (e.g., temporary containment boundary components).

5.5.5 Seismic Fragility Development

The likelihood that a given piece of equipment will fail for a given seismic hazard is based on the fragility of the equipment. The fragility of the equipment is a conditional failure probability that the equipment will fail when subjected to a specific acceleration caused by a seismic event. The likelihood the equipment will fail increases as it is subject to greater acceleration. Figure 13 shows an example fragility curve. Figure 13 shows that if the example equipment is subject to an acceleration of 1g, the failure probability is 80%.

Preliminary fragilities were determined through a combination of walkdown review of the as-installed configurations, experience-based estimates, and equipment-specific fragility calculations using the Conservative Deterministic Failure Margin (CDFM) methodology with generic representations for the variability [R-20]. In some cases, more refined fragilities were derived using the Hybrid Method, or the Separation-of-Variable method [R-20], for risk-significant SSCs.

For the 2020 DARA-SEISMIC, the fragility analysis includes consideration of the findings from the seismic walkdown, potential spatial interactions, the impact of SIIFFs, and the impact of seismically induced soil failures.

5.5.6 Seismic Level 1 PSA Quantification

Quantification of the seismically induced SCDF requires the integration of the seismic hazard developed in Section 5.5.1, the plant logic model developed in Section 5.5.2, selected portions of the DARA-L1P integrated model for systems credited in the SPSA, and seismically induced failures of credited SSCs.

In the development of DARA-SEISMIC model, the seismic hazard curve was divided into discrete ground motion intervals for the purposes of quantification. Eight intervals were used to represent the seismic hazard; Table 15 shows the intervals used for DARA-SEISMIC. These intervals are treated as the initiating events in the DARA-SEISMIC study. Their frequencies are calculated as the annual exceedance frequency at the beginning of interval minus the annual exceedance frequency at the end of the interval. The information on the seismic response of the buildings and the seismic fragility of the credited SSCs, developed in Sections 5.5.3 to 5.5.5, was used to calculate the probability of seismically induced failures in each interval. The EPRI code FRANX 4.4 [R-15] was used to model the seismically induced initiating events and SSC failures in the DARA-SEISMIC model. Quantification of the DARA-Seismic model is performed for each seismic hazard interval to represent the risk over the entire seismic hazard range. The seismic PSA presents the risk of severe core damage for earthquakes with a frequency up to 1E-04 occurrences per year (recurrence interval of 10,000 years or less). Consistent with DARA-L1P, importance, uncertainty and sensitivity analyses were performed to identify key insights.

5.5.7 Alternate Unit Analysis

The Unit 2 is the analysis unit, with one unit undergoing a refurbishment outage (i.e., Unit 3), and the remaining units operating at full power. There is the possibility that unique physical differences between units could contribute to somewhat different seismic response from unit to unit. However, the results of the Level 1 analysis for Unit 2 show that the seismic risk is driven by correlated failures of shared systems (i.e., common portions of EPS and ESW). Thus, unit-to-unit differences are not expected to have significant impact on the DARA-Seismic results and no further assessment is deemed necessary at this time.

5.6 At-Power High Wind

The DARA-WIND assessment has been developed following the methodology for preparation of a high wind PSA as described in the OPG High Wind Hazard PSA Guide. The major activities of the high wind PSA methodology and its application in the development of the DARA-WIND assessment are summarized in the subsections below.

The primary steps in developing the high wind PSA are identifying the high wind hazard, identifying the high wind targets, developing wind-borne missile fragilities for the high wind targets, evaluating the fragility of the high wind targets, developing the high-level plant logic, and quantifying the high wind scenarios. The high wind PSA was created based on the internal events At-Power PSA, DARA-L1P.

Figure 14 shows how each step feeds into the overall DARA-Wind study. The methodology applied in the high wind hazard assessment uses a high level approach in determining fragilities based on wind capacity. The approach is realistic with conservative assumptions to simplify the analysis where needed.

5.6.1 High Wind Hazard Analysis

The first step in the high wind PSA is to identify the potential contributing wind hazards at the site. The primary hazard includes straight winds (thunderstorms and extratropical cyclones), hurricanes and tornadoes. The wind hazard curve is developed for peak gusts in open terrain at 10 m height. Terrain, height, and averaging time adjustments were performed to adjust gust wind data to 3 second gust speed at a height of 10 m in flat open terrain. Figure 15 shows an example of high wind hazard curves.

Similar to the seismic results, the high wind results are reported for high winds with a frequency up to 1E-04 occ/yr.

5.6.2 Plant Logic Model Development

This task involves two related but separate sub-tasks: development of the event tree logic for the risk quantification model, and identification of target systems, structures, and components (SSCs) that are included in the high wind PSA model. The high wind plant logic model examines the response of plant SSCs to the defined high wind hazard. It then combines this response with the response of the plant to the initiating event, given the degraded condition of the plant’s SSCs and the challenges faced by the operator due to the wind hazard. The focus of the high wind analysis is estimation of severe core damage frequency for a single reference unit, with consideration of the common unit and adjacent unit impacts on the reference unit.

5.6.3 Analysis of Windborne Missile Risk

Windborne missile fragility is defined as the probability of target damage (failure) from windborne missiles for a given value of peak gust wind speed. Wind-borne missile risk includes:

(1) Missiles that hit/damage an exterior target.

(2) Missiles that enter a building and hit an interior target.

(3) Missiles that originate within a building and hit an interior target.

The windborne missile risk analysis considered the risk from all potential missiles at and near the site. Missile data were collected from the site walkdown, plant layout and SSC drawings.

Fragility functions specific to each wind hazard type were developed for each SSC subject to windborne missile risk. Interior SSCs in highly vulnerable structures were represented by a single fragility function that did not separately consider missiles, provided the building failure was judged to occur prior to (or simultaneously with) the initiation of significant missile hazard at the site.

The windborne missile risk considered failure of building components in the determination of flying missile risk and missile fragilities for targets. The failed building components (such as cladding, roof top equipment, roof elements, and loose contents) were assumed to be available missiles at appropriate wind speeds associated with the failure of the building envelope components for that building type.

The windborne missile fragilities were represented by missile hit, missile penetration, perforation, spall, or other damage relationship appropriate for the target.

5.6.4 High Wind Fragility Development

Wind fragility is defined as the conditional probability of failure for a given value of peak gust wind speed. The general objective of the wind fragility study is to assess the aerodynamic wind forces which may result in damage to buildings housing safety-related equipment and their contents and to determine associated uncertainty.

High wind capacities and corresponding fragilities were developed for the identified targets. For each wind hazard type, the fragility of screened-in targets was assessed using an advanced code-based methodology. This method applies a code-based approach with code and load-effect calculations and considers wind direction, terrain roughness, blockage, and structure enclosure state. The mean fragilities were used in the risk quantification to represent the nominal point estimate fragility of a given component.

5.6.5 High Wind Hazard Site Walkdown

The high wind hazard walkdown includes a walkdown of credited SSCs and a missile survey. The walkdowns of SSCs were performed in order to confirm all the structures and their condition, vulnerability of the equipment, etc. The walkdowns of the windborne missile survey were conducted and covered each missile source zone at the entire site. The survey collected data on the types, numbers, and locations of potential missiles (e.g., construction materials, equipment, automobiles, signs, trees, and vulnerable structures that are likely to fail in windstorms).

5.6.6 Plant Response Model Quantification

Quantification of the high wind PSA models requires the integration of the wind hazard curves from Section 5.6.1 and the fragility curves from Section 5.6.4 along with the non-high wind or random failure modes according to a Boolean representation of ways the plant response is assumed to lead to core damage.

This task involves the integration of the high wind hazard and fragility information with the overall plant logic model, by adding the fragility information to appropriate sequences and basic events in the plant logic model.

The quantification of high wind accident sequence frequencies requires first quantifying the frequency of occurrence of each initiating event and the logic models developed to represent the failure probabilities of the event tree top events.

The event tree top event failure probability model includes not only the impact of wind speed on plant failure probabilities, but also of random failures unrelated to the wind speed. The high wind initiating event frequencies and event tree top event probabilities were then combined similar to the approaches followed for non-high wind initiating events. By combining the frequencies of high wind sequences over all high wind initiating events, the end state frequencies for high wind risk were determined.

6.0 LEVEL 2 PSA METHODS

Section 5.0 described the methods used for the Level 1 PSA assessments of Darlington NGS. In the Level 1 PSA, the goal was to quantify the frequency of fuel damage. Once the fuel has been damaged, there is the potential for radioactive material to be released from the fuel into containment. The Darlington NGS design includes a containment system (described in Section 2.3.14) to prevent the release of any radioactive material in the station from being discharged into the environment.

The Level 2 PSA studies the system failures and accident phenomena that might result in a release to the environment, and the timing and magnitude of the release. This information is combined with the Level 1 DARA-L1P model to quantify the frequency of possible releases.

The DARA-L2P model has been developed following the methodology for preparation of a Level-2 PSA as described in the Level 2 PSA Guide. The major activities of the Level-2 PSA methodology and its application in the development of DARA-L2P are summarized in the subsections below.

6.1 Interface with Level 1 PSA

The Darlington Level 1 At-Power Internal Events PSA (DARA-L1P) generates results in the form of frequencies of nine Fuel Damage Categories, described in Section 5.1.2, representing a wide range of possible outcomes. The possible outcomes include the most severe involving failure to shutdown (FDC1) to relatively benign where there are no fuel failures and release is limited to the equilibrium fission product inventory of the Heat Transport System (HTS) (FDC9). A subset of the FDCs (1-7), those that involve release of significant quantities of fission products from the core, is used to develop the interface between Level 1 and Level 2. Subsets are grouped into Plant Damage States (PDSs). The PDSs serve to reduce number of the sequences assessed in the Level 2 analysis to a manageable number while still reflecting the full range of possible accident sequences and their impacts on the plant.

Only two FDCs are used to represent the range of sequences that result in severe core damage, FDC1 for rapid accident progression resulting from failures to shut down the reactor when required and FDC2 for all other sequences. FDC1 is conservatively assumed to cause early consequential containment failure and is assigned to a unique PDS, PDS1.

FDC2 is not assumed to result in immediate containment failure and was subdivided into three PDSs (2-4) to examine the potential for random and consequential failures of containment systems that could eventually lead to enhanced release to the environment:

- PDS2 represents sequences affecting a single unit with release into containment;
- PDS3 represents sequences affecting more than one unit;
- PDS4 represents single unit sequences with a release pathway that bypasses containment.

Random containment system failures are associated only with PDS2 and were identified by means of a Bridging Event Tree (Figure 16) that led to the creation of five subcategories, labelled PDS2A-E.

As described in Section 1.0, Unit 2 is the reference unit for the PSA study. In order to develop the logic for PDS3, additional simplified modelling of the other three units was undertaken to partition the FDC2 logic into sequences that impact a single unit, and sequences that could impact more than one unit.

FDCs 3-7 represent the range of accidents that fall under the general heading of “design basis events”. These were allocated to PDS5 and 6 respectively, depending on whether the initiating event involves containment bypass (PDS6) or not (PDS5).

FDCs 8-9 are excluded from Level 2 analysis on the basis that the radionuclide releases from these in-plant sequences would be negligible.

For Level 2 analysis, the characteristics of each plant damage state are represented by a single representative accident sequence. By design, the plant damage states group sequences expected to generate similar magnitude and timing of fission product release to containment and containment response. However, the frequency and releases for each sequence will vary to some extent.

The Level 1 PSA is used to identify initiating events that are the largest contributors to the frequency of the plant damage state. These sequences are then reviewed to select a representative sequence that bounds the consequence. The approach follows the guidance of the IAEA as this method selects a sequence that “largely bounds” the PDS. The representative sequences chosen for each PDS are summarized in Table 16.

6.2 Containment Event Tree Analysis

In Level 2 PSAs, Containment Event Trees (CETs) are used to delineate the sequence of events and severe accident phenomena after the onset of core damage that challenge successive barriers to radioactive release to the environment. They provide a structured approach for the evaluation of the capability of a plant, specifically its containment boundary, to cope with severe core damage accidents. The entry points into the CETs are the plant damage states that involve severe core damage.

A CET is a logic model that addresses uncertainties in the ability to predict the potential impacts of accident progression and associated physical phenomena on containment response. Figure 17 shows a simplified CET. CET branch points are not built from system based “success criteria” but from questions that are intended to ascertain the magnitude of phenomenological challenges to the containment boundary and its continued integrity at a given stage of accident progression (e.g., *“Is containment integrity maintained?”* or *“Does core concrete interaction occur?”*). The CET branch points represent major events in accident progression and the potential for fission product release to the environment. The CET also represents the evolution of the progression with time so the same nodal question may appear more than once in the tree as conditions inside containment change. The focus of the CET is to estimate the probabilities of the various ways that containment failure may occur leading to a release to the environment.

Most of the CET branch points represent alternative possible outcomes of a given physical interaction. Depending on the availability of suitable models and data for a given physical interaction or phenomenon, the methods of branch point quantification can vary. The acceptability of these probability estimates is supported via an expert review process.

6.3 Containment Fault Trees

The containment fault trees developed as part of the level 2 PSA are the following:

CEI:	Impairment of Containment Integrity Avoided
ACU:	Reactor Vault Cooling System Condenses Steam
IGN:	Hydrogen Igniters Control Possible Hydrogen Burn
CFVS	Containment Filtered Venting System (not credited in the baseline DARA-L2P assessment)
EFADS:	Emergency Filtered Air Discharge System Filters and Vents (not credited in the baseline DARA-L2P assessment)

The fault tree models documented in the Level 2 PSA are listed in Table 11. Fault tree representations for failure of these containment functions have been developed, reflecting the likelihood that random equipment failure or human error will prevent the operation of the system on demand or during the mission.

Containment system fault trees are required for quantification of the frequencies of the end-states PDS2A – PDS2E in the Level 1/Level 2 PDS2 bridging event tree, which is shown in

Figure 16. Containment failures arising as a consequence of severe accident progression are addressed in the CET.

6.4 Release Categorization

The CET analysis generates a multitude of end states associated with each specific severe accident sequence. The CET end states are binned into Release Categories (RCs), for use in subsequent applications and to facilitate comparison with safety goals (Table 1). The RCs are defined based on two criteria:

- The magnitude of release in Becquerel (Bq) of specific radionuclides considered important to offsite impacts (e.g., isotopes of cesium or iodine); and

- The timing of the release, either early in the accident sequence (where “early” is less than 24 hours) or late (after 24 hours).

Seven RCs cover the full range of possible releases and provide enough discrimination to evaluate safety goal frequencies. An eighth category is used to represent basemat melt-through, when the core debris is postulated to penetrate the floor of the fueling machine duct. Table 17 presents the release categories used in the DARA-L2P analysis. Large release frequency (LRF) is defined to be the sum of RC1 through RC3.

6.5 MAAP-CANDU Analysis

MAAP-CANDU (Modular Accident Analysis Program – CANDU) is a severe accident simulation code for CANDU nuclear stations [R-21]. It is used to calculate the consequences of severe accidents and is designated as a CANDU Owners Group (COG) Industry Standard Toolset (IST) code. MAAP-CANDU originated from MAAP developed for Pressurized Water Reactor (PWR) and Boiling Water Reactor (BWR) systems by Fauske and Associates (FAI) and is part of the EPRI suite of probabilistic safety assessment tools.

MAAP-CANDU can simulate the response of a CANDU power plant during severe accident sequences. The code quantitatively predicts the evolution of a severe accident starting from full power conditions given a set of system faults and initiating events through events such as core melt, primary heat transport system failure, calandria vessel failure, shield tank failure, and containment failure. Severe accident analysis carried out using MAAP-CANDU is the cornerstone of the Level 2 PSA. There are at least five distinct roles for the code, as outlined below:

- To establish the baseline accident progression for each plant damage state and the potential impact of associated physical phenomena on CET top events;

- To determine the sensitivity of phenomena to reasonable variations in key parameter values to support CET branch point quantification;

- To calculate releases to the environment for those sequences for which a non-zero probability of a containment failure mode has been estimated to support categorization of releases;

- To generate results to support systematic sensitivity and uncertainty analysis; and
- To provide information related to plant environmental conditions.

6.6 Severe Accident Management Guidelines

The SAMG are entered when plant conditions reach the point where actions being attempted using AIM procedures and/or EME guidelines are no longer effective and severe core damage is considered imminent. The goals of SAMG are to terminate fission product releases from the plant, maintain or return containment to a controlled, stable state, and return the core to a controlled and stable state.

SAMG documentation is treated as guidance, compared to AIM response, which uses procedures. The type of actions included in SAMG range from recovery of systems typical in the prevention of severe core damage (i.e. ECI, moderator cooling) to crediting systems or injections lineups in non-traditional ways that are not typically included in the AIM response. While Phase 1 EME is used prior to the entry into SAMG as a prevention mechanism, it can also be used within the SAMG framework if not successful in preventing severe core damage.

Credit for SAMG actions has been incorporated into the Level 2 PSA model.

6.7 Integration of the Level 1 and 2 PSA

The purpose of integration is to link the Level 1 event trees with the PDSs via the Level 1/Level 2 bridging event tree and containment fault trees and then with the RCs via the CET end-states using the results of the branch point quantification. The product is a complete set of sequences that contribute to each RC, from which the frequency of each RC can be determined.

Importance analysis is performed to identify the dominant contributors to each release category.

Sensitivity and uncertainty analysis is performed on both the frequency quantification and on the MAAP-CANDU consequence assessment.

6.8 Level 2 Outage Assessment

Given the low risk of fuel damage from internal events occurring while the unit is in GSS, a full Level 2 study of the outage risks was not performed. Instead a bounding assessment of the large release was performed while the unit is in outage.

The at-power Level 2 assessment (DARA-L2P) demonstrated that a large release can only occur if severe core damage has occurred, so the large release frequency while the unit is in outage can be bounded by the frequency of severe core damage while the unit is in outage.

Nonetheless, an LRF estimate was performed by identifying the following:

- Outage sequences leading to LRF

- Single-unit vs multi-unit cutsets
- Fraction of single unit sequences leading to LRF
- Fraction of multi unit sequence leading to LRF.

The plant configuration in each POS was reviewed for potential containment failures (random failures, containment bypass, or consequential containment failure). A limited number of outage specific considerations were identified that might impact the severe accident progression.

Additional MAAP-CANDU analysis was performed to assess the consequences of the identified outage sequences.

6.9 Level 2 Fire Assessment

The Level 2 assessment of internal fire risk was evaluated using the fire-induced risk model described in Section 5.3.5, which was developed based on the DARA-L2P model. The DARA-Fire LRF quantification has been performed using the EPRI code FRANX 4.4 [R-15] which incorporates the output of all the previous fire tasks. Since the fire-induced risk model has been prepared to quantify SCDF and LRF, and the fire scenario impact includes consideration of Level 2 equipment credited in the FSSA, the LRF is quantified as described in Section 5.3.12 with selection of a different top event in the fire-induced risk model for quantification of LRF.

6.10 Level 2 Flood Assessment

The LRF is estimated using the 2020 Level 1 Darlington NGS Internal Flood PSA SCD sequences.

To estimate LRF due to internal flooding, the cutsets were classified into one of the four groups:

- Cutsets involving single unit with flooding event inside the containment;
- Cutsets involving single unit with flooding event outside the containment;
- Cutsets involving two units;
- Cutsets involving more than two units, which will be referred to as Multi-Unit.

Cutset manipulations were performed to determine the fraction of each type of sequence that progresses to a large release. The sum of the contribution from each group is then used to estimate LRF caused by internal flooding.

6.11 Level 2 Seismic Evaluation

The Level 2 seismic evaluation included the following tasks:

- Develop the Level 2 SEL;
- Perform walkdown of Level 2 SSCs;
- Estimate of the seismic fragility of Level 2 SSCs;
- Estimate of LRF due to seismic events; and
- Evaluate the robustness of containment response to seismic events.

The development of the Level 2 SEL was performed in the same manner as the Level 1 SEL, as described in Section 5.5.2. Walkdowns of Level 2 SSCs were performed with those of Level 1, described in Section 5.5.4. Level 2 fragilities were calculated using the same techniques as those described in Section 5.5.5.

The estimate of LRF was performed by analyzing the Level 1 SCDF results, quantified in Section 5.5.6. The SCDF cutsets were divided into those that represented containment failure (e.g., containment bypass), and those for which additional failures are required to cause large releases. Containment failure SCD cutsets were treated as contributing directly to LRF. In those SCD scenarios that did not fail containment, their contribution to LRF was calculated considering:

- Insights from DARA-L2P (e.g., accident progression, phenomenological failures of containment);
- Random failure of containment; and
- Seismically induced failure of containment.

The evaluation of the robustness of containment response to seismic events was performed, based on examination of the limiting fragilities (i.e., those SSCs with the least seismic capacity in seismic events) for the containment system components.

6.12 Level 2 High Wind Assessment

The Level 2 high wind assessment was performed using insights from the Level 2 At-Power Internal Events PSA. To estimate the LRF, the Level 1 and Level 2 Models were used with specific hazards added. This approach has the advantage that the fraction of each type of cutset (e.g. single unit, multi-unit) that leads to LRF are quantified directly with the logic developed from the Level 2 CETs and fault trees.

6.13 Non-Reactor Source PSA

While the hazard screening analysis had screened out all hazards associated with the UFDS facility, selected internal and external natural hazards for the fuel in the IFB were screened in. Bounding simplified quantitative assessments were used for the following hazards.

- Loss of heat sink and loss of inventory

- Earthquake
- External flooding
- Extreme temperature
- Snow / snowpack
- Freezing rain
- Ice storms
- Tornado / high winds
- Geomagnetic storm and solar flare
- Internal fires
- Internal flooding

An assessment of interactions between accident progressions in reactor units and IFB was also conducted.

7.0 SUMMARY OF RESULTS

7.1 Frequencies of Severe Core Damage and Large Release

The DARA study uses two measures to assess the acceptability of risk. These two measures correspond to the OPG safety goals:

- Frequency of severe core damage; and
- Frequency of large release.

Table 18 compares the results of the PSA studies described in Sections 5.0 and 6.0, with the OPG safety goals for individual hazards on a per-unit basis.

OPG has both safety goals and administrative goals. The safety goal represents the limit of tolerability of risk exposure above which action shall be taken to reduce risk. The administrative safety goal represents the desired objective towards which the facility should strive to the extent practicable.

The results in Table 18 show that the severe core damage frequency results for individual hazards is below the OPG Safety Goal of 1E-04 per reactor-year. Moreover, most of the severe core damage frequency results are below the OPG Administrative Safety Goal target of 1E-05 per reactor-year. Similarly, the large release frequency results are below the OPG Safety Goal of 1E-05 per reactor-year, with most of the results being below the OPG Administrative Safety Goal of 1E-06 per reactor-year.

The internal events PSAs assess the full range of fuel damage and release categories defined in Table 10. The frequencies of fuel damage categories for the at-power internal events PSA (DARA-L1P) is presented in Table 19. The results in Table 19 show that failure to shutdown is a negligible contributor to severe core damage frequency. The frequency of fuel damage for outage internal events (DARA-L1O) by POS is presented in Table 20. The outage results in Table 18 show that the risk is below the OPG Administrative Safety Goal.

As described in Section 6.1, the fuel damage categories used as end states in the Level 1 PSA are partitioned into PDSs to use as inputs into the Level 2 PSA. Table 21 presents the frequencies of the PDSs, and Table 22 presents the results of DARA-L2P.

7.2 Conclusions

The PSA for the Darlington NGS (DARA) is performed in accordance with CNSC Regulatory Document REGDOC-2.4.2, Probabilistic Safety Assessment (PSA) for Nuclear Power Plants. The 2020 DARA update uses methodologies for which upfront CNSC's acceptance had been obtained. It addresses Level 1 and Level 2 PSA aspects for various internal and external events, for both at-power and outage operating conditions, including internal events, internal fire, internal flood, seismic, high winds, non-reactor sources, as well as an external and internal hazard screening assessment.

The 2020 DARA results demonstrate that the Darlington station satisfies OPG's safety goal for all internal and external hazards considered, and hence represents very low public risk. OPG continues to meet industry good practices through periodic PSA updates to account for operating experience, improvements in analysis methods, and changes at the station.

8.0 REFERENCES

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Figure 1: Site Area

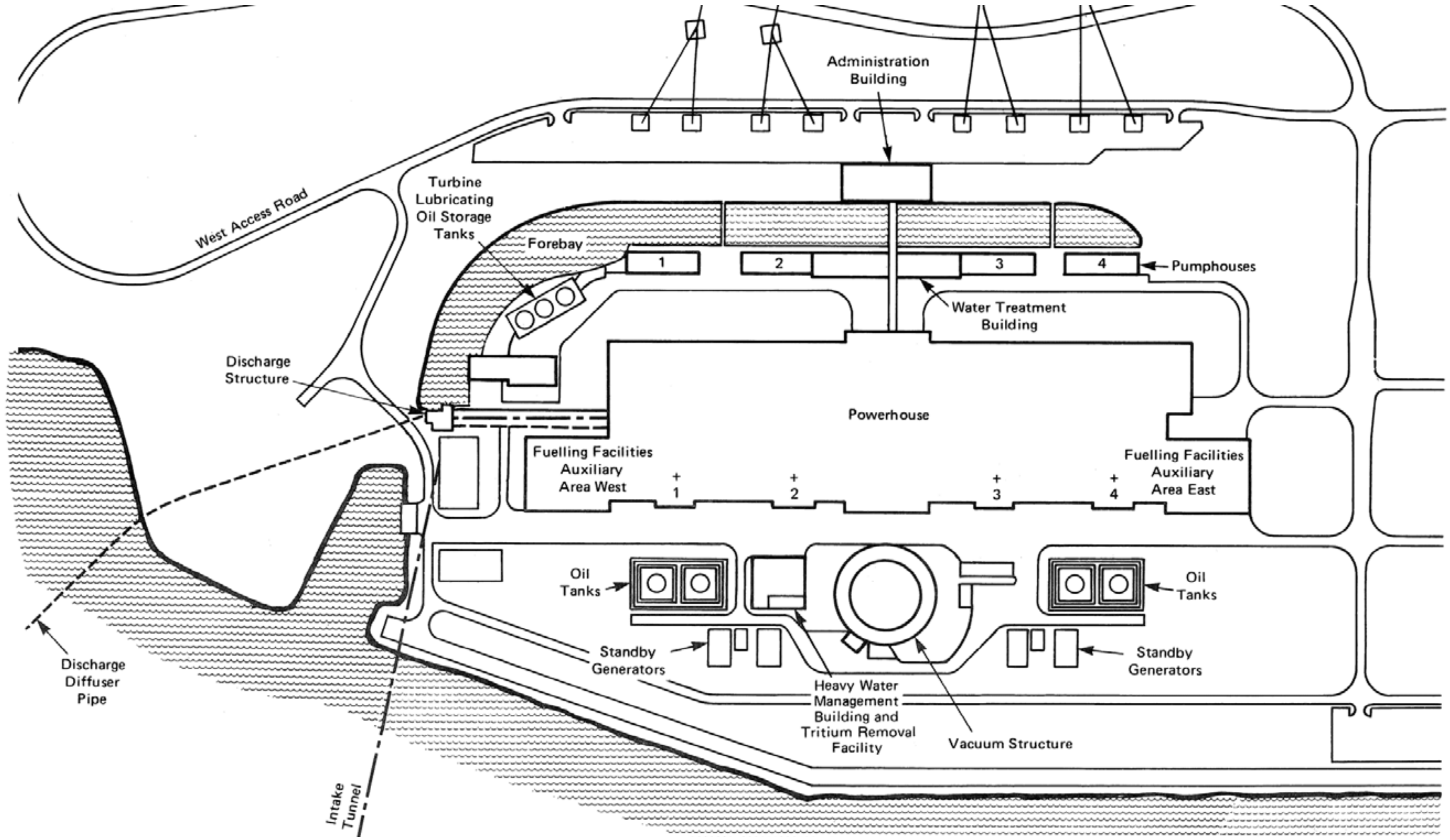
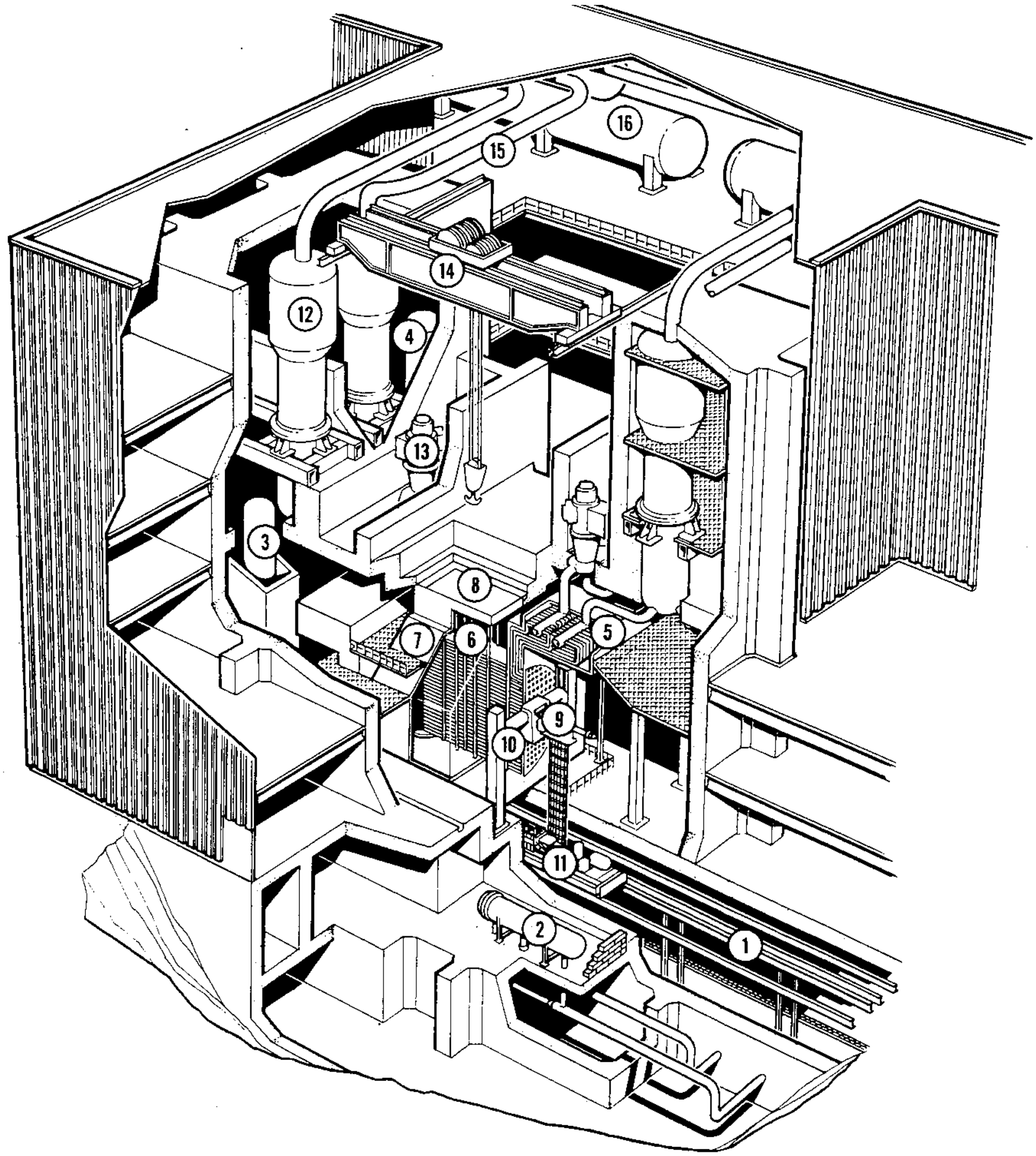


Figure 2: Darlington Station General Arrangement



20000 0005:1

1 Fuelling Duct
2 Shutdown Cooling Heat Exchanger
3 Pressurizer
4 Heavy Water Storage Tank
5 Feeder Cabinet
6 Calandria
7 Shield Tank
8 Reactivity Mechanism Deck
9 Fuelling Machine Head
10 Fuelling Machine Bridge Column
11 Fuelling Machine Transport Trolley
12 Steam Generator
13 Heat Transport Pump
14 Bridge Crane
15 Main Steam Line
16 Deaerator

Figure 3: Darlington NGS Reactor Building

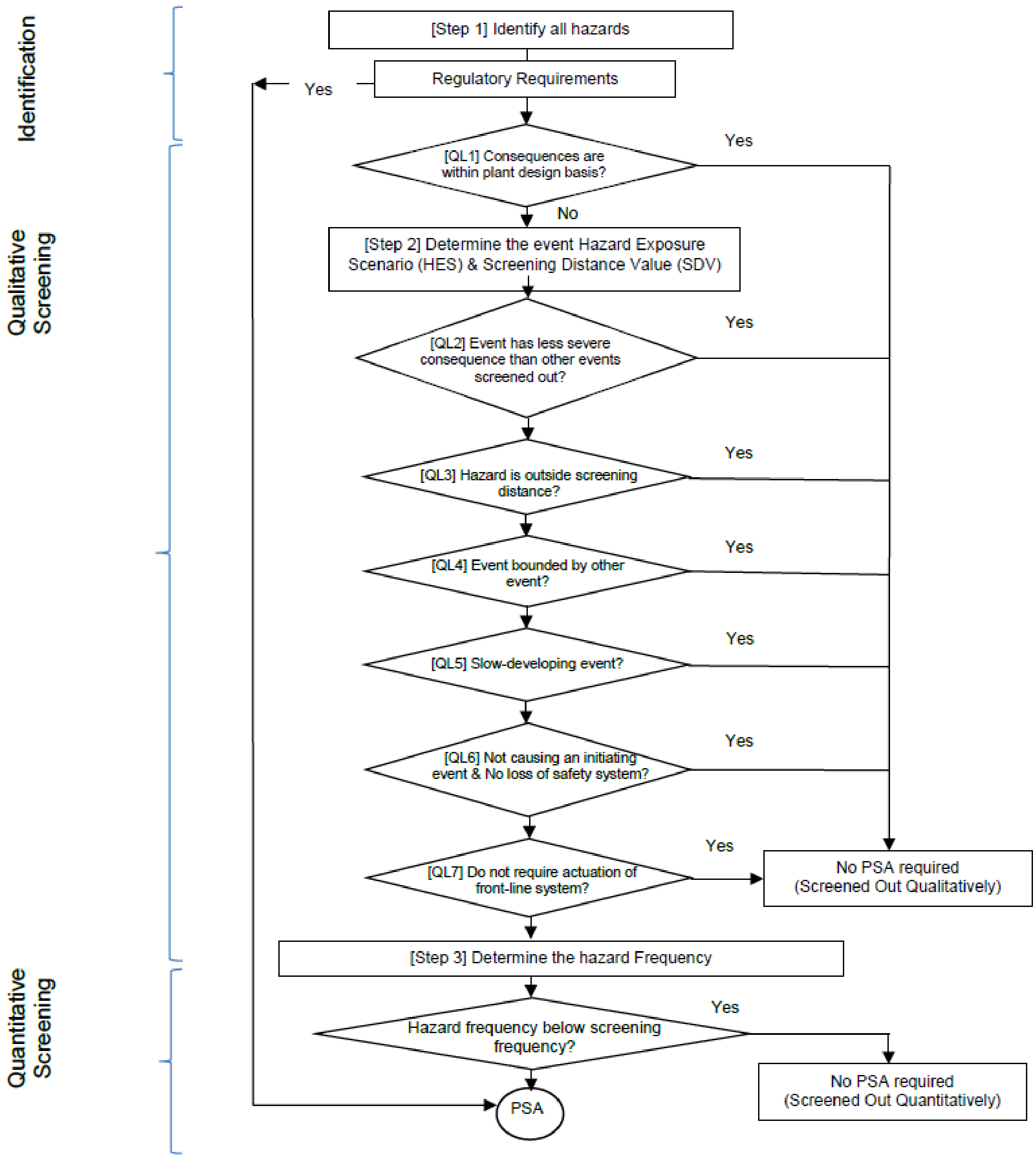


Figure 4: Hazard Screening Steps

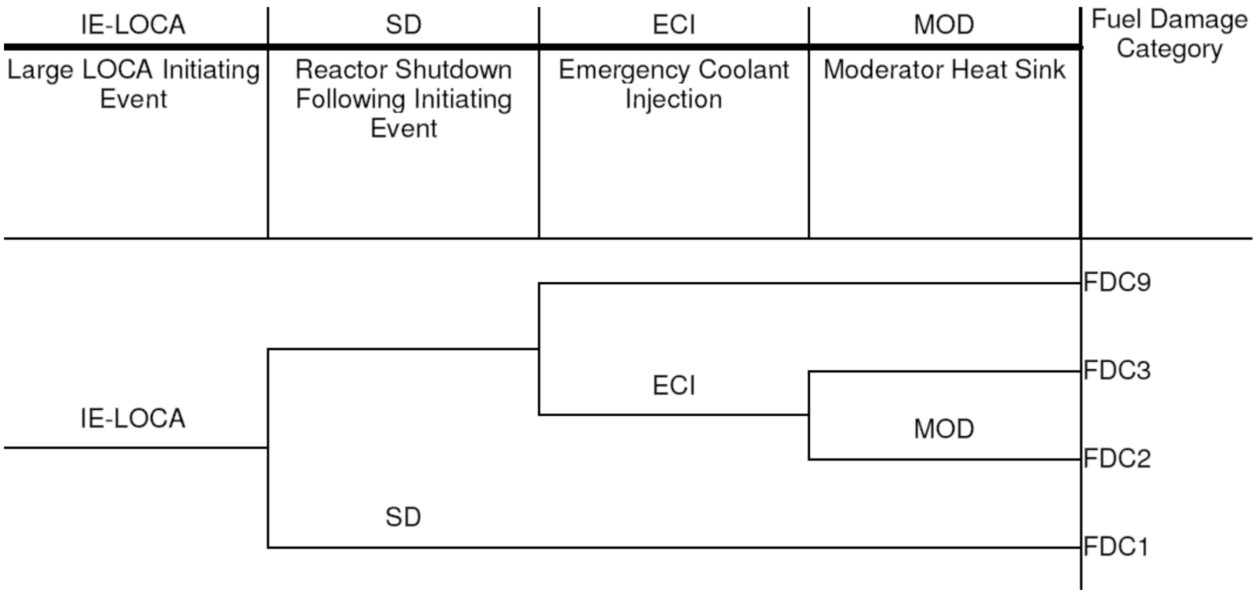


Figure 5: Example LOCA Event Tree

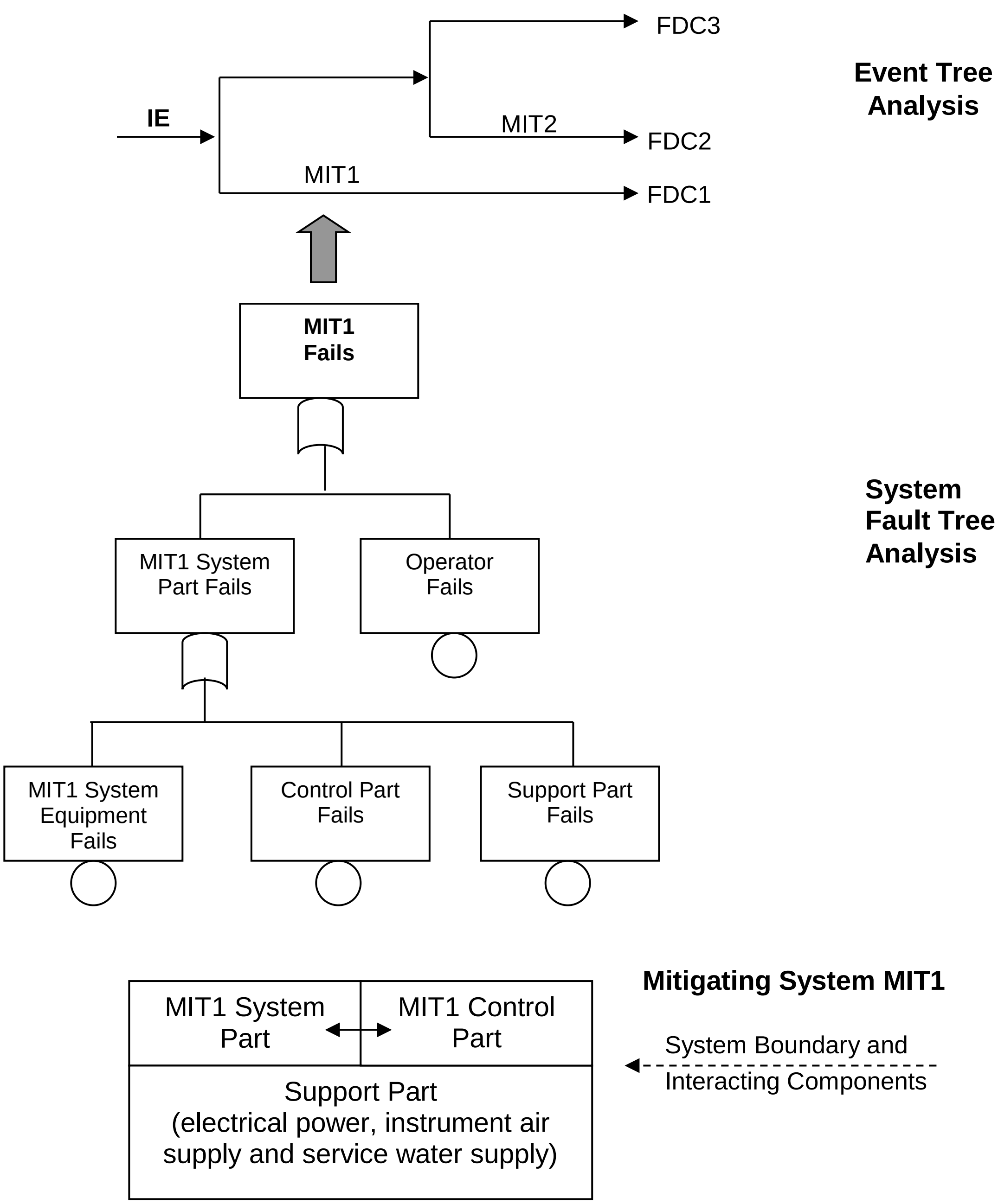


Figure 6: Fault Tree and Event Tree Integration

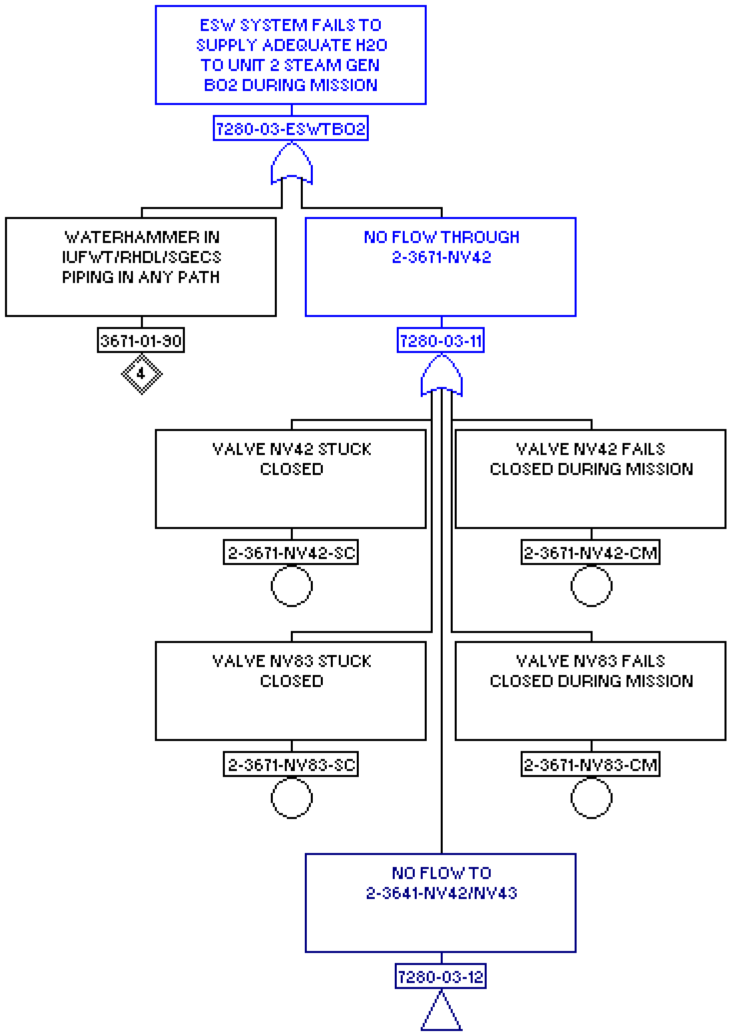


Figure 7: Example Fault Tree

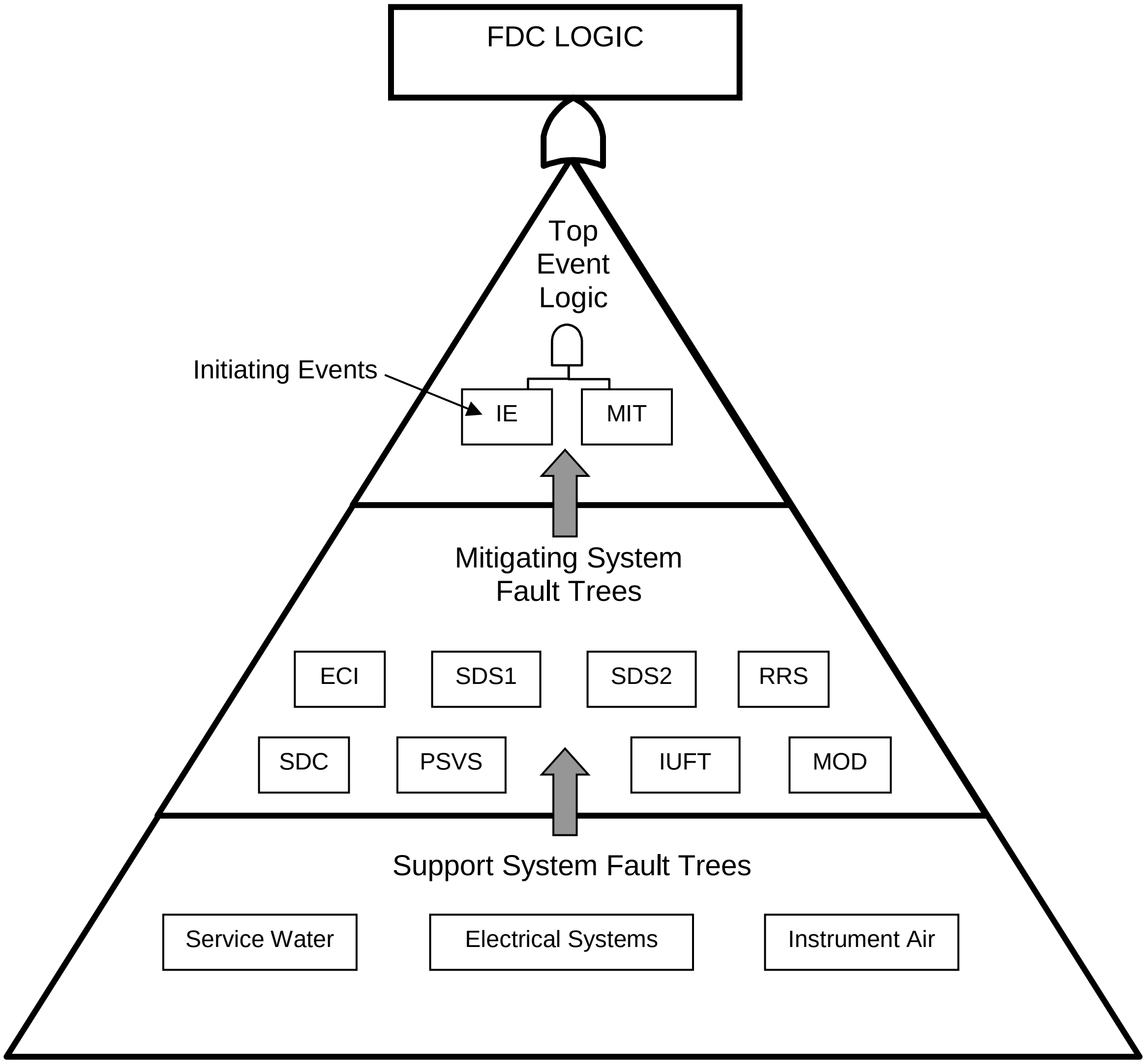


Figure 8: Fault Tree Integration

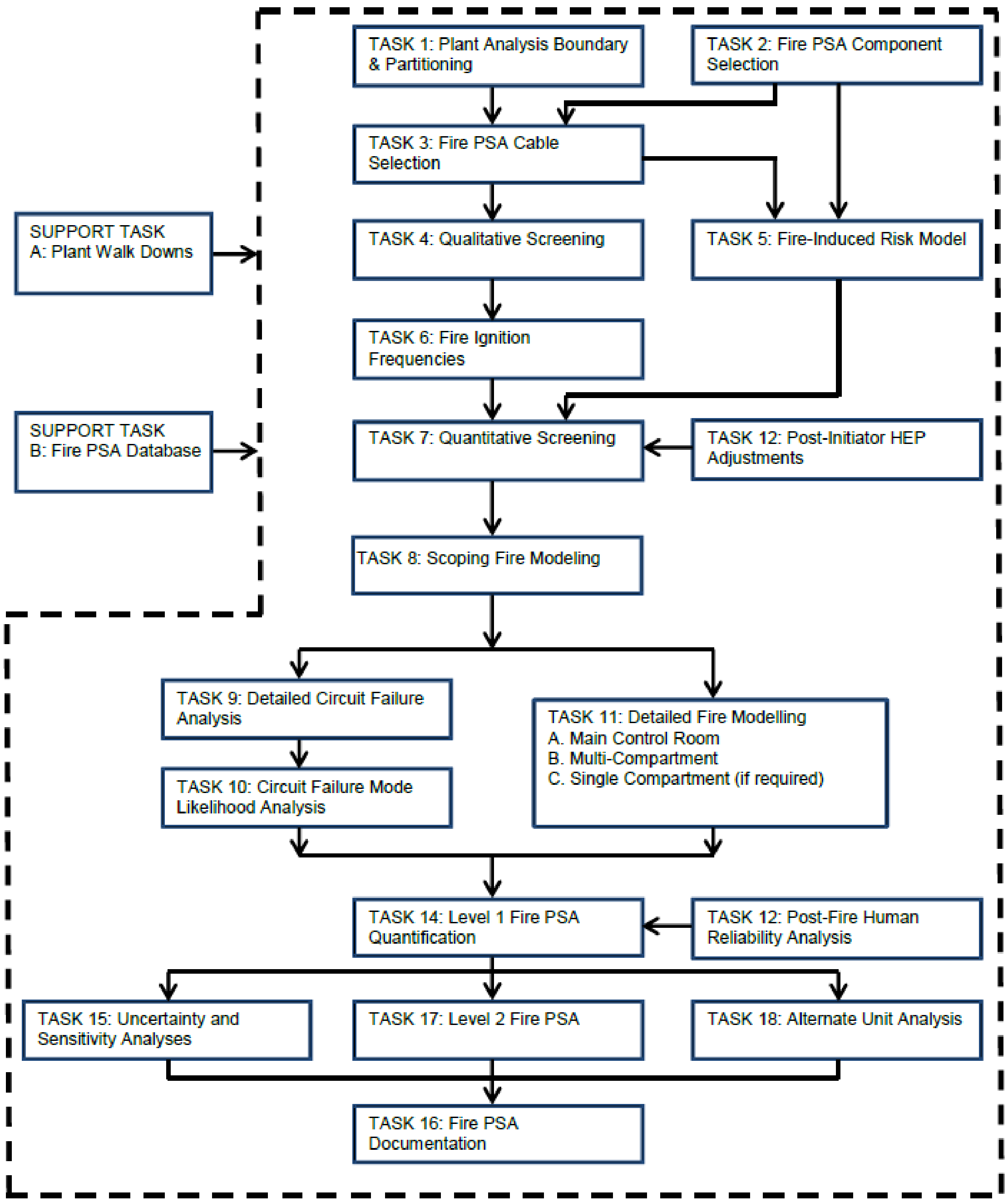


Figure 9: Fire PSA Tasks

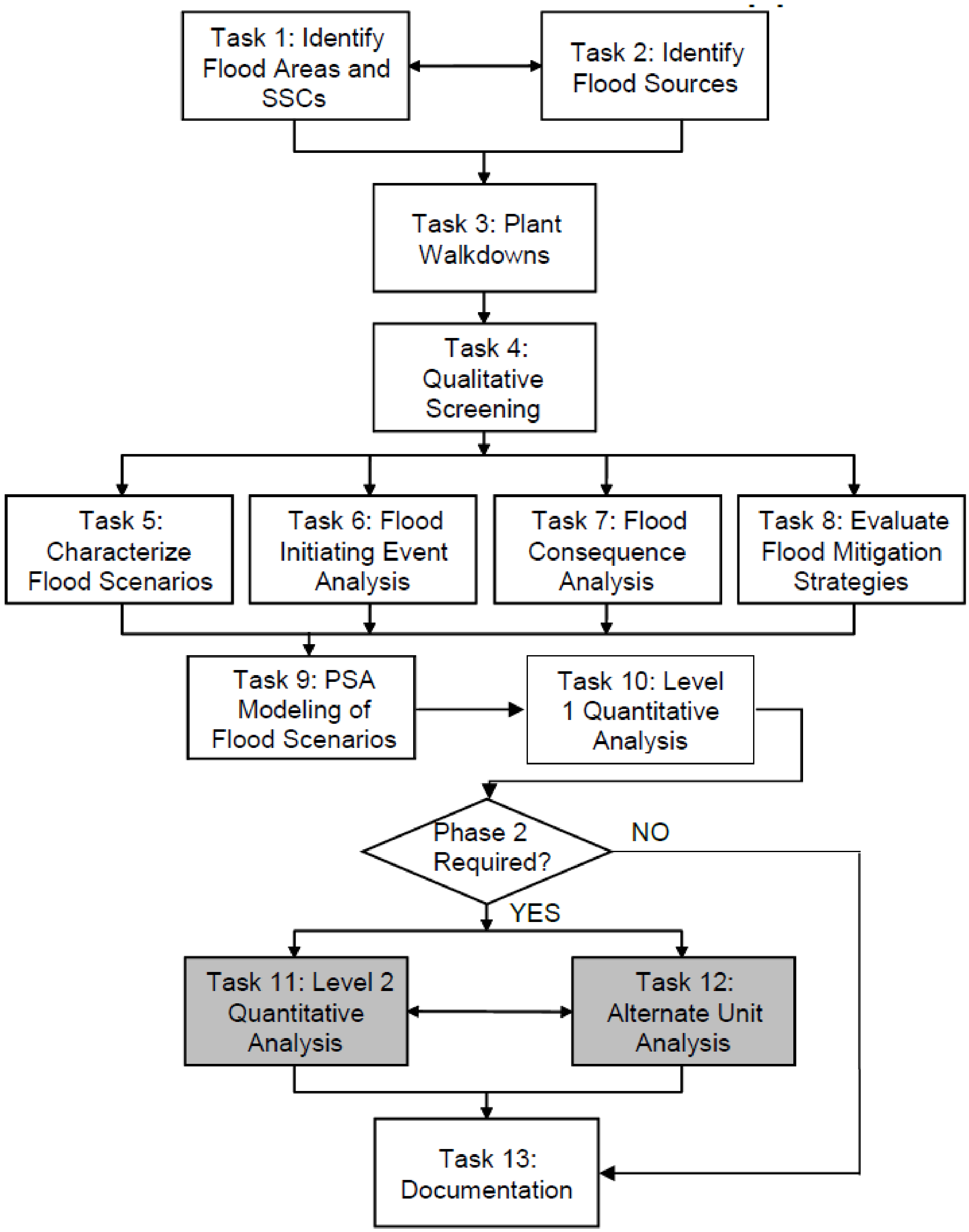


Figure 10: Internal Flood Phase 1 Tasks

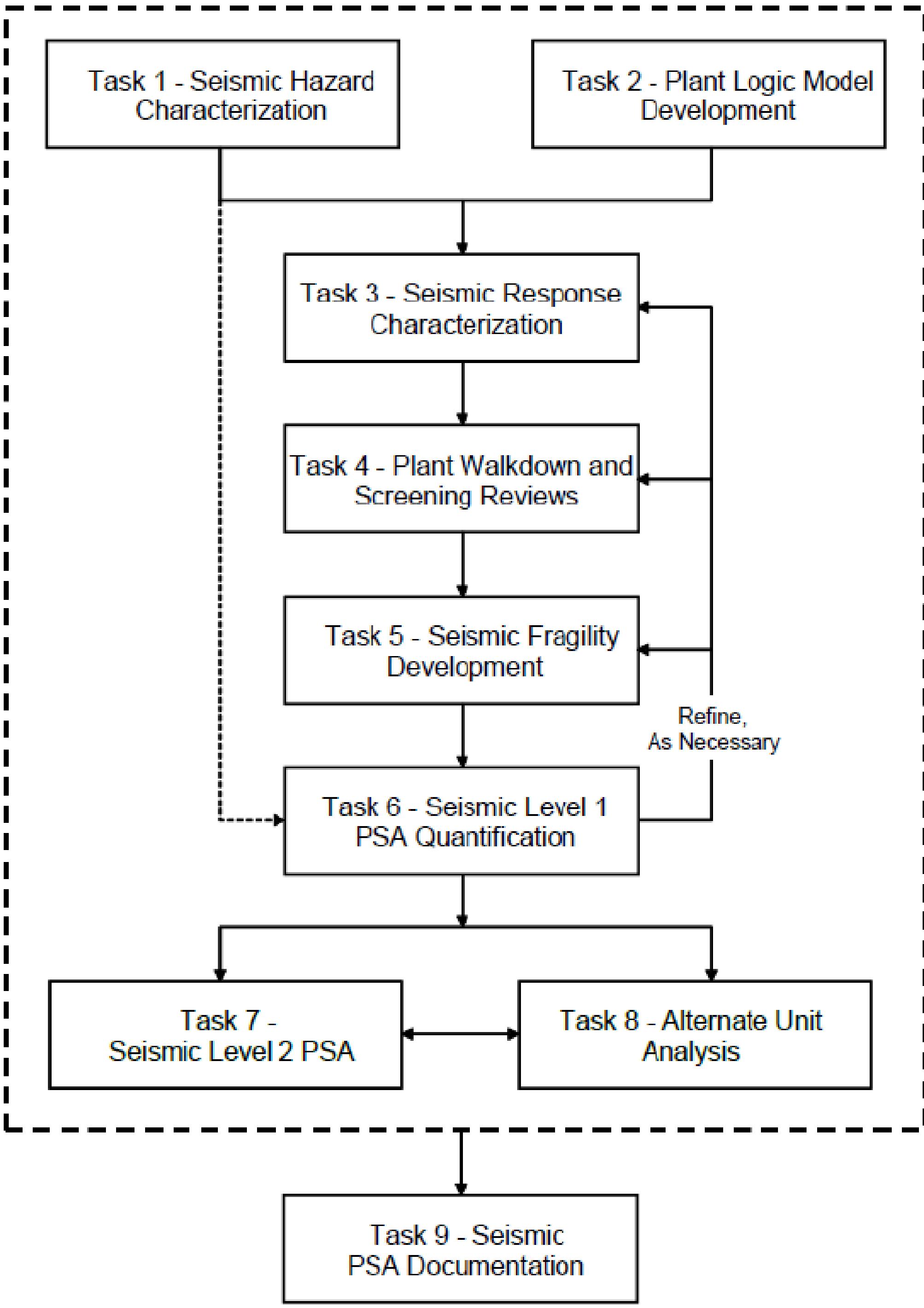


Figure 11: Seismic PSA Tasks

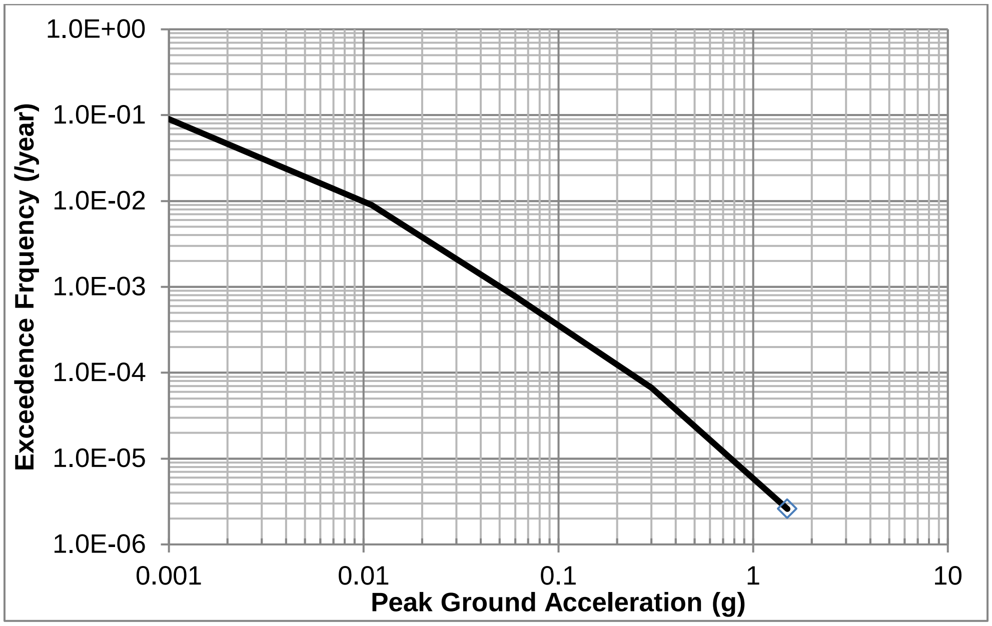


Figure 12: Example Seismic Hazard Curve

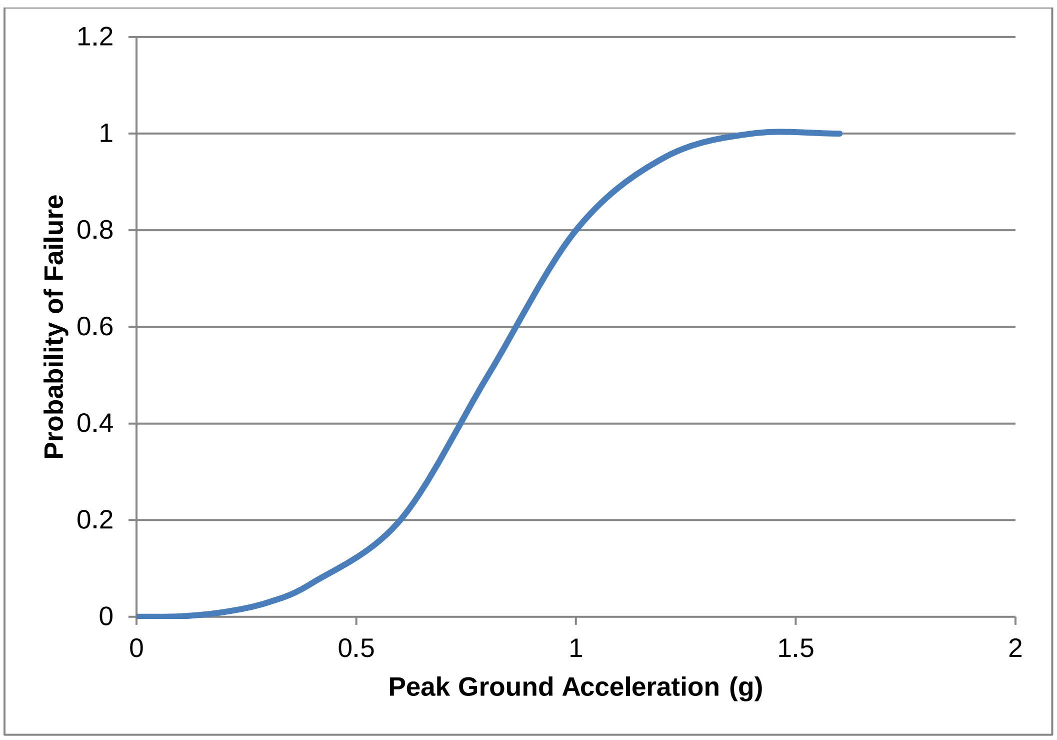


Figure 13: Example Fragility Curve

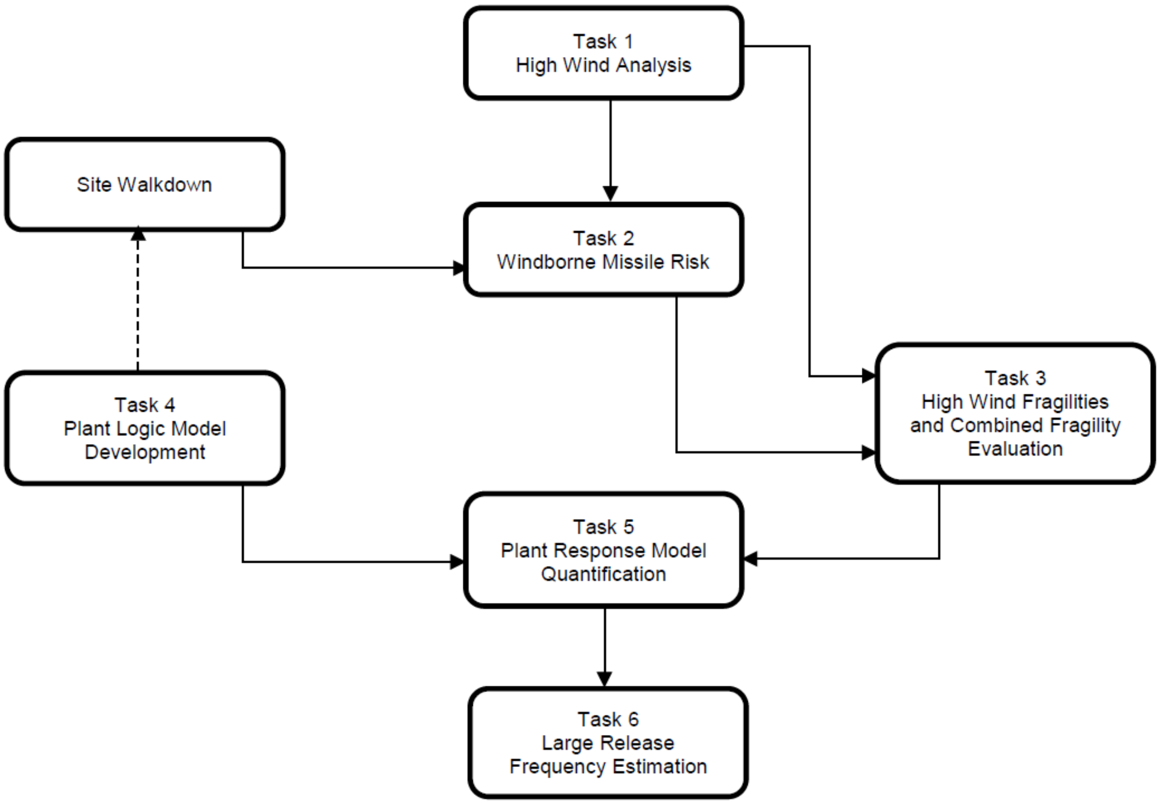


Figure 14: Overall OPG High Wind PSA Method

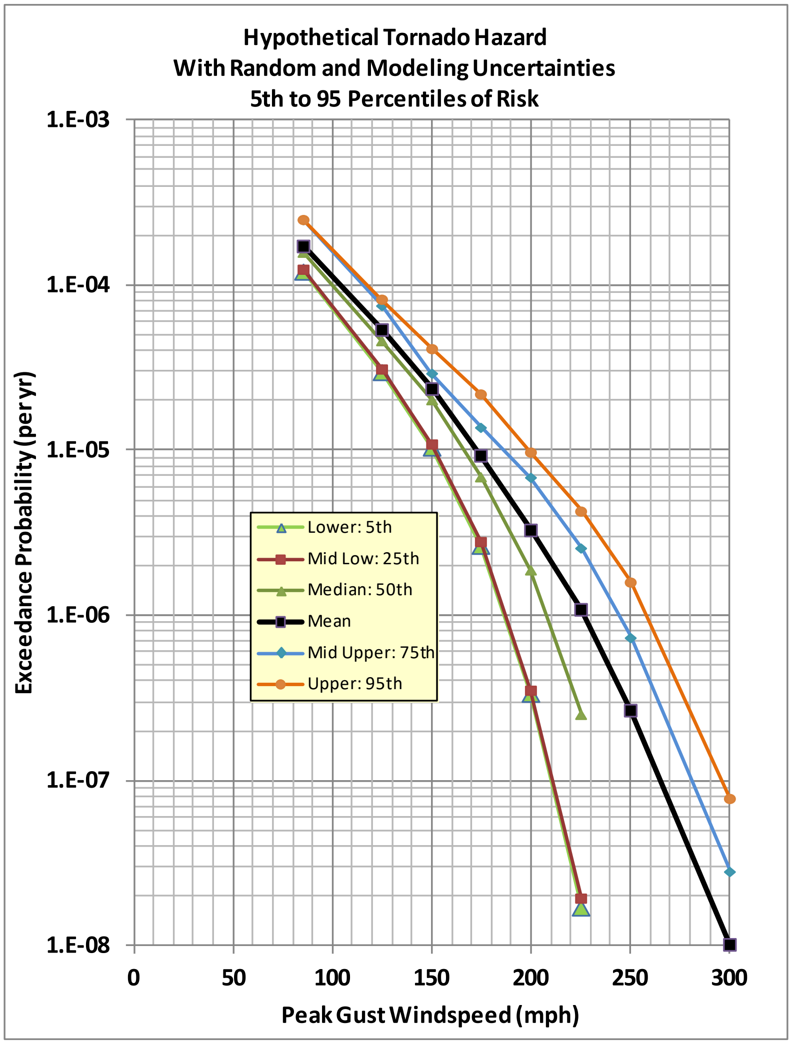


Figure 15: Example of High Wind Hazard Curves

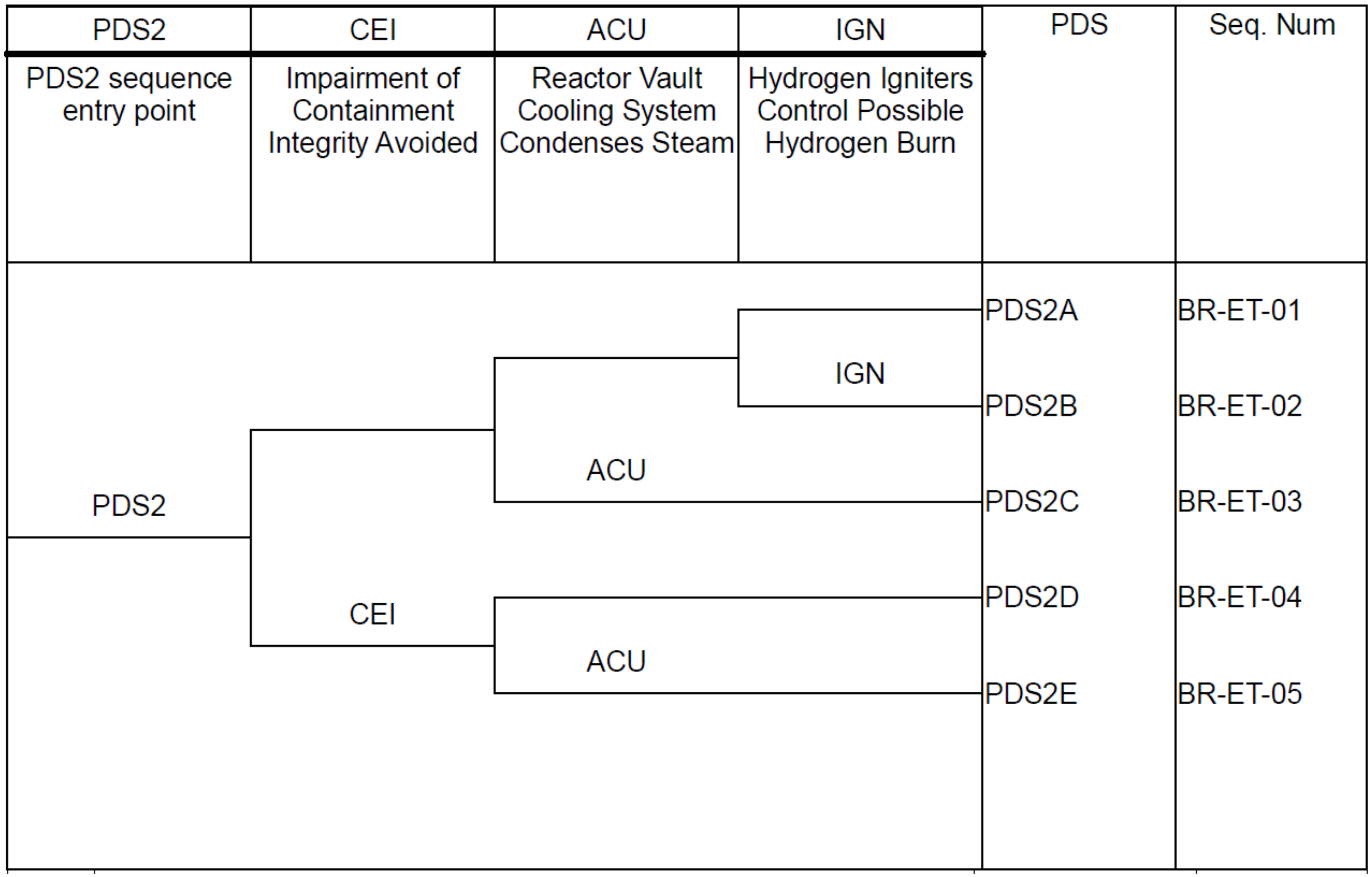


Figure 16: Darlington NGS Bridging Event Tree

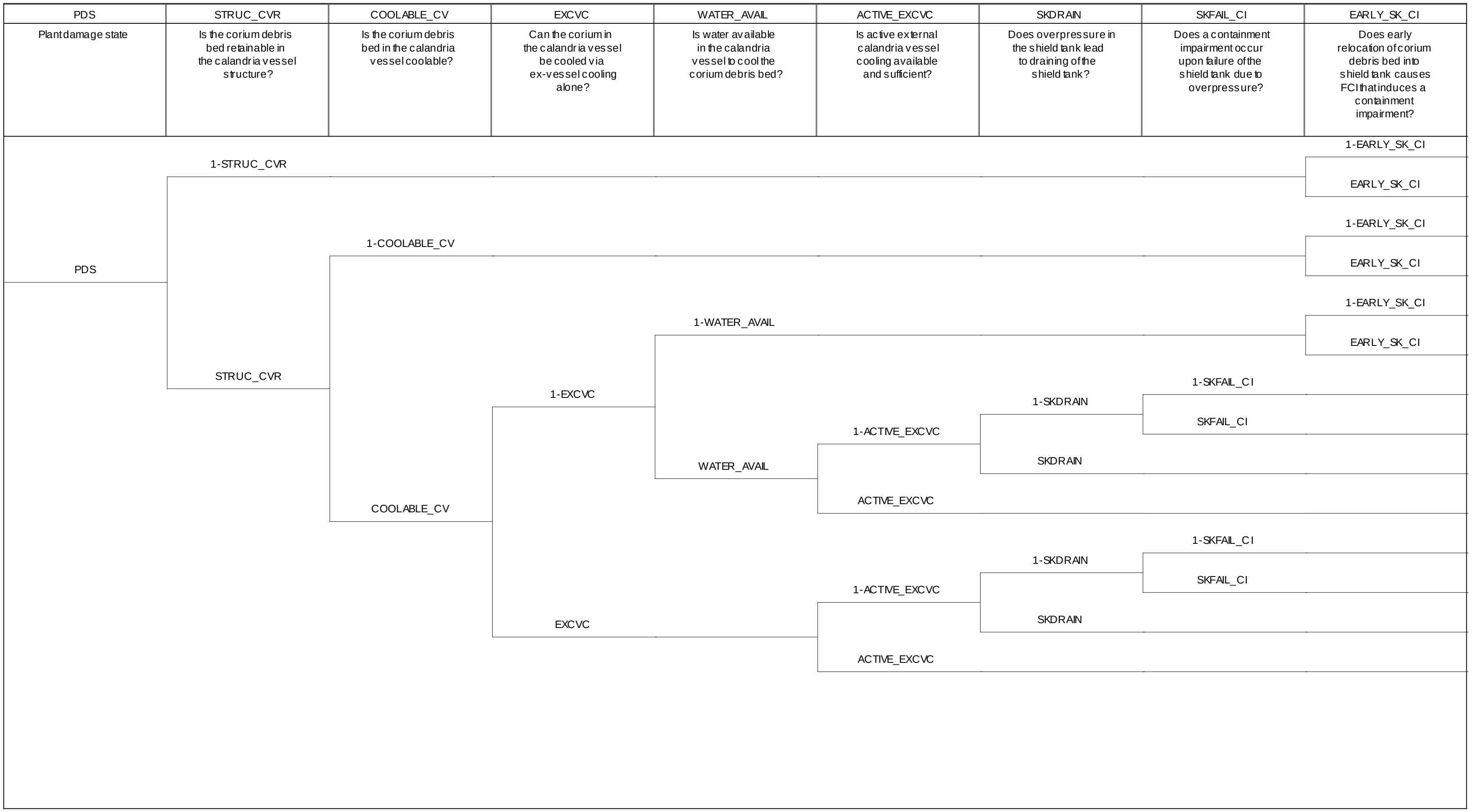


Figure 17: Simplified Containment Event Tree

Table 1: OPG Safety Goals

CRITERIA	AVERAGE RISK (PER YEAR)	
	Administrative Safety Goal	Safety Goal
Severe Core Damage (per unit)[1]	10^{-5}	10^{-4}
Large Release (per unit)[2]	10^{-6}	10^{-5}

[1] Severe Core Damage is the loss of core structural integrity.

[2] Large Release is a release greater than 1E14 Bq of Cs-137. OPG's Safety Goals are described in Reference [R-4].

Table 2: Quantitative Hazard Screening Criteria

Criteria	Description	Direct Containment Bypass or Failure (Note)	Applicability of Screening Criteria to Reactor and/or Non-Reactor Sources
QN1	SCDF < 10^{-6}/yr	No	QN-1 and QN-2 apply only to the reactor sources and not to the non-reactor sources
QN2	Design Basis Hazard Frequency, < 10^{-5}yr and CCDP < 0.1	No	
QN3	SCDF < 10^{-7}/yr	Yes	This QN applies to the reactor sources only. An equivalent QN for non-reactor sources of LRF < 10^{-7}/yr will be considered
QN4	Design Basis Hazard Frequency, < 10^{-6}/yr and CCDP < 0.1	Yes	This QN applies to the reactor sources only. An equivalent QN for non-reactor sources will be considered as follows: Design Basis Hazard Frequency, < 10^{-6}/yr and conditional large release probability (CLRP) < 0.1
QN5	IE or Hazard may be screened out if can be shown that their frequency is < 10^{-7} year.	Not Applicable	This QN applies to both the reactor and the non-reactor sources.

Note: "Direct Containment Bypass or Failure" implies that the conditional large release probability (CLRP) is equal to or very close to 1.0, as a result of the hazard's impact on the plant.

Table 3: Summary of Criteria Applied for Screening of Human-Induced External Hazards for Reactor Sources

Human-Induced Hazard Description	Screening
Small Airplane Crash	Screened out
Military Jet Crash	Screened out
Large Airplane Crash	Screened out
Train Accidents causing Toxic Chemical Release	Screened out
Train Accidents causing Explosion	Screened out
Road Transportation Accidents	Screened out
Small Marine Transportation Accidents	Screened out
Large Marine Transportation Vessels Accidents	Screened out
Stationary Nuclear Accidents	Screened out
Stationary Non-Nuclear Accidents causing Toxic Chemical Release	Screened out
Stationary Non-Nuclear Accidents causing Explosions	Screened out
Industrial Underground Blasts	Screened out
Industrial Dusts	Screened out
External Fires	Screened out
Orbital Debris Crash	Screened out

Table 4: Summary of Criteria Applied for Screening of Natural Hazards for Reactor Sources

Natural Hazard Description	Screening
Earthquake	Screened in
Slope Instability	No Hazard
Subsidence	No Hazard
Soil Failure	No Hazard
Probable Maximum Flood (PMF)	Screened out
Floods due to Runoffs	Screened out
Floods due to Rivers	No Hazard
Floods due to Waves	Screened out
Floods due to Seiche	No Hazard
Floods due to Tsunami	No Hazard
Floods due to Ponds and Dams	No Hazard
Floods due to Ice-Jamming	Screened out
Extreme Temperatures	Screened In
Snow/Snowpack	Screened out
Freezing Rain	Screened out
Avalanche	No Hazard
Ice Storm	Screened out (Impact on Class III) Screened in (Impact on PSVS)
Tornado/ High Wind / Hurricane	Screened in
Lightning	Screened out
Meteorites	Screened out
Geomagnetic Storms and Solar Flares	Screened in
Animals	Screened out

Table 5: Summary of Criteria Applied for Screening of Human-Induced External Hazards for Non-Reactor Sources - IFB

Human-Induced External Hazard	Screening
Large Aircraft Impact	Screened Out
Small Aircraft Impact	Screened Out
Train Accidents causing Explosion	Screened Out
Train Accidents causing Toxic Chemical Release	Screened Out
Road Transportation and Traffic Accidents	Screened Out
Marine Transportation Hazards	Screened Out
Stationary Nuclear Accident Stationary Non-Nuclear Accidents causing Toxic Chemical Release Stationary Non-Nuclear Accidents causing Explosions)	Screened Out
Industrial Underground Blasts Industrial Dusts	Screened Out
External Fires	Screened Out
Orbital Debris Crashes	Screened Out

Table 6: Summary of Criteria Applied for Screening of Natural Hazards for Non-Reactor Sources – IFB

Natural Hazard Description	Screening
Earthquake	Screened in
Slope Instability	No Hazard
Subsidence	No Hazard
Soil Failure	No Hazard
Probable Maximum Flood (PMF)	Screened In
Floods due to Runoffs	Screened out
Floods due to Rivers	No Hazard
Floods due to Waves	Screened out
Floods due to Seiche	No Hazard
Floods due to Tsunami	No Hazard
Floods due to Ponds and Dams	No Hazard
Floods due to Ice-Jamming	Screened out
Extreme Temperatures	Screened In
Snow/Snowpack	Screened In
Freezing Rain	Screened In
Avalanche	No Hazard
Ice Storm	Screened In
Tornado/ High Wind / Hurricane	Screened in
Lightning	Screened out
Meteorites	Screened out
Geomagnetic Storms and Solar Flares	Screened in
Animals	Screened out

Table 7: Summary of Criteria Applied for Screening of Human-Induced External Hazards for Non-Reactor Sources - UFDS

Human-Induced External Hazard	Screening
Large Aircraft Impact	Screened Out
Small Aircraft Impact	Screened Out
Train Accidents causing Explosion	Screened Out
Train Accidents causing Toxic Chemical Release	Screened Out
Road Transportation and Traffic Accidents	Screened Out
Marine Transportation Hazards	Screened Out
Stationary Nuclear Accidents Stationary Non-Nuclear Accidents causing Toxic Chemical Release Stationary Non-Nuclear Accidents causing Explosions	Screened Out
Industrial Underground Blasts Industrial Dusts	Screened Out
External Fires	Screened Out
Orbital Debris Crashes	Screened Out

Table 8: Summary of Criteria Applied for Screening of Natural Hazards for Non-Reactor Sources – UFDS

Natural Hazard Description	Screening
Earthquake	Screened Out
Slope Instability	No Hazard
Subsidence	No Hazard
Soil Failure	No Hazard
Probable Maximum Flood (PMF)	Screened out
Floods due to Runoffs	Screened out
Floods due to Rivers	No Hazard
Floods due to Waves	Screened out
Floods due to Seiche	No Hazard
Floods due to Tsunami	No Hazard
Floods due to Ponds and Dams	No Hazard
Floods due to Ice-Jamming	Screened out
Extreme Temperatures	Screened Out
Snow/Snowpack	Screened out
Freezing Rain	Screened out
Avalanche	No Hazard
Ice Storm	Screened out
Tornado/ High Wind / Hurricane	Screened out
Lightning	Screened out
Meteorites	Screened out
Geomagnetic Storms and Solar Flares	Screened out
Animals	Screened out

Table 9: Darlington At-Power Internal Events PSA Initiating Events

Category	Label	Description
Forced Shutdown	FSD	All reactor trips not included in other initiating events
LOCA	LOCA1A LOCA1A-OC	A rupture within the capacity of the D_2O transfer system and above the lower LOCA threshold (discharge rate 1-12 kg/s) (discharge rate 1-12 kg/s outside containment)
	LOCA1B LOCA1B-OC	A rupture within the capacity of the D_2O feed pump but beyond that of the D_2O transfer system (discharge rate 12-40 kg/s) (discharge rate 12-40 kg/s outside containment)
	LOCA1C	A rupture within the capacity of two D_2O feed pumps but beyond the capacity of one D_2O feed pump (discharge rate 40-70 kg/s)
	LOCA2A LOCA2B	Small breaks within the capacity of the auxiliary moderator heat sink (break discharge rate 70-220 kg/s) Small breaks (discharge rate 220-1000 kg/s)
	LOCA3	Transition breaks. Partial breaks which exhibit system response characteristics in between those of small and large breaks (initial discharge rate 1000-2000 kg/s)
	LOCA4	Large breaks which lead to significant flow degradation in the core (initial discharge rate >2000 kg/s)
	LOCATOP	A LOCA2 size break in HT piping connected to the top of the pressurizer
	LOCA1-SF	Stagnation feeder break in LOCA1 range
	LOCA2-SF	Stagnation feeder break in LOCA2 range
	LOCA2-SDC	A LOCA2 size break in the PHT-SDC interface piping inside an SDC room
Pressure Tube Rupture	PTF	Pressure tube break resulting in a discharge rate in excess of 1 kg/s
Pressure Tube Leak	PTL	Pressure tube break resulting in a discharge rate of less than 1 kg/s
End-fitting Failure	EFL1WAGA	LOCA1A size break inside annulus gas bellows
	EFL1WAGB	LOCA1B size break inside annulus gas bellows
	EFL1WAGC	LOCA1C size break inside annulus gas bellows
	EFL1OAGA	LOCA1A size break outside annulus gas bellows
	EFL1OAGB	LOCA1B size break outside annulus gas bellows
	EFL1OAGC	LOCA1C size break outside annulus gas bellows
	EFL1FMIA	LOCA1A size break involving the fuelling machine
	EFL1FMIB	LOCA1B size break involving the fuelling machine
	EFL1FMIC	LOCA1C size break involving the fuelling machine
	EFL2WAG	LOCA2 size break inside annulus gas bellows
	EFL2OAG	LOCA2 size break outside annulus gas bellows
	EFL2FMI	LOCA2 size break involving the fuelling machine
Steam Generator Tube Rupture	SGTB1	SG single tube break (initial discharge rate 1 kg/s – 12 kg/s)
	SGTB2	SG multiple tube break (>12 kg/s)
Loss of HT Pressure Control (Low)	LRVO	One or more liquid relief valves fail open (base event)
	FVFC	Both D_2O feed valves fail closed (base event)

Category	Label	Description
	SBVO	Any pressurizer steam bleed or relief valve fails open
Loss of HT Pressure Control (High)	PHFO	Pressurizer heaters energized spuriously
	BVFC	Both HT bleed valves fail closed
	FVFO	Any D_2O feed valve fails open
	FP2S	Inadvertent start-up of inactive feed pump
	BCLCVFC	Bleed condenser level control valves fail closed
	PSBVFC	Pressurizer steam bleed valves fail closed when required open
HT Pressure and Inventory Control Failures	D2OFDL	Pipe break in D_2O feed system upstream of check valve NV61
	FBSICL	Feed/bleed system pipe break inside containment
	XSPR	Bleed condenser spray valve CV12 opens spuriously
HT Pump Trip	HTPT1	Pump trip in 2/2 mode
Channel Flow Blockage	LFB	Channel flow reduced by 70% or more
Moderator Failure	LOCOOL	Loss of moderator cooling resulting in setback
	SLOMA	Loss of moderator inventory within capacity of moderator D_2O recovery system (discharge rate 1-70 kg/s)
	LLOMA	Loss of moderator inventory beyond capacity of moderator D_2O recovery system (discharge rate >70 kg/s)
Loss of End Shield Cooling	LOESHS	Loss of end shield heat sink
	LOESF	Total loss of end shield flow
	LOESI1	Non-isolable pressure boundary rupture
	LOESI2A	Rupture upstream of V15/16 where isolation leads to loss of circulation
	LOESI2B	Rupture upstream of V15/16 where isolation does not lead to loss of circulation
Steam Line Break	SSLB1	Small break that requires reactor shutdown but does not cause global harsh environment
	SSLB3	A Feedwater Line Break downstream of the last check valve before the steam generator (assumed to be in SG1 flowpath)
	100SBH-ADJN	100% Steam Balance Header (SBH) Break in a unit adjacent to the analyzed unit, North of Column Line 11 with potential for in-plant environmental consequences
	100SBH-U3	Unit 3 100% Steam Balance Header Break in a unit remote to the analyzed unit, North of Column Line 11 with potential for in-plant environmental consequences
	100SBH-U4	Unit 4 100% Steam Balance Header Break in a unit remote to the analyzed unit, North of Column Line 11 with potential for in-plant environmental consequences
	100SBH-U2N	Unit 2 100% Steam Balance Header Break, North of Column Line 11 with in-plant environmental consequences
	SRV	Any ISRV, ASDV or CSDV opens spuriously
Loss of Feedwater to Steam Generators	LOFWB	LOFW resulting in reactor trip but greater than 3% full flow remains
	LOFWC	LOFW to less than 3% full flow
Feedwater Line Break	SFLB1	Break resulting in reactor shutdown but with sufficient water remaining to remove decay heat

Category	Label	Description
	100LFB-ADJN	100% Feedwater Line Break in an Adjacent Unit, North of Column Line 11
	100FLB-U3	Remote Unit (Unit 3) 100% Feedwater Line Break, North of Column Line 11
	100FLB-U4	Remote Unit (Unit 4) 100% Feedwater Line Break, North of Column Line 11
	100FLB-U2N	Unit 2 100% Feedwater Line Break, North Column Line 11, Causing Total Loss of Feedwater
	100FLB-U2S	Unit 2 100% Feedwater Line Break, South of Column Line 11, Causing Total Loss of Feedwater
	FLBSG	Isolable break downstream of LCVs resulting in total loss of feedwater to one steam generator (assumed to be in SG1 flowpath)
	FLBCOND1	Break in condensate system resulting in total loss of feedwater
Turbine Trip	TT	All turbine trips not included in other initiating events
Loss of Condenser Vacuum	LOVAC	Loss of condenser vacuum resulting in turbine trip
High Pressure Reheater Drains Line Break to Steam Generator	RDLB	Break in lines between steam generators and second check valve (assumed to be in SG1 flowpath)
Loss of Condensate Flow	LOCOND	Total loss of condensate flow to deaerator
Unplanned Bulk Increase in Reactivity	UFBIR	Unplanned fast (>0.2 mk/s) bulk increase in reactivity
	USBIR	Unplanned slow (<0.2 mk/s) bulk increase in reactivity
Unplanned Regional Increase in Reactivity	URIR	Local neutron overpower
Loss of Computer Control	WDTOX	Controlling computer stall
	DCCF	Dual computer failure
	DCCUF	Unsafe failure of DCC leading to reactor power increase
	HTPF SGLCF SGPCF MTCF DLCF	Failure 'off' of an individual control program on both computers
Loss of Low Pressure Service Water System	LOLPSW	Total loss of LPSW flow out of header L205
	LOPH	Loss of flow to pumphouse
	LOTH	Loss of flow to turbine hall
Loss of Recirculated Cooling Water System	LORCW	Total loss of RCW flow
Loss of Powerhouse Upper Level Service Water	LOPULSW	Total loss of PULSW flow
Loss of Instrument Air	TLOIA	Total loss of instrument air out of line L17
Loss of Cooling to F/M in Transit	LOFMCIT	Loss of cooling to fuelling machine in transit
Loss of Bulk Electricity Supply	LOBES	Loss of Bulk Electrical Supply (BES)
Loss of Switchyard	LOSWYD	Loss of both switchyard buses BU1 and BU2
	LOCL4	Total loss of Unit Class IV 13.8 kV power

Category	Label	Description
Loss of Power to Unit Class IV 13.8 kV Bus	LOBU1 LOBU2 LOBU3 LOBU4	Loss of power to Unit Class IV 13.8 kV bus BU1 Loss of power to Unit Class IV 13.8 kV bus BU2 Loss of power to Unit Class IV 13.8 kV bus BU3 Loss of power to Unit Class IV 13.8 kV bus BU4
Partial Loss of Unit Class IV Power	FS1CB2 FS2CB2	Loss of Unit Class IV 13.8 kV buses BU1 and BU3 due to 1CB2 failing short Loss of Unit Class IV 13.8 kV buses BU2 and BU4 due to 2CB2 failing short
Partial Loss of Unit Class III Power	LOBU7 LOBU8	Loss of power to Unit Class III 4.16 kV bus BU7 Loss of power to Unit Class III 4.16 kV bus BU8
	LOBU13 LOBU14 LOBU15 LOBU16	Loss of power to Unit Class III 600 V bus BU13 Loss of power to Unit Class III 600 V bus BU14 Loss of power to Unit Class III 600 V bus BU15 Loss of power to Unit Class III 600 V bus BU16
Partial Loss of Unit Class II 120 V Power	LOBUA3 LOBUB3 LOBUC3	Loss of Unit Class II 120 V ac bus BUA3 Loss of Unit Class II 120 V ac bus BUB3 Loss of Unit Class II 120 V ac bus BUC3
Partial Loss of Unit Class II 45 V Power	LO45VA LO45VB LO45VC	Loss of Unit Class II 45 V dc at panel 2383-11 Loss of Unit Class II 45 V dc at panel 2859-21 Loss of Unit Class II 45 V dc at panel 3485-C1
Partial Loss of Unit Class I 48 V Power	LOBUA4 LOBUB4 LOBUC4 LOBUA141 LOBUB141	Loss of Unit Class I 48 V dc bus BUA4 Loss of Unit Class I 48 V dc bus BUB4 Loss of Unit Class I 48 V dc bus BUC4 Loss of Unit EPS 48 V dc bus BUA141 Loss of Unit EPS 48 V dc bus BUB141
Loss of Forebay	FOREBAY	Loss of Forebay leading to loss of Circulating Water System; may also lead to loss of Low Pressure Service Water and/or Emergency Service Water
ECI Blowback	BLOWBACK	Blowback of HTS D_2O at high pressure outside containment via ECI piping
Powerhouse Freeze	PHFREEZE	Spurious opening of powerhouse venting dampers during extreme cold outside condition.
ESW Blowback	ESW-BLBK	Blowback of HTS D_2O at high pressure outside containment via ESW piping

Table 10: DARA Fuel Damage Categories

FDC	Definition	Typical Events in FDC
1	Rapid loss of core structural integrity.	Positive reactivity transient and failure to shutdown.
2	Slow loss of core structural integrity.	Loss of coolant accident (LOCA) with failure of ECIS and failure of moderator heat sink.
3	Moderator required as heat sink in the short-term (< 1 hr after reactor trip).	LOCAs of LOCA2B size or greater and failures of ECIS on demand or during mission.
4	Moderator required as heat sink in the intermediate term (1 to 24 hr after reactor trip).	LOCAs of LOCA2A size or greater and failure of Emergency Coolant Recovery (ECR). Total loss of secondary side heat sink with ECI successful.
5	Moderator required as heat sink in the long-term (> 24 hr after reactor trip).	LOCA1 and failures of D_2O make up and ECR.
6	Temporary loss of cooling to fuel in many channels.	LOCA4.
7	Single channel fuel failure with sufficient release of steam or radioactivity to initiate automatic containment button-up.	In-core LOCA with end-fitting release End-fitting LOCA2B and fuel ejection. LOCA2A stagnation feeder break.
8	Single channel fuel failure with insufficient release of steam or radiation activity to initiate automatic containment button-up.	Large flow blockage (no end-fitting release). LOCA1 stagnation feeder break.
9	LOCAs with no fuel failure (ECIS successful); potential for significant economic impact.	LOCA2A, LOCA2B and LOCA3. LOCA1 with no D_2O makeup.

Table 11: List of Systems Modelled by Fault Trees

System Name	L1 At-Power	L1 Outage	Level 2 At-Power
Heat Transport Liquid Relief, Pressure and Inventory Control and D_2O Storage Systems	Y	Y	*
Heat Transport Circulation System And Heat Transport Pump Gland Seal LOCA	Y	Y	*
Shutdown Cooling System	Y	Y	*
Moderator System	Y	Y	*
Boiler Feedwater System	Y	Y	*
Condensate and Makeup Systems	Y	Y	*
Steam Generators Emergency Cooling System	Y	Y	*
Steam Relief and Bypass System	Y	Y	*
Digital Control Computer System	Y	Y	*
OH180 Programmable Controller and PK Buffer System	Y	N	*
Class IV Power Distribution System	Y	Y	*
Class III Power Distribution System	Y	Y	*
Class II Power System	Y	Y	*
Class I Power System	Y	Y	*
Emergency Power Supply System	Y	Y	*
Standby Generators	Y	Y	*
Emergency Power Generators System	Y	Y	*
Low Pressure Service Water System	Y	Y	*
Recirculated Cooling Water System	Y	Y	*
Powerhouse Upper Level Service Water System	Y	Y	*
Emergency Service Water System	Y	Y	*
Unit Instrument Air System	Y	Y	*
Common Instrument Air System	Y	Y	*
Reactivity Control System	Y	N	*
Shutdown System No. 1	Y	N	*
Shutdown System No. 2	Y	N	*
Emergency Coolant Injection System	Y	Y	*
Emergency Coolant Injection System: Blowback	Y	N	*
Inter-Unit Feedwater Tie System	Y	Y	*
D_2O Recovery and Transfer Systems	Y	Y	*
Room Air Conditioning System	Y	Y	*
Hostile Environment Events (including Powerhouse Emergency Venting System)	Y	Y	*
Annulus Gas System	Y	N	*
Emergency Mitigating Equipment	Y	Y	*
Containment Envelope Integrity (CEI) System	N	N	Y
Reactor Vault Atmosphere Cooling System	N	N	Y

System Name	L1 At-Power	L1 Outage	Level 2 At-Power
Post-Accident Hydrogen Ignition System	N	N	Y
Emergency Filtered Air Discharge System	N	N	Y**
Containment Filtered Venting System	N	N	Y**

* Included in Level 2 At-Power Model through integration with Level 1 At-Power Model

** The system is developed as a fault tree model, however, it is not included in the Level 2 At-Power baseline integrated model.

Note: Fire, seismic, flooding, and high wind risk is calculated through modifications or interrogations based on the integrated severe core damage model from the Internal Events At-Power Level 1 PSA, and do not include specific fault tree models for the individual plant systems.

Table 12: DARA-L1O Plant Operational State Definition

Input Parameter	Plant Operational State (POS)		
	A	C	D
GSS	OPGSS or RBGSS	OPGSS or RBGSS	DGSS or MD-RBGSS
Moderator State	Calandria Full	Calandria Full	Calandria Drained
HTS Inventory Level	Full	LLDS	LLDS
HTS Boundary Configuration	Closed	Closed or Open or Abnormal IC / OC	Closed or Open or Abnormal IC / OC
HTS Temp (Nominal)	60°C	30°C	30°C
HTS Pressure	Pressurized	Depressurized	Depressurized
Primary Heat Sink (Circulation)	HTS Pumps or SDC Pumps Note 1	SDC Pumps	SDC Pumps
Primary Heat Sink (Heat Removal)	SDC HXs, Bleed Cooler, or Boiler Blowdown Note 2	SDC HXs	SDC HXs
Backup Heat Sink (Circulation)	Various (SDC, NC, HTS Pumps and Steam Generators, Bleed Cooler)	Various (SDC, NC, HTS Pumps and Steam Generators)	Various (SDC, NC)
Backup Heat Sink (Heat Removal)			
Time after Shutdown at Start of POS (days for decay heat load)	1.0	4.8	28.4

Note 1: If HTS pumps are the primary shutdown heat sink circulation method, then SDC pumps are the backup (and vice versa).

Note 2: Boiler blowdown can only be used later in the outage. The limiting decay heat load of 1.0 day after shutdown is used here for the general definition of POS A; however, the shutdown heat sinks fault tree includes modelling to allow for use of boiler blowdown for a fraction of POS A that represents time later in the outage

Table 13: Initiating Events (IEs) for Darlington Level 1 Outage PSA

Outage IE Label	IE Definition	POS Applicability		
		A	C	D
Loss of Moderator Inventory				
LOMA	Loss of moderator inventory leading to a drained moderator	Y	N	N
Failures of the HT or SDC System Boundaries				
LOCA1	Small non-isolatable breaks inside containment from a pressurized HTS, within the capacity of two D_2O feed pumps	Y	N	N
LK1A	Small non-isolatable leak inside containment from a depressurized HTS, within the capacity of D_2O transfer	N	Y	Y
LK1B	Small non-isolatable leak inside containment from a depressurized HTS, within the capacity of one D_2O feed pump	N	Y	Y
LK1C	Small non-isolatable leak inside containment from a depressurized HTS, within the capacity of two D_2O feed pumps	N	Y	Y
LLOCA	Non-isolatable breaks inside containment from a pressurized HTS, beyond the capacity of two D_2O feed pumps	Y	N	N
LOCA2-OUTAGE	Non-isolatable breaks inside containment from a depressurized HTS, beyond the capacity of two D_2O feed pumps	N	Y	Y
LOCA1-OC	Small breaks outside containment from a pressurized HTS, within the capacity of one D_2O feed pump	Y	N	N
LK1-OC	Small leak outside containment from a depressurized HTS, within the capacity of one D_2O feed pump	N	Y	Y
LK1-SDCIS	Leak in piping within the SDC system when in service, within the capacity of two D_2O feed pumps	Y	Y	Y
LLOCA-SDCIS	Large break in piping within the SDC system when in service, beyond the capacity of two D_2O feed pumps	Y	Y	Y
PTF	Pressure tube failure	Y	N	N
PTL	Pressure tube leak (initial discharge rate less than 1 L/s)	Y	Y	Y
SGTB1	Steam generator tube break within the capacity of two D_2O feed pumps	Y	N	N
SGTB2	Steam generator tube break beyond the capacity of two D_2O feed pumps	Y	N	N
SDCHXTB1	SDC HX tube break within the capacity of two D_2O feed pumps	Y	Y	Y
SDCHXTB2	SDC HX tube break beyond the capacity of two D_2O feed pumps	Y	N	N
ICEPLUGS	Failure of liquid nitrogen supply to all ice plugs	N	Y	Y
Intrinsic System Failures for Primary Heat Sink				
SDC-COOL	Failure of SDC HXs to remove heat	Y	Y	Y
SDC-FLOW	Loss of HTS forced circulation using the SDC pumps	Y	Y	Y
2HTPT	2 or more heat transport pumps trip (2 in one loop)	Y	N	N
SDC-INV-LLDS	Loss of HTS inventory in Low Level Drained State (LLDS) (no rupture) leads to failure of forced circulation using SDC pumps	N	Y	Y
SDC-MV	Spurious closure of SDC isolating Motorized Valve (MV)	Y	Y	Y
Pressure and Inventory Control System Failures				
LOPIC	Failure of HTS pressure and inventory control (no pressure boundary failure) while HTS is pressurized in solid mode	Y	N	N

Outage IE Label	IE Definition	POS Applicability		
		A	C	D
PIC-LOC	Loss of HTS inventory through HTS P&IC pressure boundary while pressurized in solid mode	Y	N	N
Large Pipe Breaks or Other Events in Operating Units with Effects on Outage Unit				
100SBH-ADJN	100% Steam Balance Header (SBH) Break in a unit adjacent to the analyzed unit, North of Column Line 11 with potential for in-plant environmental consequences	Y	Y	Y
100FLB-ADJN	Adjacent Unit 100% Feedwater Line Break, North of Column Line 11	Y	Y	Y
100SBH-U3	100% SBH Break in remote Unit 3, North of Column Line 11 with potential for in-plant environmental consequences	Y	Y	Y
100SBH-U4	100% SBH Break in remote Unit 4, North of Column Line 11 with potential for in-plant environmental consequences	Y	Y	Y
100FLB-U3	100% Feedwater Line Break in remote Unit 3, North of Column Line 11 with potential for in-plant environmental consequences	Y	Y	Y
100FLB-U4	100% Feedwater Line Break in remote Unit 4, North of Column Line 11 with potential for in-plant environmental consequences	Y	Y	Y
EVAC-CNMT	Internal event, not originating from U2, that leads to an evacuation of the outage unit work areas inside containment	Y	Y	Y
Electrical System Failures				
LOBES	Loss of Bulk Electricity System	Y	Y	Y
LOSWYD	Loss of Switchyard	Y	Y	Y
LOCL4	Loss of Class IV	Y	Y	Y
LOBU1	Loss of power to Unit Class IV 13.8 kV bus BU1	Y	Y	Y
LOBU2	Loss of power to Unit Class IV 13.8 kV bus BU2	Y	Y	Y
LOBU3	Loss of power to Unit Class IV 13.8 kV bus BU3	Y	Y	Y
LOBU4	Loss of power to Unit Class IV 13.8 kV bus BU4	Y	Y	Y
LOBU5	Loss of power to Unit Class IV 13.8 kV bus BU5	Y	Y	Y
LOBU6	Loss of power to Unit Class IV 13.8 kV bus BU6	Y	Y	Y
FS1CB2	Loss of Unit Class IV 13.8 kV buses BU1 and BU3 due to 1CB2 failing short	Y	Y	Y
FS2CB2	Loss of Unit Class IV 13.8 kV buses BU2 and BU4 due to 2CB2 failing short	Y	Y	Y
LOBU7	Loss of power to Unit Class III 4.16 kV bus BU7	Y	Y	Y
LOBU8	Loss of power to Unit Class III 4.16 kV bus BU8	Y	Y	Y
LOBU13	Loss of power to Unit Class III 600 V bus BU13	Y	Y	Y
LOBU14	Loss of power to Unit Class III 600 V bus BU14	Y	Y	Y
LOBU15	Loss of power to Unit Class III 600 V bus BU15	Y	Y	Y
LOBU16	Loss of power to Unit Class III 600 V bus BU16	Y	Y	Y
LOBUA3	Loss of Unit Class II 120 V ac bus BUA3	Y	Y	Y
LOBUB3	Loss of Unit Class II 120 V ac bus BUB3	Y	Y	Y
LOBUC3	Loss of Unit Class II 120 V ac bus BUC3	Y	Y	Y
LO45VA	Loss of Unit Class II 45 V dc at panel 2383-11	Y	Y	Y
LO45VB	Loss of Unit Class II 45 V dc at panel 2859-21	Y	Y	Y
LO45VC	Loss of Unit Class II 45 V dc at panel 3485-C1	Y	Y	Y

Outage IE Label	IE Definition	POS Applicability		
		A	C	D
LOBUA4	Loss of Unit Class I 48 V dc BUA4	Y	Y	Y
LOBUB4	Loss of Unit Class I 48 V dc BUB4	Y	Y	Y
LOBUC4	Loss of Unit Class I 48 V dc BUC4	Y	Y	Y
LOBUA141	Loss of EPS 48 V dc bus BUA141	Y	Y	Y
LOBUB141	Loss of EPS 48 V dc bus BUB141	Y	Y	Y
Failures of Other Support Systems				
LOLPSW	Total loss of low pressure service water	Y	Y	Y
LOPULSW	Total loss of powerhouse upper level service water	Y	Y	Y
LORCW	Total loss of recirculated water flow	Y	N	N
TLOIA	Total loss of instrument air	Y	Y	Y
FOREBAY	Forebay severe condition	Y	Y	Y
ESW-BLBK	Emergency service water blowback	Y	Y	Y

Table 14: Summary of Fuel Damage Categories for DARA-L1O

FDC	Definition	Typical Outage Events in FDC
1-SD	**Rapid loss of core structural integrity.**	**Positive reactivity transient during outage and failure to terminate the event.** [Note 1]
2-SD	**Slow loss of core structural integrity.**	**LOCA with failure of HTS make-up and failure of the moderator heat sink.**
3	Moderator required as heat sink in the short term (< 1 hr after reactor shutdown).	Not applicable to Outage PSA. Unit has been shutdown for greater than 1 hour and therefore the short term moderator heat sink is not required.
4	Moderator required as heat sink in the intermediate term (1 to 24 hr after reactor shutdown).	Not applicable to Outage PSA. Unit has been shutdown for >24 hours and intermediate term moderator heat sink not required.
5-SD	**Moderator required as heat sink in the long term (> 24 hr after reactor shutdown).**	**LOCA1 with failure of D_2O make-up and ECR.**
6	Temporary loss of cooling to fuel in many channels.	Not applicable to Outage PSA.
7-SD	**Single channel fuel failure with sufficient release of steam or radioactivity to initiate automatic containment button-up.**	**In-core LOCA and fuel ejection. Large flow blockage. LOCA1 stagnation feeder break.**
8	Single channel fuel failure with insufficient release of steam or radiation activity to initiate automatic containment button-up.	Not applicable to Outage PSA (single channel events adequately covered by FDC7-SD.
9-SD	**HTS leaks with no fuel failure (ECIS successful); potential for significant economic impact.**	**LOCA1 with failure of D_2O make-up.**

Note 1: Potential initiating events representing inadvertent criticality during an outage have been screened out of DARA-L1O on the basis that they have an extremely low frequency. Similarly, the likelihood of an inadvertent criticality during the mission is assumed to be negligible when compared to the other causes of severe core damage during an outage. Therefore, no DARA-L1O event tree sequences are assigned to the FDC1-SD end state.

Table 15: Seismic Hazard Bins

BIN	Bin Seismic Range (g)			Representative Ground Motion PGA (g)	Seismic Bin Frequency (occ/yr.)
%G1 (Bin 1)	0.01 Note 1	-	0.1	0.03	3.82E-03
%G2 (Bin 2)	0.1	-	0.16	0.13	1.05E-04
%G3 (Bin 3)	0.16	-	0.4	0.25	8.20E-05
%G4 (Bin 4)	0.4	-	0.64	0.51	1.47E-05
%G5 (Bin 5)	0.64	-	0.9	0.76	5.39E-06
%G6 (Bin 6)	0.9	-	1.4	1.12	3.20E-06
%G7 (Bin 7)	1.4	-	2	1.67	1.04E-06
%G8 (Bin 8)	>2			2.20 Note 2	6.20E-07 Note 3

Note 1: The beginning of the first seismic hazard bin was defined as 0.01g PGA. Since the Darlington NGS DBE is 0.08g, little seismic risk contribution was expected below the 0.01g PGA.

Note 2: The representative ground motion value for the final interval is calculated as 1.1 x the lower bound ground motion magnitude of the final interval.

Note 3: The seismic bin frequency of the last seismic interval (%G8) was defined as the exceedance frequency at the beginning of the interval.

Table 16: Summary of Selected Accident Sequence

PDS	Representative Accident Sequence
PDS1	No representative sequence defined.
PDS2A	LOCA2A, with loss of moderator cooling and failure of ECI.
PDS2B	LOCA2A, with loss of moderator cooling and failure of ECI, combined with failure of hydrogen igniters.
PDS2C	LOCA2A, with loss of moderator cooling and failure of ECI, combined with failure of reactor vault Air Conditioning Units (ACUs).
PDS2D	LOCA2A, with loss of moderator cooling and failure of ECI, combined with containment envelope impairment.
PDS2E	LOCA2A, with loss of moderator cooling and failure of ECI, combined with containment envelope impairment and failure of reactor vault ACUs.
PDS3-2U	2-Unit blackout with failure of FW, IUFT, IA, SDC, ESW, ECI.
PDS3-4U	100% steam line break in Unit 2, loss of Class IV and III power and EPS affecting 3 or more units, with PSVS success.
PDS3-4U-PSVS	100% steam line break in Unit 2 with PSVS failure, affecting all at-power units.
PDS4	Gland seal LOCA, failure of ECI and moderator cooling.
PDS4-BLBK	ECI Blowback event with failure of moderator cooling.
PDS5	LOCA2 end fitting failure plus failure of ECI, with the moderator providing a long term heat sink, and failure of containment isolation.
PDS6	Multiple steam generator tube rupture with failure of ECI, with the moderator providing a long term heat sink.

Table 17: Darlington NGS Release Categorization Scheme

Release Category #	Description	Definition
D-RC1	Very large release with potential for acute offsite radiation effects and/or widespread contamination	Release containing > 3% core inventory of I-131
D-RC2	Early release in excess of “Large Release” definition	Mixture of fission products containing > 1E14 Bq of Cs-137 but less than RC1 occurring mainly within 24 hours
D-RC3	Late release in excess of “Large Release” definition	Mixture of fission products containing > 1E14 Bq of Cs-137 but less than RC1 occurring mainly after 24 hours
D-RC4	Early release in excess of “Small Release” definition	Mixture of fission products containing > 1E15 Bq of I-131 but < 1E14 Bq of Cs-137 occurring mainly within 24 hours
D-RC5	Late release in excess of “Small Release” definition	Mixture of fission products containing > 1E15 Bq of I-131 but < 1E14 Bq of Cs-137 occurring mainly after 24 hours
D-RC6	Greater than normal containment leakage below Small Release limit	Mixture of fission products containing > 1E14 Bq of I-131 but < 1E15 Bq of I-131
D-RC7	Normal containment leakage	Leakage across an intact containment envelope or long-term filtered release
D-RC8	Basemat Melt-through	No release to atmosphere

Note: The prefix ‘D’ refers to Darlington.

Table 18: Summary of DARA Severe Core Damage and Large Release Frequency Results

Model	Severe Core Damage Frequency (occurrences per reactor year)	Large Release Frequency (occurrences per reactor year)
Internal Events At-Power	1.7E-06	7.9E-07
Internal Events Outage	4.7E-07	4.6E-07
Internal Fire At-Power	2.8E-05	9.1E-06
Seismic At-Power	7.4E-06	7.4E-06
Internal Flooding At-Power	4.9E-08	1.3E-08
High Wind At-Power	1.9E-06	1.7E-06
Non-Reactor Sources	N/A	7.1E-08
OPG Safety Goal	1E-04	1E-05
OPG Administrative Safety Goal	1E-05	1E-06

Table 19: DARA Level 1 At-Power Internal Events Fuel Damage Results

Fuel Damage Category	Baseline Predicted Frequency (/yr)
FDC1	<<1E-09
FDC2	1.7E-06
FDC3	1.5E-05
FDC4	2.9E-04
FDC5	7.5E-06
FDC6	4.9E-06
FDC7	9.6E-04
FDC8	2.1E-03
FDC9	2.1E-02
Severe Core Damage Frequency FDC1 + FDC2	1.7E-06

Table 20: Frequencies of Fuel Damage Categories for DARA-L1O

Fuel Damage Category	Plant Operating State	Time-Average Note 1 Frequency (/yr)
FDC2-SD	POS A	3.4E-09
	POS C	3.0E-08
	POS D	9.4E-07
Severe Core Damage Note 2	(all)	9.8E-07

Note 1: Time-average FDC results are on a reactor-year basis, using the weighted duration and outage frequency from the POS analysis.

Note 2: FDC2-SD represents Severe Core Damage for the DARA-L1O model.

Table 21: Plant Damage State Frequency

PDS	Predicted Frequency (occ/yr)
PDS1	2.5E-11
PDS2	9.8E-07
PDS3-2U	4.5E-07
PDS3-4U	2.0E-07
PDS4	3.2E-07
PDS5*	1.1E-03
PDS6*	1.6E-04

*PDS5 and PDS6 sequences are limited core damage sequences.

Table 22: Release Category Frequencies for DARA L2P

Release Category	Baseline Predicted Frequency (occ/yr)
D-RC1	2.9E-07
D-RC2	3.1E-07
D-RC3	2.3E-07
D-RC4*	0
D-RC5	1.4E-07
D-RC6	2.1E-07
D-RC7	1.1E-06
D-RC8*	0

* No sequences above the truncation limit were identified in which a release was predicted in the range of magnitude and timing corresponding to the definitions of RC4 and RC8.

Appendix A: Acronyms

Acronym	Definition
ACU	Air Conditioning Unit
AIM	Abnormal Incident Manual
ASDV	Atmospheric Steam Discharge Valve
BES	Bulk Electrical System
BWR	Boiling Water Reactor
CANDU	CANadian Deuterium Uranium
CCDP	Conditional Core Damage Probability
CDFM	Conservative Deterministic Failure Margin
CEI	Containment Envelope Integrity
CET	Containment Event Tree
CFVS	Containment Filtered Venting System
CLRP	Conditional Large Release Probability
CNSC	Canadian Nuclear Safety Commission
COG	CANDU Owners Group
CSDV	Condenser Steam Discharge Valve
D_2O	Deuterium Oxide (Heavy Water)
DARA	Darlington NGS Probabilistic Safety Assessment
DARA-FIRE	Darlington Internal Fire Probabilistic Safety Assessment
DARA-FLOOD	Darlington Internal Flooding Probabilistic Safety Assessment
DARA-L1O	Darlington Level 1 Outage Internal Events Probabilistic Safety Assessment
DARA-L1P	Darlington Level 1 At-Power Internal Events Probabilistic Safety Assessment
DARA-L2P	Darlington Level 2 At-Power Internal Events Probabilistic Safety Assessment
DARA-SEISMIC	Darlington Seismic Probabilistic Safety Assessment
DARA-WIND	Darlington High Wind Probabilistic Safety Assessment
DBE	Design Basis Earthquake
DCC	Digital Control Computer
DGSS	Drained Guaranteed Shutdown State
DSC	Dry Storage Container
DWMF	Darlington Waste Management Facility

Acronym	Definition
ECI	Emergency Coolant Injection
ECIS	Emergency Coolant Injection System
ECR	Emergency Coolant Recovery
EFADS	Emergency Filtered Air Discharge System
EME	Emergency Mitigating Equipment
EPG	Emergency Power Generator
EPRI	Electric Power Research Institute
EPS	Emergency Power System
ESC	End Shield Cooling
ESW	Emergency Service Water
ET	Event Tree
FAI	Fauske and Associates
FDC	Fuel Damage Category
FFAA	Fuelling Facilities Auxiliary Area
FHA	Fire Hazard Assessment
FIF	Fire Ignition Frequency
FIS	Fixed Ignition Source
FSSA	Fire Safe Shutdown Analysis
FT	Fault Tree
FW	Feedwater
GSS	Guaranteed Shutdown State
HEP	Human Error Probability
HES	Hazard Exposure Scenario
HRA	Human Reliability Analysis
HT	Heat Transport
HTS	Heat Transport System
HX	Heat Exchanger
HVAC	Heat, Ventilation and Air Conditioning
IAEA	International Atomic Energy Association
IA	Instrument Air
IC	Inside Containment
IE	Initiating Event
IFB	Irradiated Fuel Bay
ISRV	Instrumented Steam Relief Valve

Acronym	Definition
IST	Industry Standard Toolset
IUFT	Inter-Unit Feedwater Tie
LLDS	Low Level Drained State
LOCA	Loss-Of-Coolant Accident
LPECI	Low Pressure Emergency Coolant Injection
LPSW	Low Pressure Service Water
LRF	Large Release Frequency
MAAP	Modular Accident Analysis Program
MCR	Main Control Room
MD-RBGSS	Moderator Drained Rod-Based Guaranteed Shutdown State
MSO	Multiple Spurious Operation
MV	Motorized Valve
MW	Megawatt
NC	Natural Circulation
NGS	Nuclear Generating Station
NPC	Negative Pressure Containment
NRC	Nuclear Regulatory Commission (U.S.)
NUREG	Nuclear Regulation
OC	Outside Containment
OPG	Ontario Power Generation
OPGSS	Over Poisoned Guaranteed Shutdown State
OSR	Operational Safety Requirements
PAU	Physical Analysis Unit
PAWCS	Post-Accident Water Cooling System
PDS	Plant Damage State
PHT	Primary Heat Transport
PK	Programmable Controller
PMF	Probable Maximum Flood
POS	Plant Operational State
PSA	Probabilistic Safety Assessment
PSF	Performance Shaping Factor
PSVS	Powerhouse Steam Venting System
PULSW	Powerhouse Upper Level Service Water
PUPS	Portable Uninterruptable Power Supply

Acronym	Definition
PWR	Pressurized Water Reactor
RBGSS	Rod-Based Guaranteed Shutdown State
RC	Release Category
RCW	Recirculating Cooling Water
RLC	Review Level Condition
RRS	Reactor Regulating System
SAMG	Severe Accident Management Guideline
SBH	Steam Balance Header
SCD	Severe Core Damage
SCDF	Severe Core Damage Frequency
SDC	Shutdown Cooling
SDS	Shutdown System
SDV	Screening Distance Value
SEL	Seismic Equipment List
SGECS	Steam Generator Emergency Cooling System
SIIFF	Seismically Induced Internal Fires and Floods
SIO	Safety Improvement Opportunity
SMA	Seismic Margin Assessment
SPSA	Seismic Probabilistic Safety Assessment
SSC	Systems Structures and Components
SSLB	Secondary Side Line Break
THERP	Technique for Human Error Rate Prediction
UFDS	Used Fuel Dry Storage

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DARLINGTON NGS PERIODIC SAFETY REVIEW SUMMARY REPORT

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Revision Summary

Revision Number	Date	Comments
R000	2024-06-14	Summary of Periodic Safety Review issued for OPG acceptance.

Executive Summary

The current Darlington Nuclear Generating Station (NGS) Power Reactor Operating Licence is valid until November 2025. Ontario Power Generation (OPG) will be submitting a licence renewal application to support the continued operation of Darlington NGS beyond 2025. Two of the station's four nuclear reactors have been recently refurbished and returned to service. These are Units 2 and 3. Refurbishment has commenced on Units 1 and 4 and is expected to be completed in Q2 2025 and Q4 2026 respectively.

OPG has completed a Periodic Safety Review (PSR) of Darlington NGS to support the licence renewal and continued operation. A PSR is an internationally accepted method of evaluating the safety of an operating nuclear power plant against current standards and identifying practicable enhancements that would further increase safety.

This document is a summary of the Darlington PSR, referred to as D-PSR, which builds upon the review basis of earlier OPG Integrated Safety Review (ISR)/PSR work and other relevant assessments for OPG nuclear facilities. D-PSR comprises four major elements:

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

The Global Assessment Report describes the current plant safety basis, including the plant design, management system, operating practices and the means by which personnel are qualified and trained to safely execute their responsibilities. This description accounts for the extensive safety enhancements, including equipment replacements and upgrades, that have been completed over the life of the station to date. The Global Assessment also describes the plant's multiple, overlapping barriers to the release of radioactivity to the environment. These multiple barriers result in extensive defence-in-depth for the plant. The assessment describes how the enhancements that will be implemented via the Integrated Implementation Plan will further strengthen safety and defence-in-depth.

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

The D-PSR identified 23 Global Issues. Ten of the Global Issues can be resolved in a practicable way to enhance the safety of the station, with a total of 35 potential safety enhancements, referred to as Resolution Statements, each of which describes an action or actions that resolve specific aspects of the associated Global Issue.

The Global Assessment identifies the other 13 Global Issues were either:

- Resolved subsequent to completion of the Safety Factor Reports so no further action is needed,
- Being addressed by ongoing activities outside of the D-PSR,
- Being resolved through Resolution Statements associated with another Global Issue,
- Have low safety significance and are addressed to the extent practicable, or
- Will be addressed through combinations of the above.

The Global Assessment includes a detailed assessment of the defence-in-depth of the station, considers the safety significance of the Global Issues and the safety benefits of the Resolution Statements, and performs an objective assessment which concludes that the station will be operated safely throughout the period of continued operation.

The Integrated Implementation Plan, which was produced in the final phase of the Periodic Safety Review, takes the Resolution Statements from the Global Assessment as input, and develops specific actions with planned completion dates for each.

Of the 35 Resolution Statements, 25 have been excluded from the D-PSR Integrated Implementation Plan because they are either already being tracked in the D-ISR Integrated Implementation Plan, covered by an existing action, or were completed following the finalization of the D-PSR Global Assessment Report. For the remaining 10 Resolution Statements, the Integrated Implementation Plan identifies a total of 17 specific actions, each with documented completion criteria. These actions are included in Appendix C. More than half of the actions will be completed by the end of 2024, and all actions are scheduled to be completed by the end of 2028. The safety of the plant is incrementally enhanced as each action in the Integrated Implementation Plan is completed.

Nine of the 10 Resolution Statements and 16 of the 17 specific actions in the Integrated Implementation Plan will support and enhance the station's fitness for service by aligning practices with the most current standards, completing assessments for additional components, and updating the Periodic Inspection Program (PIP) for the Tritium Removal Facility (TRF).

One of the 10 Resolution Statements and one of the 17 specific actions in the Integrated Implementation Plan will enhance the station's emergency management and fire protection by evaluating the benefit of revising existing governance to align with a newer National Building Code of Canada (NBCC) for future construction or modifications related to fire protection, occupant safety and accessibility.

A total of nineteen preliminary strengths were identified as part of the PSR process, as detailed in Table 5-1 below. These strengths were refined as part of the stakeholder review, resulting in twelve of these strengths being finalized in the GAR.

OPG has completed a Periodic Safety Review for Darlington NGS. The Periodic Safety Review has been performed consistent with Canadian regulatory requirements and accepted international practice. The Periodic Safety Review confirms the safety of the current plant and includes enhancements that will increase safety and strengthen defence-in-depth for continued operation. Actions are presently underway to implement these enhancements, which are being managed by the Integrated Implementation Plan. The Periodic Safety Review demonstrates that plant design, operation and practices will ensure continued safe operation.

D-PSR concludes that the current plant design, operation, processes and management system will ensure continued safe operation of the station both in the short term, and for operation to 2035. The Darlington NGS units will continue to be operated while assuring fitness for service of the structures, systems and components important to safety. OPG and the Darlington Station Leadership Team are committed to continual investment in the plant and focusing the organization to strive for continued improvement in the plant condition, operation and performance.

1.0 INTRODUCTION

This report summarizes the PSR conducted in support of licence renewal and continued operation of Darlington NGS. This PSR builds upon the review basis of earlier OPG ISR/PSR work and other relevant assessments for OPG nuclear facilities. The work has been performed consistent with the requirements of CNSC REGDOC-2.3.3, *Periodic Safety Reviews* [R-1].

The objective of the D-PSR is to assess the design, condition and operation of Darlington NGS in support of continued safe operation for the period of D-PSR. The D-PSR will also determine if there are reasonable and practical enhancements that may be adopted to improve plant safety.

D-PSR was performed according to the D-PSR Basis Document [R-2]. The D-PSR Basis Document details the four PSR phases, the first of which is preparation of the Basis Document. The Basis Document establishes the scope and methodology for performing the D-PSR. The planning basis for D-PSR covers the period of operation of Darlington NGS units from November 2025 to November 2035.

The second phase is the Safety Factor Assessments. A Safety Factor is an aspect of safety to be assessed in a Periodic Safety Review. D-PSR assessed fifteen Safety Factors, listed in Table 1-1, which cover all aspects of plant design, operation, management, safety analysis, radiological impact on the environment and radiation protection. Each Safety Factor Report is comprised of assessments of review tasks per International Atomic Energy Agency (IAEA) Specific Safety Guide (SSG) No. 25, *Periodic Safety Review of Nuclear Power Plants* [R-3] and REGDOC-2.3.3 [R-1]. The D-PSR Basis Document further elaborates on these Review Tasks [R-2]. The Safety Factor Reports also document the results of the assessments of Darlington NGS against relevant modern Laws, Regulations, Codes and reviews the results of OPG Program effectiveness reviews, which includes audits and self-assessments.

The Safety Factor assessments also include a review of other sources of information that could provide useful information on the safety of continued operation, such as the Fukushima Action Items (FAIs) and open regulatory actions.

The Safety Factor reviews identify Strengths, Compliances, Gaps and Enhancement Opportunities (EOs). A Strength indicates that a safety requirement is exceeded. Compliance indicates that a safety requirement is met. A Gap indicates that a portion of the plant design or practices does not align with an element of a modern standard. An EO is where the plant or practice does not align with an optional requirement. Gaps and EOs are identified where the plant design or programs do not fully meet a review task or a safety significant element of a modern Law, Regulation, Code or Standard. Gaps and EOs may represent opportunities to further enhance safety over and above current requirements, and are the input to the next phase of D-PSR.

The third phase is the Global Assessment [R-4], which presents an assessment of the five levels of defence-in-depth, including consideration of other findings, such as Strengths and enhancements proposed through the Global Issue resolutions, in order to make a conclusion on the overall safety of continued operation of the plant. The Global Assessment also takes into account the results from the Safety Factor Reports. The Global Assessment consolidates similar Gaps and EOs into Global Issues and develops Resolution Statements for each Global Issue.

The fourth phase is the Integrated Implementation Plan (IIP) [R-5], which assembles the Global Issue Resolution Statements resulting from the Global Assessment and establishes explicit actions with corresponding schedules for implementation.

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

Table 1-1: PSR Safety Factors

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

2.0 OVERVIEW OF THE PERIODIC SAFETY REVIEW PROCESS

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

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

1. Darlington ISR results applicable to D-PSR,
2. Pickering PSR2 results applicable to D-PSR, which included programmatic components applicable to Darlington; and
3. OPG commitments to the CNSC and open CNSC action items.

The Gaps identified in the Safety Factor Reports provided input to the Global Assessment process, which consisted of the following main elements:

1. Consolidation of Gaps into Global Issues

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

2. Prioritization of the Global Issues

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

3. Development of Global Issue resolutions

   Resolution Statements for Global Issues based on their safety significance.

4. Assessment of Defence-in-Depth

   The adequacy of the provisions for defence-in-depth was confirmed by demonstrating that the Darlington NGS design and operation are aligned with the specific safety principles covered in IAEA Safety Report Series (SRS) No.46, *Assessment of Defence in Depth for Nuclear Power Plants* [R-6], taking into account the Strengths and Resolution Statements, and the impact of Acceptable Deviations.

The Global Assessment Report documented the results of the elements listed above and the assessment of overall acceptability.

The final phase of the Periodic Safety Review was the development of the IIP, which defined actions derived from the Resolution Statements to address the Global Issues identified in the Global Assessment. The IIP Actions included new initiatives as well as existing initiatives.

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

1. Review of the methodologies, Gaps, Global Issues, Resolution Statements, IIP Actions and overall conclusions by a third party Expert Panel.

2. Review of the Periodic Safety Review reports by OPG Subject Matter Experts.
3. Review and approval of Global Issue Resolution Statements, the overall Global Assessment Report conclusions, and the IIP Actions and schedule by a Senior Management Scope Review Board.
4. Authorization of and a commitment to execute the IIP by the Senior Vice President for Darlington.

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

3.0 OVERALL PLANT PERFORMANCE

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

3.1 Management and Organization

Nuclear safety and security are core values at OPG. This is reflected in OPG Policy N-POL-0001, *Nuclear Safety & Security Policy* [R-7], which is endorsed by OPG's Board of Directors. The policy places nuclear safety and security as the overriding priority above that of cost, schedule and production. It requires that all employees conduct themselves in a manner consistent with the behaviour of a healthy nuclear safety culture. Such conduct requires that staff always consider how their everyday activities can impact the fundamental safety functions of the station.

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

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

Darlington NGS management is committed to continuously strengthen the safety culture within the Darlington NGS organization and safety culture is identified as a Strength for Darlington NGS.

3.2 Plant Design Features

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

3.2.1 Major Modifications Since Initial Operation

Numerous improvement modifications have been made to Darlington NGS units since initial operation. These improvements reflect OPG's continuous improvement philosophy and bring the station into closer alignment with modern codes and standards. Furthermore, OPG's underlying philosophy regarding the application of defence-in-depth has focused on strengthening various layers of defence-in-depth at Darlington NGS, including these three initiatives:

- Darlington Life Extension;
- Safety Improvement Opportunities (SIOs); and
- Fukushima Project.

The Darlington Life Extension Project was undertaken to extend the life of the plant for 30 additional years of operation and involved a series of major component replacements, design modifications, inspection campaigns, and maintenance. The scope of this project included actions identified as part of the Environmental Assessment (EA) and D-ISR. An EA was conducted to assess the potential impacts of refurbishment and continued operation on the environment, including public safety and socio-economic considerations. Actions arising from the EA and the D-ISR were captured in the Darlington NGS IIP and are being tracked to completion in accordance with the IIP process.

The SIO Project was undertaken by OPG to identify practicable modifications which would reduce plant risk, the potential for public exposure to radiation and/or to address important regulatory issues.

Following the Fukushima event in 2011, OPG developed actions to enhance safety based on the lessons learned from the event. The key major modifications that have been made in response to the initiatives described above are as follows:

- **Shield Tank Overpressure Protection (STOP):** This modification enhances the relief capacity of the shield tank to prevent shield tank catastrophic failure from over-pressurization under severe Beyond Design Basis Accident (BDBA) conditions. The modification adds a rupture disc to provide overpressure relief for the shield tank on each unit.
- **Third Emergency Power Generator (EPG):** A third EPG has been designed and installed to withstand a seismic event more severe than the design basis earthquake (DBE) for which the existing two EPGs are designed, and to increase emergency power reliability when one EPG is not available.

- **Emergency Heat Sink (EHS):** EHS allows for direct Emergency Service Water (ESW) inventory addition to the Heat Transport System (HTS). This SIO improves mitigating capability for a low frequency event of an in-core loss-of-coolant accident (LOCA) with Loss of Emergency Coolant Injection (LOECI) and BDBAs.
- **Auxiliary Shutdown Cooling (ASDC):** This modification provides two additional Shutdown Cooling (SDC) pumps to the existing SDC System. These two additional pumps provide additional diversity, independence, redundancy and physical separation for common mode failures during outages.
- **Containment Filtered Venting System (CFVS):** Following certain severe accidents, there is postulated to be a significant challenge to containment envelope integrity due to pressure exceeding design limits. The CFVS provides a means of relieving the containment pressure while minimizing radioactivity release. The system is capable of operation under severe conditions, including a complete loss of power.
- **Auxiliary Service Water (ASW) Load Shedding:** Automatic ASW load shedding has been installed to improve firewater margin and provides a connection point for the Fukushima Emergency Mitigating Equipment (EME) pumps to supply emergency water to ESW.
- **Powerhouse Steam Venting System (PSVS) enhancements:** PSVS that is an important system to protect plant systems following a steam line break. Enhancements to improve redundancy and reliability of the system have been implemented.
- **Modified 37-Element (37M) Fuel:** The 37M fuel design was introduced to enhance heat transfer along the centre of the fuel bundle and improve safety margins. Compared to the original design, the 37M fuel features a smaller element diameter, a thinner sheath to maintain collapsibility and higher space pads to compensate for the smaller diameter.
- **Replacement of fuel channels, calandria tubes and feeders:** The refurbishment project has or will remove and replace all of the fuel channels, calandria tubes and feeder portions.
- **Passive Autocatalytic Recombiners (PARs):** PARs have been installed to effectively mitigate hydrogen in the long term under accident conditions. PARs operate passively to reduce hydrogen concentration inside containment and provide an additional means of mitigating potential containment flammability challenges for BDBAs, particularly in events where the hydrogen igniters are not operational.
- **Column Line 11 Wall Enhancements:** Originally designed and constructed as a tornado/rail line blast wall, Column Line 11 runs East-West and forms the boundary between the Reactor Auxiliary Bay (RAB) and the Turbine Auxiliary Bay (TAB). It acts as an environmental barrier and can protect equipment south of it from Secondary Side Line Breaks (SSLBs) in the TAB, and equipment north of it from SSLBs in the RAB. Modifications have been implemented to make Column Line 11 a steam barrier to protect critical equipment located within the RAB from an SSLB in the TAB.
- **Fire Protection Upgrades:** A number of modifications have been installed or are in-progress to address findings from the code related gaps from the D-ISR. Examples of these upgrades include changes to the fire alarm system to allow transfer of the fire alarm to the Secondary Control Area, installation of fire dampers and fire doors, and Class II power supply to emergency lighting in the Unit 0 transfer chamber.

In summary, a significant number of modifications have been implemented at Darlington NGS in support of continued operations and to align with current industry best practices.

3.3 Programs and Processes

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

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

  Implementation of the Equipment Reliability Program at Darlington NGS is a station priority, and OPG continues to focus on improving the program to achieve safe, reliable, and economic production.

- **Environmental Qualification (EQ):** This program establishes an integrated and comprehensive set of requirements that provides assurance that essential equipment can perform as required if exposed to harsh Design Basis Accident (DBA) conditions, and that this capability is preserved over the life of the plant.

  Under this program, there is a requirement for the EQ of Group 1 and Group 2 systems allowing them to be available for all SSLBs except for those of low frequency. This requirement exceeds modern requirements for the EQ of structures, systems, and components (SSCs).

- **Risk and Reliability Program:** This program establishes a framework for the development and use of Probabilistic Safety Assessment (PSA) as a means to manage radiological risks from nuclear accidents and to contribute to safe operation of the reactors.

  OPG recently completed the most recent update of the Darlington Probabilistic Safety Assessment (referred to as “DARA”), which is comprised of several distinct elements covering such hazards as internal events (e.g., steam line break, loss of coolant accidents), seismic events, internal fires, internal flooding, and high winds. The use of the DARA study helped identify plant design changes, some of which have now been installed and have resulted in significant benefits to nuclear safety and reduced risk to the public.

3.4 Continuous Improvement

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

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

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

3.4.1 Fukushima Operating Experience

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

OPG acted promptly to understand what had happened at Fukushima Daiichi and confirmed that the OPG nuclear fleet remained safe for continued operation. OPG has completed additional assessments including those requested by the CNSC to review the impact of a similar event (that is, an event resulting in a total loss of all AC power, subsequently resulting in a total loss of heat sinks) at OPG stations. Enhancements to provisions to maintain or re-establish the Control, Cool, Contain and Monitor safety functions were assessed to determine those that are most practical to implement and also meet specified requirements. Several enhancements have been implemented and additional ones are being implemented. These include the use of EME and Severe Accident Management Guidelines (SAMG). Emergency response planning is also undertaken, and emergency drills are run on a periodic basis to ensure staff are prepared to respond as required.

The latest Darlington PSA study credits the use of EME installed as part of the lessons learned from Fukushima and shows that the risk of severe core damage and large release has significantly decreased.

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

OPG continues to have a strong presence in international forums and with all operators of Canadian nuclear generating stations to ensure that any further lessons learned from the Fukushima accident are assessed for Darlington NGS.

3.4.2 Radiation Protection Initiatives

Consistent with the policy of continuous improvement, OPG identifies and implements strategic improvement initiatives which would further reduce radiation exposures, to ensure that doses will be As Low As Reasonably Achievable (ALARA) during continued operation. These strategic initiatives include radiation source elimination, shielding and worker protection. Darlington NGS has been recognized by external organizations for the strength of its ALARA program performance and received the Information Systems on Occupational Exposure (ISOE) World Class ALARA Performance Award in 2008. In the 2019 Regulatory Oversight Report for

Canadian Nuclear Power Plants, the CNSC concluded that Darlington NGS exceeded expectations for the application of ALARA.

4.0 RESULTS OF THE SAFETY FACTOR REVIEW AND GAP EVALUATION

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

A number of Gaps and EOs were identified in the Safety Factor Reports. However, none of the fifteen Safety Factor Reports identified any fundamental safety issues. Overall, OPG has effective programs and processes in place for continued safe operation of the Darlington NGS.

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

The Global Issues resulting from the consolidation of Gaps and EOs and for which Resolution Statements are developed are listed in Appendix C. Resolutions are not developed for Global Issues that have low safety significance and are addressed to the extent practicable, so these Global Issues are not listed in Appendix C. Other Global Issues are also not listed in Appendix C because the resolutions are either already being tracked in the D-ISR IIP, covered by an existing action, or were completed following the finalization of the D-PSR GAR. Appendix C shows the Resolution Statement(s) and IIP Action(s) associated with each Global Issue listed.

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

5.0 ASSESSMENT OF OVERALL ACCEPTABILITY OF CONTINUED OPERATION

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

5.1 Strengths Identified in D-PSR

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

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

Strengths were identified from the following:

- Safety Factor Reports
- Codes and Standards Assessments
- Independent Third Party Assessments

A total of nineteen preliminary strengths were identified as part of the PSR process, as detailed in Table 5-1 below. These strengths were refined as part of the stakeholder review, resulting in twelve of these strengths being finalized in the GAR.

These twelve strengths are identified in Appendix B, which also shows the levels of defence-in-depth supported by each Strength.

Table 5-1: Strengths Identified During the PSR Process

Strength Title and Description
Darlington NGS Effectiveness of Configuration Management The effectiveness of configuration management practices at Darlington NGS represent a D-PSR strength in terms of the ability to maintain the adequacy of station design documentation in the future. Specific observations which support this conclusion are the CSA N286.10-16 compliance review and self-assessments that indicate the Engineering Change Control Program and Design Management Program have effective managed systems controls and are consistent with industry-best practices.
Modifications to Reduce Plant Risk and Strengthen Defence in Depth The SIO project resulted in recommendations to implement a suite of modifications to reduce plant risk and strengthen defence in depth. One of the recommendations from the SIO Project was the installation of new ASDC pumps in each unit. This modification represents a significant improvement to Level 2 and 3 defence in depth as the ASDC pumps provide an additional barrier to protect against challenges to the backup heat sink in the SDC Odd/SDC Even configuration. The installation of the ASDC pumps during the unit refurbishment outages at Darlington NGS represents a D-PSR strength.
Installation of a CFVS for BDBAs Mitigation The CFVS is an engineering filtered venting pathway designed specifically for BDBAs involving elevated containment pressures. The installation of CFVS represents a significant modification implemented after D-ISR which provides significant benefits in terms of minimizing on-site and off-site radiological doses during the BDBA response. This is because an underlying principle of the operating strategy is to maximize the time prior to placing CFVS into service in order to minimize on-site and off-site radiological doses. The CFVS operating strategy demonstrates that CFVS would not be required within 24 hours of the initiating event. This exceeds the requirements contained in Section 8.6.12 of CNSC REGDOC-2.5.2, “Design of Reactor Facilities: Nuclear Power Plants” and represents a D-PSR strength.
BDBA Guidance Exceeds Requirements As part of the BDBA Program, a framework has been established for managing the availability of systems which perform BDBA functions. Key features of this framework are guidelines that: • identify functional requirements for systems. • provide a means of managing the response to potential operability issues related to the BDBA response. The formalized guidance exceeds the requirements specified in CSA N290.16-16, “Requirements for Beyond Design Basis Accidents” and represents a D-PSR strength.

Strength Title and Description
Pressure Boundary Program Effectiveness Based on an assessment of programmatic audits and self-assessment results, there is a strength related to the effectiveness of the Pressure Boundary Program. Specifically, this strength reflects the conclusions of multiple, independent audits and self-assessments which determined that the Pressure Boundary Program is consistent with industry best practices and has effective managed system controls. Relevant audits and self-assessments involved are listed below: • Independent review of OPG Nuclear Pressure Boundary Quality Program by the ANRIC Evaluation Team; • Performance Based Audit by the OPG Nuclear Oversight of the Pressure Boundary Program in October 2020; and • CNSC Type II Compliance Inspection of the Pressure Boundary Program which was performed in March 2017.
State-of-the-art Reactor Mock-up and Rehearsal Facilities The Darlington Energy Centre (DEC) building includes a new state-of-the-art training facility with a full-scale mock-up of the inside of a reactor, plus a tooling and testing facility to allow for the design and development of tools and processes needed for the refurbishment project. The DEC also houses multiple other mock-up models (e.g., end fitting arrays) and specialized tools being used during removal and replacement of pressure tubes, calandria tubes, the feeder pipes in the reactor. The ability to perform maintenance activity rehearsals on a full-scale facility mitigates the potential for in-reactor discovery issues, maintenance errors, and it facilitates planning for radiological dose minimization. This reactor mock-up and rehearsal facilities exceeds the objectives of Review Task #2 [of Safety Factor 2] and is first-of-kind maintenance facility for CANDU reactors. This is considered a D-PSR Strength for Darlington NGS.
Seismic Qualification program The seismic qualification program at OPG provides framework for activities related to the requirements for seismic design and qualification of DNGS in accordance with the CSA N289 series of standards. The Law, Regulation, Code and Standard (LRCS) reviews have demonstrated that DNGS is fully compliant with the modern editions of the standards and exceeds the seismic requirements in the design basis and the licensing basis which is the 2008 version of CSA N289.1. Further, the DNGS applies a lower frequency Margin Design Earthquake (MDE) for new modifications, which exceeds the amplitude used for the Design Basis Earthquake. The extent of seismic qualification at DNGS and the fact that Darlington is fully compliant with the modern editions of the CSA N289 series of standards, is a D-PSR strength.
EQ of Group 1 and Group 2 systems The EQ of DNGS Group 1 and Group 2 systems provides redundancy and diversity. The requirement for EQ of Group 1 and Group 2 system mitigating capability is unique to the DNGS design and licensing basis and exceeds modern requirements for the EQ of SSCs. This requirement has resulted in an extensive set of EQ’d systems. This qualification combined with the extent of activities relating to the preservation and maintenance of EQ result in EQ of being a D-PSR strength.

Strength Title and Description
Performance of Chemistry Program OPG has consistently performed well and has continually raised internal targets to progress towards achieving nuclear excellence for Chemistry Control. The strong performance of CNSC Chemistry Index (CI) and Chemistry Compliance Index (CCI) for Chemistry Program for a number of years is identified as a D-PSR strength.
Acceptance of PSA Methodologies OPG has prepared and updated a suite of PSA Guides to describe the methodologies for different PSA elements and obtained CNSC acceptance of the methodologies prior to completion of the analysis. A series of detailed PSA reports have been created to document the analyses.
PSA Modelling of Plant Configurations Prior to Refurbishment The PSA elements included sensitivity cases to assess other station configurations, including assessment of a pre-refurbishment model unit, and assessment of all four units in the post-refurbishment configuration. This modelling of the different refurbishment configurations in the 2020 PSA study is a D-PSR strength.
Use of the PSA to Identify Potential Design Changes for Risk Reduction The risk assessment study was used to identify potential plant design changes (e.g., refurbishment related Safety Improvement Opportunities) that would lead to a decrease in the nuclear safety risk.
Assessment of Internal and External Hazards The systematic identification of internal and external hazards as prescribed in the current licence exceeds that of newer requirements and those in this review task. Further, the current application of a comprehensive suite of screening guides systematically establishes the basis for screening-in or -out initiating events and combinations of events represents a D-PSR Strength.
Development and Implementation of New OPEX Database OPG has recently developed and released a new OPEX database to facilitate the distribution of external OPEX from COG to departmental OPEX Single Points of Contact (SPOCs), management of OPEX reviews, and documentation of initial assessments or dispositions from site departments. The OPEX database also provides a readily available repository of all previous external OPEX and site reviews/responses to new OPEX with searching capabilities. This database provides various dashboards to present OPEX related information at a glance. Several OPEX health metrics are also monitored and tracked through the OPEX database. The new database has improved functionality and user interface, reducing the potential for relevant OPEX to be missed or not effectively actioned upon. The development and implementation of the OPG OPEX database to readily capture/access OPEX related information in a single repository demonstrates an innovative use of advanced IT tools to facilitate improvements for OPEX management. With the identified efficiencies and notable improvements in the OPEX database, the OPEX database represents the use of industry best practices in the sending and receiving of OPEX from other nuclear power plants. This exceeds the requirements of the Review Task and is considered to be a D-PSR strength.

Strength Title and Description
Nuclear Safety and Security Culture Monitoring Panel (NSSCMP) The NSSCMP reviews Nuclear Safety and Security Culture trends and potential issues that could impact Nuclear Safety and Security Culture health and ensure issues are appropriately addressed. The processes are aligned with the NSSCMP requirements outlined in Nuclear Energy Institute guidance for fostering a strong nuclear safety culture. The use of NSSCMPs is considered to be a D-PSR strength as it exceeds the requirements of CNSC REGDOC-2.1.2 and further promotes meaningful conversations and the spread of lessons learned amongst station leaders to ensure any emergent issues that could impact nuclear safety culture are addressed.
Resilience Training for Accident Management The OPG training element relating to resilience training for accident management is identified as a strength relating to Review Task #4 [of Safety Factor 13]. The purpose of this training is to facilitate improved decision-making capabilities of authorized staff and key roles in the Emergency Response Organization (ERO) when faced with increased levels of stress that could be anticipated during Design Basis and Beyond Design Basis Accidents, including multi-unit accidents. This training has been provided to personnel with key roles in emergency response (i.e., Shift Manager, Emergency Response Director, and Emergency Response Manager). This resiliency training to emergency responders is beyond that required for regulatory and licensing requirements. This represents a D-PSR strength for the OPG Emergency Preparedness Program in responding and adapting successfully to extreme events. The provision of this training exceeds the objective of Review Task #4 and is considered to be a best practice.
Management of EITER The OPG and Darlington programs relating to the management of EITER is a strength. With high levels of equipment reliability, this demonstrates that the management of EITER is effective within the Consolidated Nuclear Emergency Plan (CNEP) and is consistent with industry best-practices. Further, the management of the EITER program has been recognized as an industry strength. Therefore, this exceeds the objective of the Review Task in confirming the adequacy of on-site equipment for emergencies and is recognized as a D-PSR strength.
Implementation of Phase 2 EME The implementation of Phase 2 EME provides defence-in-depth for scenarios where efforts to recover Emergency Power Supply (EPS) are unsuccessful; this is a strength relating to Review Task #10. The robustness of the EPGs and the EPS system as a whole has been demonstrated for Beyond Design Basis Events. This includes a combination of analysis activities (e.g., survivability assessments for Review Level Conditions (RLC) associated with various external hazards) and design modifications (e.g., hardening EPS and installation of a third EPG qualified for RLC and Margin Design Earthquake). As a result, there is reasonable confidence that emergency response actions which attempt to restore EPS will be successful for a wide range of external events. In the event that actions to recover EPS are unsuccessful, Phase 2 EME is deployed as part of the longer-term emergency response. The defence-in-depth afforded by Phase 2 EME in terms of facilitating unit(s) stabilization and recovery exceeds requirements and is a D-PSR strength.

Strength Title and Description
Performance of radiation exposures ALARA Program DNGS has been recognized by external organizations for the strength of its ALARA program performance and received the ISOE World Class ALARA Performance Award in 2008. In the 2019 Regulatory Oversight Report for Canadian Nuclear Power Plants, the CNSC concluded that DNGS exceeded expectations for the application of ALARA. DNGS ALARA performance is identified as a D-PSR strength.

5.2 Defence-in-Depth

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

The approach taken in this assessment was based on IAEA SRS-46 [R-6]. The approach analyzed the five independent levels of defence. All levels of defence-in-depth rely on multiple barriers of protection to prevent or limit equipment failures or human errors and mitigate the consequences should these failures or errors occur. The intent of the review was to confirm that, for each of the five levels of defence, the barriers will be effective for the period of continued operation.

The scope considered the following elements of D-PSR:

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

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

Level 1 – Prevention of abnormal operation and failures

The objective of the first level of defence is to prevent deviations from normal operation, and to prevent failures of SSCs important to safety. A strong Level 1 defence requires a conservative design and high-quality construction and operation. This is particularly important for the physical barriers between the fuel and the environment.

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

Level 2 – Control of abnormal operation and detection of failures

The objective of the second level of defence is to detect and intercept deviations from normal operating conditions, in order to prevent Anticipated Operational Occurrences (AOOs) from escalating to accident conditions. A strong Level 2 defence requires control of plant behaviour using both inherent and engineered design features including both protective systems and surveillance features.

The Level 2 defence-in-depth design features at Darlington NGS include the Reactor Regulating System and plant process control systems. These components are all coordinated to monitor and control total reactor power and reactor flux shape, and to monitor important plant parameters so that reactor power can be reduced via reactor power setback or stepback, if any parameter is beyond its setpoint and to avoid the need for special safety system action. Reactor control in Darlington NGS has a high degree of immunity to process upsets and measurement failures due to extensive redundancy in control devices and process measurements.

The Safe Operating Envelope (SOE) defines the set of limits and conditions within which the plant shall be operated to ensure conformance with the safety analysis basis. The SOE limits and conditions are mapped into operating constraints in station documentation and compliance with the SOE ensures that the plant is operated safely within its licensing basis, such that time spent operating outside the SOE is detected in a timely manner and appropriate actions are taken to ensure a timely return back within the SOE.

The assessment of defence-in-depth Level 2 concludes that the provisions in place are mature and robust. Implementation of measures to ensure compliance with modern requirements for inspections and maintenance, and improvements to the Deterministic Safety Analysis (DSA) and PSA will further enhance the Level 2 barrier at Darlington NGS.

Level 3 – Control of accidents within the design basis

The objective of the third level of defence is to minimize the consequences of accidents by providing inherent safety features, fail-safe design, additional equipment and mitigating procedures. A strong Level 3 defence is evidenced by the design and robustness of engineered safety features coupled with correspondingly robust operating procedures.

Darlington NGS has four special safety systems that limit consequential fission product releases to the public following any DBA and multiple heat removal systems of adequate capacity to ensure that heat generated in the fuel is transferred to the atmosphere or the lake under normal operating, shutdown/outage, and DBA conditions. The reactors are equipped with multiple sources of electrical power to ensure that controls and equipment important to safe operation are available.

The Darlington NGS Safety Report [R-8] contains analyses demonstrating the effectiveness of the Special Safety Systems and other Systems Important to Safety.

Effectiveness is ultimately demonstrated by the safety analyses showing that public dose meets the applicable regulatory limits for the full range of accidents considered in the design.

The review confirms that the Darlington NGS has strong Level 3 barriers, due to the high quality of the design, which include extensive mitigating provisions and comprehensive accident management procedures. A robust set of safety analyses and assessments, which will be further enhanced through the implementation of CNSC REGDOC-2.4.1 and best practices from CSA N290.17-17, demonstrate the adequacy of this level of defence-in-depth.

Level 4 – Control of severe plant conditions

The objective of the fourth level of defence is to ensure that radioactive releases caused by BDBAs including severe accidents are kept as low as practicable. A strong Level 4 defence requires a robust containment design, as well as strong complementary design features and accident management strategies to prevent accident progression and mitigate the consequences of Design Extension Conditions.

Several complementary design features for BDBAs have been fully implemented at Darlington NGS since its initial construction. CFVS provides protection of containment against the potential of slow over-pressurization failure while reducing radioactive release to the atmosphere in the event of a BDBA. The effectiveness of CFVS is enhanced by the STOP modification. The Hydrogen Ignition System provides a means to safely combine any hydrogen (or deuterium) gases generated in containment following postulated events. PARs provide an additional means of mitigating potential containment flammability challenges for BDBAs, particularly in events where the Hydrogen Ignition System is not operational. The implementation of EME provides another key line of defence for BDBAs.

OPG has a mature emergency response infrastructure in place, and dedicated and qualified emergency response personnel and EITER are maintained at all times.

The measures considered at the first three levels of defence-in-depth will ensure maintenance of the structural integrity of the core and limit potential radiation hazards for members of the public. The D-PSR assessments and review of safety principles demonstrate that additional design features and procedural provisions are in place and adequate to address severe accident conditions.

A significant number of improvements have been implemented since initial operation specifically to reinforce Level 4 defence-in-depth. Nonetheless, OPG, as a learning and continuous improvement organization, continues to evaluate industry OPEX, best practices and recommendations in order to identify opportunities for improving their accident management capabilities.

Level 5 – Mitigation of radiological consequences

The objective of the fifth level of defence is to mitigate the radiological consequences of potential releases of radioactive materials. A strong Level 5 defence is evidenced by a robust emergency response program consisting of adequately equipped emergency support facilities and plans for on-site and off-site emergency response.

OPG has extensive plans and procedures in place to ensure capability and readiness to respond to a nuclear emergency, with the support of a coordinated effort from various response organizations. The implementation of SAMG, post-accident monitoring capability, installation of CFVS, and implementation of OPEX from Fukushima have also significantly improved the existing robust barriers for the Level 5 defence-in-depth.

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

5.3 Acceptable Deviations

An assessment was performed to determine if Gaps that were not individually significant could become more significant when their collective effect was considered. The interaction assessment focused on the Gaps that were categorized as Acceptable Deviations. The results of this assessment concluded that the aggregate impact of Acceptable Deviations on the associated safety principles related to all levels of defence-in-depth is very low and there are no additional D-PSR Issues resulting from this assessment.

6.0 THE INTEGRATED IMPLEMENTATION PLAN

As discussed in Section 2.0, the IIP is completed in the final phase of the Periodic Safety Review process and defines the actions derived from the Resolution Statements to address the Global Issues identified in the Global Assessment [R-4].

The Global Assessment identified 23 Global Issues. Dispositions of 13 of these Global Issues were categorized in the Global Assessment as follows and thus Resolution Statements are not required:

- The Global Issue is either resolved subsequent to completion of the Safety Factor Reports so no further action is needed, or
- The Global Issue is being addressed by ongoing activities outside of the D-PSR process, or
- The Global Issue will be resolved through Resolution Statements associated with another Global Issue, or
- The Global Issue has low safety significance and is addressed to the extent practicable, or
- The Global Issue will be addressed through combinations of the above.

The Global Assessment identified 35 Resolution Statements for the remaining 10 Global Issues. Of the 35 Resolution Statements, 25 have been excluded from the D-PSR Integrated Implementation Plan because they are either already being tracked in the D-ISR Integrated Implementation Plan, covered by an existing action, or were completed following the finalization of the D-PSR Global Assessment Report. Specific actions to enhance safety were prepared in the IIP for the remaining 10 Resolution Statements, resulting in 17 IIP Actions. These 17 IIP Actions may be grouped as follows:

- 16 specific actions will support the station's fitness for service by ensuring compliance with relevant standards, completing assessments for unmapped components, revising the PIP for TRF structures and inspecting TRF structures per the updated PIP.
- One specific action will support the station's emergency management and fire protection by evaluating the benefit of revising existing governance to align with the NBCC for future construction or modifications related to fire protection, occupant safety and accessibility.

More than half of these actions are scheduled in the IIP to be completed by the end of 2024, and all actions are currently scheduled to be completed by the end of 2028. The IIP Actions are shown in Appendix C.

7.0 CONCLUSIONS OF THE D-PSR

7.1 D-PSR Review and Acceptance by the CNSC

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

The CNSC accepted the D-PSR Basis Document [R-2]. The D-PSR Safety Factor Reports were submitted to the CNSC. CNSC staff reviewed the reports and their comments have been taken into account in the subsequent elements of D-PSR, including the identification of additional Gaps. The Global Assessment Report [R-4] was submitted to the CNSC. CNSC staff reviewed the Global Assessment Report and their comments have been taken into account in the IIP. The IIP [R-5] was submitted to CNSC staff, who confirmed that it fulfills regulatory requirements, meets CNSC staff expectations and is acceptable [R-9].

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

The PSR demonstrates that Darlington NGS will operate safely during the continued operating period. Activities that will further enhance safe plant operation are planned or in progress. The justification for this conclusion is based on the following:

Current Plant State:

i) OPG has comprehensive programs in place to ensure the condition of SSCs important to safety at Darlington NGS is well understood, to assess the level of fitness for service, and to effectively take action to maintain good plant condition. This has led to continuous improvement in the condition of the plant, and plant performance.

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

iii) The design and operation of the plant meet the current deterministic safety analysis dose limits, and processes are in place to ensure the safety analysis accounts for any additional aging effects associated with continued operation. The Probabilistic Safety Assessment shows that the OPG risk-based Safety Goals for Core Damage Frequency and Large Release Frequency are met.

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

Results of the PSR:

i) The Global Assessment identified 12 Strengths (refer to Section 5.1), indicating that Darlington NGS is well aligned with modern codes, standards and best practices in key areas.

ii) The Global Assessment identifies 23 Global Issues. Resolution Statements for Global Issues were developed, and many are in progress to further enhance safety. Most of the Resolution Statement actions reflect existing work programs and plans at the station. In particular, for the Global Issues of highest safety significance (e.g., Fitness for Service Assessments to cover the operating period), OPG is already actively working on addressing the Global Issues for the operating period to the end of 2035. One Global Issue, which is related to the replacements of the Heat Transport System Liquid Relief Valves, was assessed as having a high impact on nuclear safety and assigned Safety Significance Level 1. OPG was already fully aware of the need to complete the replacement of these valves and there are open actions associated with the D-ISR IIP to track the replacement of these valves to completion. None of the Global Issues identify an immediate safety concern that requires additional planned or urgent action to be taken outside of the PSR process. Specific IIP Actions in the Integrated Implementation Plan have been identified to address the Global Issues.

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

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

v) The IIP comprises a total of 17 specific actions, which will address 10 Global Assessment Resolution Statements. More than half of the specific actions in the IIP are planned for completion by the end of 2024, and all are planned for completion by the end of 2028.

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

In summary, the current plant design, operation, processes and management system will ensure continued safe operation of Darlington. Completion of the actions identified in the IIP will further enhance safety. OPG and the Darlington Station Leadership Team are committed to investing in the plant, and focusing the organization to strive for continued improvement in the plant condition, operation and performance.

8.0 ACRONYMS AND ABBREVIATIONS

ALARA	As Low As Reasonably Achievable
AOO	Anticipated Operational Occurrence
ASDC	Auxiliary Shutdown Cooling
ASME	American Society of Mechanical Engineers
ASW	Auxiliary Service Water
BDBA	Beyond Design Basis Accident
BOP	Balance of Plant
CANDU	CANada Deuterium Uranium
CANUTEC	Canadian Transport Emergency Centre
CCI	Chemistry Compliance Index
CFVS	Containment Filtered Venting System
CI	Chemistry Index
CNEP	Consolidated Nuclear Emergency Plan
CNSC	Canadian Nuclear Safety Commission
CSA	Canadian Standards Association
CT	Calandria Tube
DARA	Darlington Probabilistic Safety Assessment
DBA	Design Basis Accident
DBE	Design Basis Earthquake
DEC	Darlington Energy Centre
DNGS	Darlington Nuclear Generating Station
D-PSR	Darlington Periodic Safety Review
DSA	Deterministic Safety Analysis
EA	Environmental Assessment
EHS	Emergency Heat Sink
EITER	Equipment Important to Emergency Response
EME	Emergency Mitigating Equipment
EO	Enhancement Opportunity
EPG	Emergency Power Generator
EPRI	Electric Power Research Institute
EPS	Emergency Power Supply
EQ	Environmental Qualification

ERO	Emergency Response Organization
ESW	Emergency Service Water
FAI	Fukushima Action Item
FFS	Fitness for Service
GAR	Global Assessment Report
GI	Global Issue
HTS	Heat Transport System
IAEA	International Atomic Energy Agency
IAM	Integrated Aging Management
IIP	Integrated Implementation Plan
INPO	Institute of Nuclear Power Operations
ISOE	Information Systems on Occupational Exposure
ISR	Integrated Safety Review
LCMP	Life Cycle Management Plan
LOCA	Loss of Coolant Accident
LOECI	Loss of Emergency Coolant Injection
LRCS	Law, Regulation, Code, and Standard
MDE	Margin Design Earthquake
MECP	Ministry of Environment, Conservation and Parks
NBCC	National Building Code of Canada
NGS	Nuclear Generating Station
NPP	Nuclear Power Plant
NSSCMP	Nuclear Safety and Security Culture Monitoring Panel
NWM	Nuclear Waste Management
OPEX	Operating Experience
OPG	Ontario Power Generation
PAR	Passive Autocatalytic Recombiner
PIP	Periodic Inspection Program
PSA	Probabilistic Safety Assessment
PSR	Periodic Safety Review
PSR2	Periodic Safety Review 2
PSVS	Powerhouse Steam Venting System
RAB	Reactor Auxiliary Bay

REGDOC	Regulatory Document
RLC	Review Level Condition
RS	Resolution Statement
SAMG	Severe Accident Management Guidelines
SCA	Safety and Control Area
SDC	Shutdown Cooling
SF	Safety Factor
SIO	Safety Improvement Opportunity
SOE	Safe Operating Envelope
SPOC	Single Point of Contact
SRS	Safety Report Series
SSCs	Structures, Systems and Components
SSG	Specific Safety Guide
SSLB	Secondary Side Line Break
STOP	Shield Tank Overpressure Protection
TAB	Turbine Auxiliary Bay
TRF	Tritium Removal Facility
WANO	World Association of Nuclear Operators

9.0 REFERENCES

[R-1] CNSC Regulatory Document, "Periodic Safety Reviews", REGDOC-2.3.3, April 2015.

[R-2] OPG Report, "DNGS Periodic Safety Review Basis Document", NK38-REP-03680-11844 R002, February 03, 2021.

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

[R-4] OPG Report, "Darlington NGS Periodic Safety Review (D-PSR): Global Assessment Report", NK38-REP-03680-11938 R000, December 08, 2022.

[R-5] OPG Report, "Darlington NGS Periodic Safety Review (D-PSR): Integrated Implementation Plan", NK38-REP-03680-11940 R000, August 24, 2023.

[R-6] IAEA Report, "Assessment of Defence in Depth for Nuclear Power Plants", Safety Report Series No. 46, February 2005.

[R-7] OPG Policy, "Nuclear Safety & Security Policy", N-POL-0001-R004, May 13, 2020.

[R-8] OPG Safety Report, "Darlington Nuclear 1-4 Safety Report: Part 3 - Accident Analysis", NK38-SR-03500-10002 R005, October 30, 2017.

[R-9] CNSC Correspondence, "Darlington NGS – Periodic Safety Review (D-PSR) – CNSC Staff Acceptance of the Integrated Implementation Plan (IIP)", e-Doc 7248767, OPG File No. NK38-CORR-00531-25314 R000, March 25, 2024.

[R-10] CNSC Report, Regulatory Oversight Report for Canadian Nuclear Power Plants: 2018, 2019, 2020, 2021, 2022.

Appendix A: D-PSR Results by CNSC Safety and Control Area

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

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

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

This appendix states the purpose of each SCA, identifies the Safety Factors applicable to each SCA and summarizes the findings of D-PSR for each SCA. Appendix C provides a list of the Global Issues, Resolution Statements, and IIP Actions and identifies the associated SCA.

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

The CNSC has assessed Darlington Nuclear Generating Station's overall performance as satisfactory or fully satisfactory over the last five years [R-10].

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

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

A.1 Management System

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

D-PSR addressed specific aspects of the Management System SCA in the Use of Experience from Other Nuclear Power Plants and Research Findings, Organization, Management System, and Safety Culture, Procedures, and Human Factors Safety Factors. In addition to the review tasks associated with these Safety Factors, OPG programs and modern codes and standards related to the Management System subject area were assessed.

The assessment of the Organization, Management System, and Safety Culture Safety Factor states that the review has confirmed that the Darlington NGS organization, management system and safety culture are adequate and effective for ensuring safe operation of the plant.

The assessment of the Procedures Safety Factor states that the review has confirmed that the Darlington NGS processes for managing, implementing and adhering to operating procedures and for maintaining compliance with operational limits and requirements are adequate and effective and ensure plant safety.

Global Issues against the Safety Factors related to the Management SCA were identified however the Global Issues were either resolved, are being addressed by activities outside of D-PSR, will be resolved through Resolution Statements associated with another Global Issue, or have low safety significance, thus there are no Global Issues listed in Appendix C that are associated with the Management System SCA.

The CNSC has consistently assessed the Management System SCA as satisfactory over the last five years [R-10]. The positive results of D-PSR related to this SCA, including Strengths shown in Appendix B,

- SF9-S1, Development and implementation of new OPEX database, and
- SF10-S1, Use of Nuclear Safety and Security Culture Monitoring Panel reviews,

indicate that this will apply for continued operation.

A.2 Human Performance Management

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

D-PSR addressed specific aspects of human performance in the Organization, Management System, and Safety Culture, Procedures, and Human Factors Safety Factors.

The assessment of the Human Factors Safety Factor states that the review has confirmed, by assessment against the current licensing basis and applicable standards, requirements, and practices, that the design of Darlington and its documentation is adequate.

Global Issues against the Safety Factors related to the Human Performance Management SCA were identified however the Global Issues were either resolved, are being addressed by activities outside of D-PSR, will be resolved through Resolution Statements associated with another Global Issue, or have low safety significance and are addressed to the extent practicable, thus there are no Global Issues listed in Appendix C that are associated with the Human Performance Management SCA.

The CNSC has consistently assessed the Human Performance Management SCA as satisfactory over the last five years [R-10]. The positive results of D-PSR related to this SCA, including the Strength shown in Appendix B,

- SF10-S1, Use of Nuclear Safety and Security Culture Monitoring Panel reviews,

indicate that this will apply for continued operation.

A.3 Operating Performance

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

D-PSR addressed specific aspects of the Operating Performance SCA in the Safety Performance, Use of Experience form Other Plants and of Research Findings, Organization, Management System, and Safety Culture, and Procedures Safety Factors.

The assessment of the Safety Performance Safety Factor states that the review has confirmed, through an assessment of the safety performance of Darlington NGS (DNGS) and its trends from records of operating experience, that OPG is effectively monitoring and ensuring safe operation of the plant.

The assessment of the Use of Experience from Other Nuclear Power Plants and Research Findings Safety Factor states that the review has confirmed that the processes for feedback of experience from nuclear operations and research that are used to evaluate practicable safety improvements are acceptable.

Global Issues against the Safety Factors related to the Operating Performance SCA were identified however the Global Issues were either resolved, are being addressed by activities outside of D-PSR, will be resolved through Resolution Statements associated with another Global Issue, or have low safety significance and are addressed to the extent practicable, thus there are no Global Issues listed in Appendix C that are related to the Operating Performance SCA.

The CNSC has consistently assessed the Operating Performance SCA as satisfactory or fully satisfactory over the last five years [R-10]. The positive results of D-PSR related to this SCA, including Strengths shown in Appendix B,

- SF9-S1, Development and implementation of new OPEX database, and
- SF10-S1, Use of Nuclear Safety and Security Culture Monitoring Panel reviews,

indicate that this will apply for continued operation.

A.4 Safety Analysis

The Safety Analysis SCA pertains to maintaining the safety analysis that supports the overall safety case for the facility. Safety analysis is a systematic evaluation of the potential hazards associated with the conduct of a proposed activity or facility and considers the effectiveness of preventive measures and strategies in reducing the effects of such hazards.

D-PSR addressed specific aspects of the Safety Analysis SCA in the Deterministic Safety Analysis, Probabilistic Safety Assessment, and Hazard Analysis Safety Factors.

The assessment in the Deterministic Safety Analysis Safety Factor Report states that the review has confirmed, by assessment against the current licensing basis and applicable standards, requirements and practices, that the design of Darlington NGS and its documentation is adequate.

The assessment in the Probabilistic Safety Assessment Safety Factor Report states that the PSA programs and procedures at OPG and implemented at Darlington NGS are comprehensive, resulting in a systematic and disciplined approach to identifying, prioritizing, and addressing any PSA related issues. The OPG PSA methodology and latest Darlington PSA study is compliant with the current licence requirements.

The assessment in the Hazard Analysis Safety Factor Report states that the review has confirmed, by assessment against the current licensing basis and applicable standards, requirements and practices, that the design of Darlington NGS and its documentation is adequate.

Global Issues against the Safety Factors related to the Safety Analysis SCA were identified however the Global Issues were either resolved, are being addressed by activities outside of D-PSR, will be resolved through Resolution Statements associated with another Global Issue, or have low safety significance and are addressed to the extent practicable, thus there are no Global Issues listed in Appendix C that are related to the Safety Analysis SCA.

The CNSC has consistently assessed the Safety Analysis SCA as satisfactory or fully satisfactory over the last five years [R-10]. The positive results of D-PSR related to this SCA, including the Strength shown in Appendix B,

- SF6-1, Use of DARA study to identify potential plant design changes for risk reduction,

indicate that this will apply for continued operation.

A.5 Physical Design

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

D-PSR addressed specific aspects of the Physical Design SCA in the review of Plant Design, Actual Condition of SSCs Important to Safety, Equipment Qualification, and Aging Safety Factors. The majority of review tasks for the Actual Condition of SSCs Important to Safety and Aging Safety Factors are relevant to the Fitness for Service SCA, so these aspects are discussed in Section A.6 below.

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

The Equipment Qualification Safety Factor Report states that the review has confirmed that Darlington NGS has effective programs and procedures to ensure equipment important to safety is qualified to perform its designated safety function throughout its installed service life.

Global Issues against the Safety Factors related to the Physical Design SCA were identified however the Global Issues were either resolved, are being addressed by activities outside of D-PSR, will be resolved through Resolution Statements associated with another Global Issue, or have low safety significance and are addressed to the extent practicable, thus there are no Global Issues listed in Appendix C that are related to the Physical Design SCA.

The CNSC has consistently assessed the Physical Design SCA as satisfactory over the last five years [R-10]. The positive results of D-PSR related to this SCA, including Strengths shown in Appendix B,

- SF1-S1, Installation of CFVS,
- SF2-S1, State-of-the-art reactor mock-up and rehearsal facilities at the Darlington Energy Centre,
- SF3-S1, Seismic Qualification program,
- SF3-S2, Environmental qualification of Group 1 and Group 2 systems, and
- SF4-S1, Performance of Chemistry Program,

indicate that this will apply for continued operation.

A.6 Fitness for Service

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

D-PSR addressed specific aspects of the Fitness for Service SCA in the review of Actual Condition of SSCs Important to Safety, Equipment Qualification, and Aging Safety Factors. The conclusions of the review of the Equipment Qualification Safety Factor are provided in Section A.5 above. The results of the Safety Factor Reports on Actual Condition of SSCs Important to Safety and Aging are discussed under this SCA.

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

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

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

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

The Safety Factor Report on Actual Condition of SSCs Important to Safety states that the review has confirmed the actual condition of SSCs important to safety is adequate for them to meet their design requirements.

The Aging Safety Factor Report states that the review has confirmed that aging at Darlington NGS is being effectively managed so that required safety functions are maintained, and an effective Aging Management Program is in place for future plant operation.

Five Global Issues related to the Fitness for Service SCA are listed in Appendix C and summarized as follows:

- GI-11: The Resolution Statements for GI-11 propose developing accepted methodologies to perform uncertainty analyses in probabilistic evaluations for pressure tubes and combine allowable failure frequencies from different degradation mechanisms.
- GI-12: The Resolution Statement for GI-12 proposes completing element selection of Balance of Plant (BOP) systems, additional assessments and program scope adjustments. It also proposes submitting a transition plan to the CNSC describing the strategy for program implementation and establishing regulatory commitments and internal actions once CNSC concurrence is obtained.
- GI-15: The Resolution Statements for GI-15 propose developing a transition plan for DNGS complying with mandatory and non-mandatory clauses of CSA N290.9-19 and developing a strategy to confirm compliance with the new requirements of CSA N290.9 Clause 4.2.6.
- GI-16: The Resolution Statement for GI-16 proposes implementing N-PROC-MA-0066 R006 for in-service examination of concrete containment to comply with CSA N287.7-17.
- GI-21: The Resolution Statement for GI-21 proposes completing scoping, screening, and condition assessments for unmapped components in D-PSR scope, performing inspections of the TRF structures per the PIP and revising the PIP to reflect additional knowledge obtained since the PIP was issued in 2014 to ensure that scope of inspection activities covers the full scope of structures in the various buildings addressed in this PIP.

The CNSC has consistently assessed the Fitness for Service SCA as satisfactory over the last five years [R-10]. The positive results of D-PSR related to this SCA, including Strengths shown in Appendix B,

- SF2-S1, State-of-the-art reactor mock-up and rehearsal facilities at the Darlington Energy Centre,
- SF3-S1, Seismic Qualification program,
- SF3-S2, Environmental qualification of Group 1 and Group 2 systems, and
- SF4-S1, Performance of Chemistry Program,

and the enhancements to safety through resolution of the Global Issues, indicate that this will apply for continued operation.

A.7 Radiation Protection

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

D-PSR addressed specific aspects of the Radiation Protection SCA in the Plant Design, Safety Performance, Organization, Management, and Safety Culture, Procedures, Human Factors, Emergency Planning, and Radiation Protection Safety Factor Reports.

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

Global Issues against the Safety Factors related to the Radiation Protection SCA were identified however the Global Issues were either resolved, are being addressed by activities outside of D-PSR, will be resolved through Resolution Statements associated with another Global Issue, or have low safety significance and are addressed to the extent practicable, thus there are no Global Issues listed in Appendix C that are related to the Radiation Protection SCA.

The CNSC has consistently assessed the Radiation Protection SCA as satisfactory or fully satisfactory over the last five years [R-10]. The positive results of D-PSR related to this SCA, including Strengths shown in Appendix B,

- SF10-S1, Use of Nuclear Safety and Security Culture Monitoring Panel reviews, and
- SF15-S1, Performance of ALARA Program,

indicate that this will apply for continued operation.

A.8 Conventional Health and Safety

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

The Conventional Health and Safety SCA was addressed in the D-PSR review of the Organization, Management System, and Safety Culture, Procedures, and Human Factors Safety Factors.

The Organization, Management System, and Safety Culture Safety Factor Report confirmed that an adequate safety policy is in place to ensure safety takes precedence over production. Pre-Job Briefings and Safe Work Plans are performed and provide an opportunity for the briefer and the team performing the task to review and discuss safety hazards and steps to decrease or eliminate hazards.

The Human Factors Safety Factor Report confirmed that effective pre-job briefs assist in the safe and efficient planning preparation and execution of plant activities and include the identification of conventional safety hazards and effective defences against these risks such as work practices, procedures, oversight, event free tools and physical barriers.

Global Issues against the Safety Factors related to the Conventional Health and Safety SCA were identified however the Global Issues were either resolved, are being addressed by activities outside of D-PSR, will be resolved through Resolution Statements associated with another Global Issue, or have low safety significance and are addressed to the extent practicable, thus there are no Global Issues listed in Appendix C that are related to the Conventional Health and Safety SCA.

The CNSC has consistently assessed the Conventional Health and Safety SCA as satisfactory over the last five years [R-10]. The positive results of D-PSR related to this SCA, including the Strength shown in Appendix B,

- SF10-S1, Use of Nuclear Safety and Security Culture Monitoring Panel reviews, and

indicate that this will apply for continued operation.

A.9 Environmental Protection

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

The D-PSR review of the Safety Performance, Organization, Management, and Safety Culture, and Radiological Impact on the Environment Safety Factors confirmed that the Darlington NGS operating organization has an adequate program for the surveillance of the radiological and non-radiological impacts of the station on the environment.

The Radiological Impact on the Environment Safety Factor Report states that the review has confirmed that the design of Darlington NGS and its documentation is adequate as it relates to Safety Factor 14, with some gaps in effectiveness, against the requirements of LRCSs and related to an open regulatory action to be addressed.

Global Issues against the Safety Factors related to the Environmental Protection SCA were identified however the Global Issues were either resolved, are being addressed by activities outside of D-PSR, will be resolved through Resolution Statements associated with another Global Issue, or have low safety significance and are addressed to the extent practicable, thus there are no Global Issues listed in Appendix C that are related to the Environmental Protection SCA.

The CNSC has consistently assessed the Environmental Protection SCA as satisfactory over the last five years [R-10]. The positive results of D-PSR related to this SCA and the enhancements to safety through resolution of the open regulatory action indicate that this will apply for continued operation.

A.10 Emergency Management and Fire Protection

The Emergency Management and Fire Protection SCA covers emergency plans and emergency preparedness programs that exist for emergencies and for non-routine conditions including any results of exercise participation.

The Emergency Management and Fire Protection SCA was addressed in the D-PSR review of the Hazard Analysis and Emergency Planning Safety Factors. The Emergency Planning Safety

Factor Report includes the fire response assessment results while fire protection operations, design and analysis are discussed and rated in the appropriate SCA of operating performance, safety analysis or physical design.

The Emergency Planning Safety Factor Report states that the review has confirmed that Darlington NGS has effective plans, staff, facilities and equipment for dealing with emergencies and arrangements have been adequately coordinated with local and national system and are regularly exercised.

There is one Global Issue listed in Appendix C (GI-5) that originates from a Plant Design Safety Factor gap but relates to the Emergency Management and Fire Protection SCA. The Resolution Statement for GI-5 proposes evaluating the benefit of formally using NBCC 2015 for future construction or modifications related to fire protection, occupant safety, and accessibility and developing a strategy if judged beneficial.

The CNSC has consistently assessed the Emergency Management and Fire Protection SCA as satisfactory over the last five years [R-10]. The positive results of D-PSR related to this SCA, including Strengths shown in Appendix B,

- SF13-S1, Provision of resilience training for accident management,
- SF13-S2, Management of the Equipment Important to Emergency Response program, and
- SF13-S3, Implementation of Phase 2 Emergency Mitigating Equipment,

and the enhancements to safety through resolution of the Global Issue, indicate that this will apply for continued operation.

A.11 Waste Management

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

The Waste Management SCA was addressed in the D-PSR review of the Safety Performance, Organization, Management, and Safety Culture and Radiological Impact on the Environment Safety Factors.

The Safety Performance Safety Factor Report identified that waste specific Nuclear Waste Management (NWM) governance is implemented for waste acceptance to ensure that all waste received and managed by NWM facilities is in accordance with the facility licensing basis and applicable standards. Records of the amount of low and intermediate-level radioactive solid waste generated are documented in quarterly reports and issued to the CNSC per REGDOC-3.1.1 requirements. Additionally, records of non-radioactive hazardous chemical waste shipments are sent to the Ontario Ministry of Environment, Conservation and Parks (MECP) and stored by DNGS for a minimum of 2 years as required by provincial regulation.

The Radiological Impact on the Environment Safety Factor Report identified that the waste classification process did not include instruction regarding management of supporting documentation or the requirement to perform an annual review of waste classifications performed at DNGS and the Management of Waste and Other Environmentally Regulated Materials standard did not indicate where the accountability lies, within OPG, for updating the

Canadian Transport Emergency Centre (CANUTEC) registration each year. However, the necessary corrective actions were implemented to address these issues.

Global Issues against the Safety Factors related to the Waste Management SCA were identified however the Global Issues were either resolved, are being addressed by activities outside of D-PSR, will be resolved through Resolution Statements associated with another Global Issue, or have low safety significance and are addressed to the extent practicable, thus there are no Global Issues listed in Appendix C that are related to the Waste Management SCA.

The CNSC has consistently assessed the Waste Management SCA as satisfactory over the last five years [R-10].

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

Strength ID	Strength Title and Description	Defence-in-Depth Level
SF1-S1	**Installation of a CFVS for BDBAs Mitigation** The CFVS is an engineering filtered venting pathway designed specifically for BDBAs involving elevated containment pressures. The installation of CFVS represents a significant modification implemented after D-ISR which provides significant benefits in terms of minimizing on-site and off-site radiological doses during the BDBA response. This is because an underlying principle of the operating strategy is to maximize the time prior to placing CFVS into service in order to minimize on-site and off-site radiological doses. The CFVS operating strategy demonstrates that CFVS would not be required within 24 hours of the initiating event. This exceeds the requirements contained in Section 8.6.12 of CNSC REGDOC-2.5.2, “Design of Reactor Facilities: Nuclear Power Plants” and represents a D-PSR strength.	4, 5
SF2-S1	**State-of-the-art Reactor Mock-up and Rehearsal Facilities** The DEC building includes a new state-of-the-art training facility with a full-scale mock-up of the inside of a reactor, plus a tooling and testing facility to allow for the design and development of tools and processes needed for the refurbishment project. The DEC also houses multiple other mock-up models (e.g., end fitting arrays) and specialized tools being used during removal and replacement of pressure tubes, calandria tubes, the feeder pipes in the reactor. The ability to perform maintenance activity rehearsals on a full-scale facility mitigates the potential for in-reactor discovery issues, maintenance errors, and it facilitates planning for radiological dose minimization. This reactor mock-up and rehearsal facilities exceeds the objectives of Review Task #2 [of Safety Factor 2] and is first-of-kind maintenance facility for CANDU reactors. This is considered a D-PSR Strength for Darlington NGS.	1, 2

Strength ID	Strength Title and Description	Defence-in-Depth Level
SF3-S1	**Seismic Qualification program** The seismic qualification program at OPG provides framework for activities related to the requirements for seismic design and qualification of DNGS in accordance with the CSA N289 series of standards. The LRCS reviews have demonstrated that DNGS is fully compliant with the modern editions of the standards and exceeds the seismic requirements in the design basis and the licensing basis which is the 2008 version of CSA N289.1. Further, the DNGS applies a lower frequency MDE for new modifications, which exceeds the amplitude used for the Design Basis Earthquake. The extent of seismic qualification at DNGS and the fact that Darlington is fully compliant with the modern editions of the CSA N289 series of standards, is a D-PSR strength.	2, 3
SF3-S2	**EQ of Group 1 and Group 2 systems** The EQ of DNGS Group 1 and Group 2 systems provides redundancy and diversity. The requirement for EQ of Group 1 and Group 2 system mitigating capability is unique to the DNGS design and licensing basis and exceeds modern requirements for the EQ of SSCs. This requirement has resulted in an extensive set of EQ'd systems. This qualification combined with the extent of activities relating to the preservation and maintenance of EQ result in EQ of being a D-PSR strength.	2, 3
SF4-S1	**Performance of Chemistry Program** OPG has consistently performed well and has continually raised internal targets to progress towards achieving nuclear excellence for Chemistry Control. The strong performance of CNSC CI and CCI for Chemistry Program for a number of years is identified as a D-PSR strength.	1
SF6-S1	**Use of the PSA to Identify Potential Design Changes for Risk Reduction** The risk assessment study was used to identify potential plant design changes (e.g., refurbishment related Safety Improvement Opportunities) that would lead to a decrease in the nuclear safety risk.	1, 2, 3, 4

Strength ID	Strength Title and Description	Defence-in-Depth Level
SF9-S1	**Development and Implementation of New OPEX Database** OPG has recently developed and released a new OPEX database to facilitate the distribution of external OPEX from COG to departmental OPEX SPOCs, management of OPEX reviews, and documentation of initial assessments or dispositions from site departments. The OPEX database also provides a readily available repository of all previous external OPEX and site reviews/responses to new OPEX with searching capabilities. This database provides various dashboards to present OPEX related information at a glance. Several OPEX health metrics are also monitored and tracked through the OPEX database. The new database has improved functionality and user interface, reducing the potential for relevant OPEX to be missed or not effectively actioned upon. The development and implementation of the OPG OPEX database to readily capture/access OPEX related information in a single repository demonstrates an innovative use of advanced IT tools to facilitate improvements for OPEX management. With the identified efficiencies and notable improvements in the OPEX database, the OPEX database represents the use of industry best practices in the sending and receiving of OPEX from other nuclear power plants. This exceeds the requirements of the Review Task and is considered to be a D-PSR strength.	1, 2, 3, 4
SF10-S1	**Nuclear Safety and Security Culture Monitoring Panel** The NSSCMP reviews Nuclear Safety and Security Culture trends and potential issues that could impact Nuclear Safety and Security Culture health and ensure issues are appropriately addressed. The processes are aligned with the NSSCMP requirements outlined in Nuclear Energy Institute guidance for fostering a strong nuclear safety culture. The use of NSSCMPs is considered to be a D-PSR strength as it exceeds the requirements of CNSC REGDOC-2.1.2 and further promotes meaningful conversations and the spread of lessons learned amongst station leaders to ensure any emergent issues that could impact nuclear safety culture are addressed.	1, 2, 3, 4

Strength ID	Strength Title and Description	Defence-in-Depth Level
SF13-S1	**Resilience Training for Accident Management** The OPG training element relating to resilience training for accident management is identified as a strength relating to Review Task #4 [of Safety Factor 13]. The purpose of this training is to facilitate improved decision-making capabilities of authorized staff and key roles in the ERO when faced with increased levels of stress that could be anticipated during Design Basis and Beyond Design Basis Accidents, including multi-unit accidents. This training has been provided to personnel with key roles in emergency response (i.e., Shift Manager, Emergency Response Director, and Emergency Response Manager). This resiliency training to emergency responders is beyond that required for regulatory and licensing requirements. This represents a D-PSR strength for the OPG Emergency Preparedness Program in responding and adapting successfully to extreme events. The provision of this training exceeds the objective of Review Task #4 and is considered to be a best practice.	4
SF13-S2	**Management of EITER** The OPG and Darlington programs relating to the management of EITER is a strength. With high levels of equipment reliability, this demonstrates that the management of EITER is effective within the Consolidated Nuclear Emergency Plan (CNEP) and is consistent with industry best-practices. Further, the management of the EITER program has been recognized as an industry strength. Therefore, this exceeds the objective of the Review Task in confirming the adequacy of on-site equipment for emergencies and is recognized as a D-PSR strength.	3, 4
SF13-S3	**Implementation of Phase 2 EME** The implementation of Phase 2 EME provides defence-in-depth for scenarios where efforts to recover EPS are unsuccessful; this is a strength relating to Review Task #10. The robustness of the EPGs and the EPS system as a whole has been demonstrated for Beyond Design Basis Events. This includes a combination of analysis activities (e.g., survivability assessments for RLCs associated with various external hazards) and design modifications (e.g., hardening EPS and installation of a third EPG qualified for RLC and Margin Design Earthquake). As a result, there is reasonable confidence that emergency response actions which attempt to restore EPS will be successful for a wide range of external events. In the event that actions to recover EPS are unsuccessful, Phase 2 EME is deployed as part of the longer-term emergency response. The defence-in-depth afforded by Phase 2 EME in terms of facilitating unit(s) stabilization and recovery exceeds requirements and is a D-PSR strength.	4, 5

Strength ID	Strength Title and Description	Defence-in-Depth Level
SF15-S1	**Performance of radiation exposures ALARA Program** DNGS has been recognized by external organizations for the strength of its ALARA program performance and received the ISOE World Class ALARA Performance Award in 2008. In the 2019 Regulatory Oversight Report for Canadian Nuclear Power Plants, the CNSC concluded that DNGS exceeded expectations for the application of ALARA. DNGS ALARA performance is identified as a D-PSR strength.	1, 2, 3, 4

Appendix C: Global Issue and IIP Actions Summaries

Global Issue	Global Issue Title	Resolution Statements & IIP Actions	CNSC Safety & Control Area	Defence-in-Depth Level
GI-05	NBCC – National Building Code of Canada	**Resolution Statement:** Evaluate the benefit of formally using NBCC 2015 for future construction or modifications related to fire protection, occupant safety, and accessibility and, if judged beneficial, a strategy should be developed to ensure alignment with the requirements of NBCC 2015 Part 3. **IIP Action:** Review, evaluate, and revise existing governance, as required, to include use of NBCC 2015 Part 3 for future construction or modifications related to fire protection, occupant safety, and accessibility.	10 – Emergency Management and Fire Protection (A.10)	2, 3
GI-11	CSA N285.8 – Technical Requirements for In-Service Evaluation of Zirconium Alloy Pressure Tubes in CANDU Reactors	**Resolution Statement:** Develop and submit an implementation plan for developing inputs to satisfy the methodology in the Non-Mandatory Annex G of CSA N285.8-15 (Update No. 1) to perform uncertainty analyses in probabilistic evaluations where the threshold requirement is met per CSA N285.8. **IIP Action:** Develop implementation plan for developing inputs to satisfy the methodology in the Non-Mandatory Annex G of CSA N285.8-15 (Update No. 1) for performing uncertainty analyses in probabilistic evaluations where the threshold is met and OPG to submit the implementation plan to the CNSC.	06 – Fitness for Service (A.6)	2, 3
		Resolution Statement: Develop and submit an implementation plan for developing inputs to satisfy the methodology for combining allowable failure frequencies from different degradation mechanisms per Clause 7.3.1.2 of CSA N285.8-15 (Update No. 1). **IIP Action:** Revise/issue a compliance plan providing for the means by which OPG will comply with Clause 7.3.1.2 of CSA N285.8 (Update No.1). The approach to compliance with CSA Clause 7.3.1.2 will be provided for in OPG's CSA N285.8 compliance plan that addresses current and future actions pursuant to core assessment compliance with the latest revision of the CSA N285.8 standard.	06 – Fitness for Service (A.6)	2, 3

Global Issue	Global Issue Title	Resolution Statements & IIP Actions	CNSC Safety & Control Area	Defence-in-Depth Level
GI-12	CSA N285.7 Periodic Inspection Program	**Resolution Statement:** Complete final element selection of all pre-screened Balance of Plant (BOP) systems, additional assessments (where necessary) and program scope adjustments. Submit a transition plan to the CNSC describing the strategy for program implementation. Once CNSC concurrence is obtained with the transition plan, establish regulatory commitments and internal actions to track the following steps for program implementation: 1. Preparation of program documentation such as PIP Plans, PIP Databases, PIP Schedules, and required governance. 2. Preparation of new CSA N285.7 compliance inspection procedures and/or updates to existing inspection procedures to include CSA N285.7. 3. Revision of affected OPG governance and other documents to include CSA N285.7 requirements where necessary. 4. Receipt of necessary regulatory acceptance, approval, and concurrence of the final PIP and supporting documentation; and 5. Commencement of periodic inspections. Once done, this will facilitate compliance with the CSA N285.7 standard. **IIP Actions:** 1. Strategy and Support Department to provide the Nuclear Regulatory Affairs with CNSC package to submit OPG's transition plan identifying the compliance date and describing the plan and key transition dates for full implementation of the 2021 edition of CSA Standard N285.7 in Darlington NGS. 2. OPG to submit transition plan to CNSC identifying the compliance date and describing the plan and key transition dates for full implementation of the 2021 edition of CSA Standard N285.7 in Darlington NGS.	06 – Fitness for Service (A.6)	1, 2, 3

Global Issue	Global Issue Title	Resolution Statements & IIP Actions	CNSC Safety & Control Area	Defence-in-Depth Level
GI-15	CSA N290.9 – Reliability and Maintenance Programs for Nuclear Power Plants	**Resolution Statement:** CSA N290.9-19 introduces new requirements for reliability and maintenance activities that are not explicitly reflected in relevant OPG governance. Develop a transition plan for DNGS complying with mandatory clauses of CSA N290.9-19. The transition plan will address the approach to be followed to demonstrate compliance with Clauses 4.1.1, 4.2.5, 6.3.3, 6.3.7, 6.3.9, 6.5.2, 6.5.4, 6.5.10, 6.5.11, and 8.5 of CSA N290.9-19. **IIP Action:** Evaluate and incorporate new requirements for reliability and maintenance activities into OPG governance, as required, to demonstrate compliance with Clauses 4.1.1, 4.2.5, 6.3.3, 6.3.7, 6.3.9, 6.5.2, 6.5.4, 6.5.10, 6.5.11, and 8.5 of CSA N290.9-19.	06 – Fitness for Service (A.6)	2, 3
		Resolution Statement: Develop a strategy to confirm compliance with the new requirements of CSA N290.9 Clause 4.2.6 for monitoring function reliability. Strategy to include implementation and governance update as required. **IIP Actions:** 1. Develop a strategy to confirm compliance with the new requirements of Clause 4.2.6 of CSA N290.9 for monitoring function reliability. 2. Evaluate and incorporate the requirements for reliability and maintenance activities into OPG governance, as required, to demonstrate compliance with Clause 4.2.6 of CSA N290.9.	06 – Fitness for Service (A.6)	2, 3
		Resolution Statement: CSA N290.9-19 introduces new, non-mandatory requirements for reliability and maintenance activities that are not explicitly reflected in relevant OPG governance. Develop a transition plan for DNGS complying with non-mandatory clauses of CSA N290.9-19. The transition plan will address the approach that will be followed to demonstrate compliance with Clauses 5.4.5, 6.4.3, 6.4.6, and 6.5.13 of CSA N290.9-19, recognizing that the method of compliance with these clauses needs to consider whether the required activities are practical to implement.	06 – Fitness for Service (A.6)	2, 3

Global Issue	Global Issue Title	Resolution Statements & IIP Actions	CNSC Safety & Control Area	Defence-in-Depth Level
		IIP Action: Evaluate and incorporate new non-mandatory requirements for reliability and maintenance activities into OPG governance, where the required activities are practical to implement, to demonstrate compliance with Clauses 5.4.5, 6.4.3, 6.4.6, and 6.5.13 of CSA N290.9-19.		
GI-16	Governance Issues	**Resolution Statement:** Implement N-PROC-MA-0066 R006, and update implementing documentation as applicable, for in-service examination of concrete containment at Darlington to comply with CSA N287.7-17. **IIP Actions:** 1. Review and update the Reactor Building, Containment and Vacuum Building PIPs for compliance with CSA N287.7-17. 2. Review and update post tensioning inspections per CSA N287.7-17. 3. Review and update leakage rate documents per CSA N287.7-17. 4. OPG to submit transition documents to the CNSC.	06 – Fitness for Service (A.6)	1, 2, 3
GI-21	Aging Management	**Resolution Statement:** Complete scoping, screening, and condition assessments for unmapped components in D-PSR scope. **IIP Actions:** 1. Conduct a gap assessment to scoping and screening of the “unmapped” components to define new and revised commodity groups and determine which of them warrant detailed Condition Assessments. 2. Perform condition assessments for the selected commodity groups of components which warrant detailed condition assessments as identified in the gap assessment.	06 – Fitness for Service (A.6)	1, 2
		Resolution Statement: Perform inspections of the TRF structures as per the TRF Structures PIP. Revise the TRF Structures PIP to reflect additional knowledge obtained since the PIP was issued in 2014 to ensure that the scope of inspection	06 – Fitness for Service (A.6)	1, 2

Global Issue	Global Issue Title	Resolution Statements & IIP Actions	CNSC Safety & Control Area	Defence-in-Depth Level
		activities covers the full scope of structures in the various buildings addressed in this PIP. **IIP Actions:** 1. Review, evaluate, and update the TRF Structures PIP to include additional inspection scope for all applicable TRF structures, as required. 2. Perform inspection of the TRF structures.		

ONTARIO POWER GENERATION

Allan Grace
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OPG Proprietary

December 18, 2024

CD# NK38-CORR-00531-25844 P

Ms. Candace Salmon
Commission Registrar
Canadian Nuclear Safety Commission
P.O. Box 1046
280 Slater Street
OTTAWA, Ontario, K1P 5S9

Dear Ms. Salmon:

Darlington NGS – Supplemental Update in Support of the Power Reactor Operating Licence Renewal Application

The purpose of this letter is to submit supplemental information to the Application for Renewal of the Darlington Nuclear Generating Station (NGS) Power Reactor Operating Licence that was submitted in Reference 1.

Attachment 1 provides updates on metrics and information that were pending at the time of the Darlington NGS application for renewal, submitted on May 30, 2024 (Reference 1). The supplemental application also includes information related to CNSC staff's technical sufficiency review (Reference 2) and OPG's response to CNSC staff's review (Reference 3). This supplemental document is meant to be read in conjunction with the application (Reference 1) and does not negate any information that was already provided.

Please note that since the submission of the Darlington NGS licence renewal application (Reference 1), Power Reactor Operating Licence PROL 13.03/2025 has been amended to revision PROL 13.04/2025 through CNSC Commission Record of Decision – DEC 24-H101 (Reference 4).

Should you have any questions please contact Ms. Aditi Bhardwaj, Senior Manager, Regulatory Affairs at 289-387-2110 or at aditi.bhardwaj@opg.com.

Sincerely,

Allan Grace
Senior Vice President
Darlington Nuclear
Ontario Power Generation Inc.

Attach.

cc: CNSC Site Supervisor - Darlington
A. Viktorov - Ottawa
A. Mathai - Ottawa
forms-formulaires@cnsc-ccsn.gc.ca
registry-greffe@cnsc-ccsn.gc.ca

References:

1. OPG letter, A. Grace to C. Salmon, “Darlington NGS – Application for Renewal of the Darlington Nuclear Generating Station Power Reactor Operating Licence 13.03/2025”, May 30, 2024, CD# NK38-CORR-00531-25450.

2. CNSC letter, A. Baig to A. Grace, “Darlington Nuclear Generating Station: CNSC Staff Technical Sufficiency Review of the Application to Renew the Power Reactor Operating Licence”, August 1, 2024, e-Doc# 7334720, CD# NK38-CORR-00531-25589.

3. OPG letter, A. Grace to A. Baig, “Darlington NGS – OPG Response to CNSC Staff Technical Sufficiency Review of the Application to Renew the Power Reactor Operating Licence: Action Item OPG-2024-33652”, August 16, 2024, CD# NK38-CORR-00531-25595.

4. CNSC Record of Decision DEC 24-H101, “Application to Amend Power Reactor Operating Licence PROL-13.03/2025 to Authorize the Production of Cobalt-60 at the Darlington Nuclear Generating Station”, June 5, 2024, e-Doc# 7295750 (PDF), CD# NK38-CORR-00531-25501.

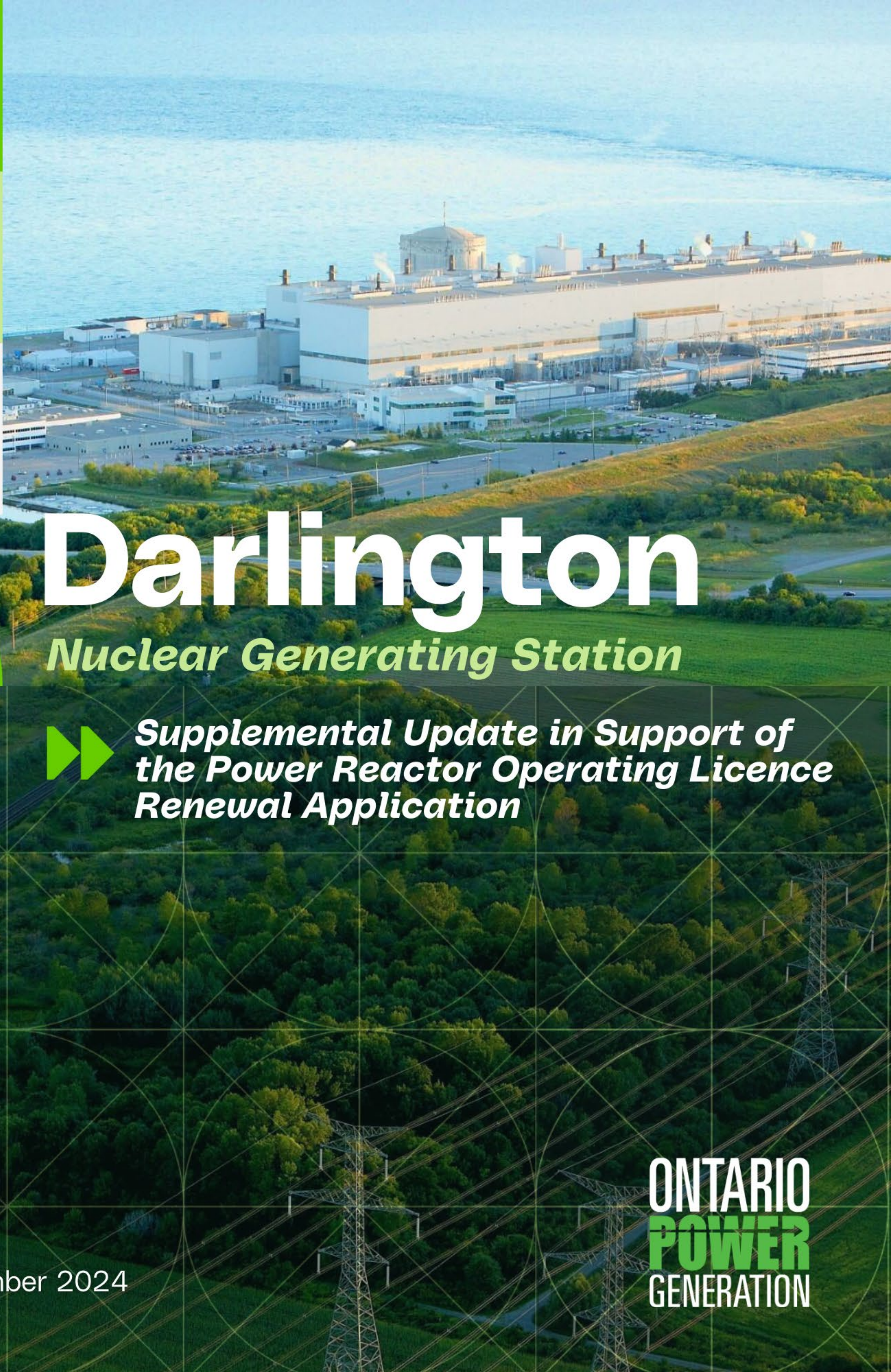
ATTACHMENT 1

OPG letter, A. Grace to C. Salmon, “Darlington NGS – Supplemental Update in Support of the Power Reactor Operating Licence Renewal Application”

CD# NK38-CORR-00531-25844 P

Supplemental Update in Support of the Power Reactor Operating Licence Renewal Application

(91 pages)



Darlington

Nuclear Generating Station

Supplemental Update in Support of the Power Reactor Operating Licence Renewal Application

December 2024

Land Acknowledgement

The lands and waters on which the Darlington Nuclear Generating Station (NGS) is situated are the treaty and traditional territory of the Michi Saagiig and Chippewa Nations, collectively known as the Williams Treaties First Nations.

Darlington NGS is within the territory of the Gunshot Treaty and the Williams Treaties of 1923. These Treaty Rights were reaffirmed in 2018 in a settlement with Canada and the Province of Ontario.

Ontario Power Generation Inc. (OPG) respectfully acknowledges that the Williams Treaties First Nations are the Rights holders, stewards, and caretakers of these lands and the waters that touch them, and that they continue to ensure their health and integrity for generations to come.

As a company, OPG remains committed to developing positive and mutually beneficial relationships with the Williams Treaties First Nations.

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1.0 Overview

1.1 Introduction – Supplemental Information

In May 2024, Ontario Power Generation Inc. (OPG) requested authorization from the Canadian Nuclear Safety Commission (CNSC) for renewal of the Darlington Nuclear Generating Station (NGS) Power Reactor Operating Licence (PROL) 13.03/2025 for a 30-year licence term from December 1, 2025 to November 30, 2055 (Reference 1).

This application demonstrated that OPG will continue to safely operate the Darlington NGS while meeting the requirements of the *Nuclear Safety and Control Act* (NSCA) and associated Regulations. OPG will continue its licensed activities and make 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.

This supplemental submission provides updated information on metrics and information that was pending at the time of the requested authorization, including information related to CNSC staff's review of OPG's application in Reference 2 and OPG's response to CNSC staff's review in Reference 3. 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 following the submission of the Darlington NGS PROL renewal application (Reference 1), PROL 13.03/2025 was amended to PROL 13.04/2025 through CNSC Commission Record of Decision – DEC 24-H101 (Reference 4) to authorize the production of Cobalt-60 at Darlington NGS. Updates associated with this amendment are included in this supplemental document.

In support of the Darlington NGS PROL renewal application (Reference 1), OPG also provided information regarding implementation timelines of CNSC Regulatory Documents and Canadian Standards Association (CSA) standards in References 5 and 6.

In summary, the original licence renewal application provided in May 2024, together with this supplemental document, contains the information to demonstrate that OPG meets all the regulatory requirements and is 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, and maintain national security and measures required to implement international obligations.

2.0 Safety and Control Areas

The following information is provided as updates to specific Safety and Control Areas (SCAs), supplementary to the information provided in Darlington NGS's May 2024, Power Reactor Operating Licence Renewal Application (Reference 1). The relevant section which is being updated is referenced to this document, referred to as the *"2025 Licence Renewal Application"*.

2.1 Management System

The fundamental objective of OPG's nuclear management system is to ensure OPG nuclear facilities are operated and maintained using sound nuclear safety and defence-in-depth practices to ensure radiological risks to workers, the public, and the environment are As Low As Reasonably Achievable (ALARA), and in keeping with the OPG *Nuclear Safety and Security Policy* and the best practices of the international nuclear community.

OPG's nuclear management system sets out the principles, required supporting actions and documentation to support safe and reliable nuclear facilities, and brings together in a planned and integrated manner, the processes necessary to satisfy requirements and to carry out licenced activities safely.

Management system requirements provide direction to develop and implement management practices and controls. Programs and processes are created such that all applicable regulatory requirements and codes and standards are embedded and integrated within the nuclear management system, including aspects of health, safety, environment, security, economics and quality.

The following sections provide a description of updates, including information related to CNSC staff's review of OPG's application in Reference 2 and OPG's response to CNSC staff's review in Reference 3, since the application submission in this area. More information on the Management Systems SCA is available in Section 2.1 of the 2025 Licence Renewal Application (Reference 1).

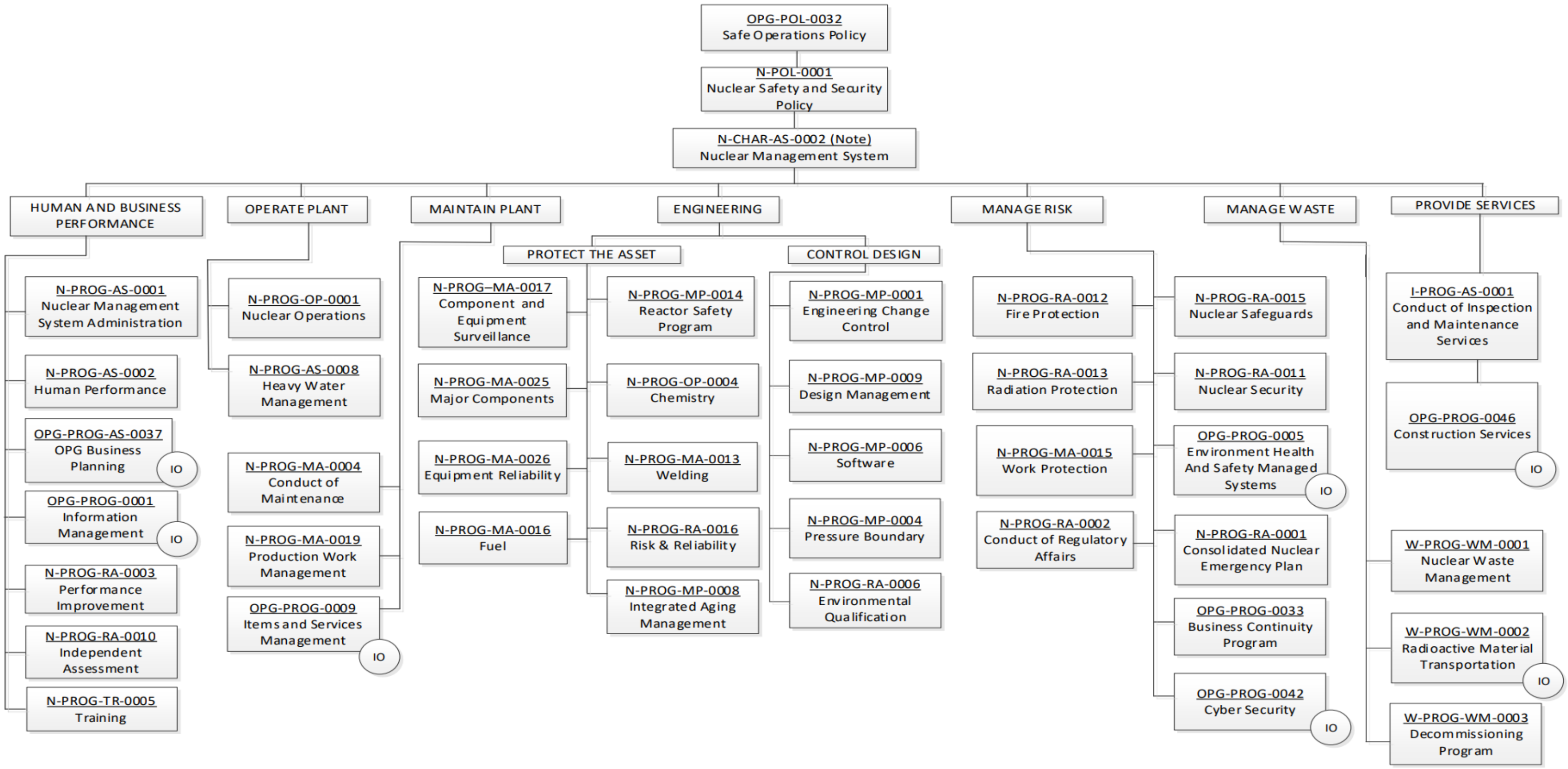
2025 Licence Renewal Application, Sections 2.1.1 (Management System), 2.1.2 (Organization) and 2.1.3 (Performance Assessment, Improvement and Management Review)

The following provides additional information regarding OPG's organizational structure:

An organization chart has been provided in Appendix D that identifies OPG Nuclear and Nuclear Interfacing organizations. It also identifies positions with responsibilities for the management and control of licensed activities.

The following provides clarification regarding OPG governing document framework:

N-CHAR-AS-0002, *Nuclear Management System* gives authority to N-PROG-AS-0001, *Nuclear Management System Administration*, which defines the generic programs within the nuclear management system. N-CHAR-AS-0002, Appendix A also provides the governing framework that documents the programs. The figure below provides a copy of N-CHAR-AS-0002, Appendix A.



NOTE - N-CHAR programs implemented under other corporate policies:

- OPG-PROG-0001: OPG-CHAR-0002, CIO Management System
- OPG-PROG-0005: OPG-POL-0001, Employee Health and Safety
  OPG-POL-0021, Environment Policy
- OPG-PROG-0042: OPG-CHAR-0002, CIO Management System

Legend:

IO Indicates a Program owned by an Interfacing Organization (IO) that does not report directly to the CNO.

Figure 1: OPG Governing Document Framework (N-CHAR-AS-0002, Appendix A)

Figure 3 in the 2025 Licence Renewal Application (Reference 1) also provides activities, programs and configuration information (similar to N-CHAR-AS-0002, Appendix A of the governing framework). Figure 3 in the 2025 Licence Renewal Application ("Configuration Management Relationship") is taken from N-STD-MP-0027, *Configuration Management* which takes authority from N-PROG-AS-0001.

2025 Licence Renewal Application, Section 2.1.4 – Operating Experience (OPEX), Problem Identification and Resolution

The following provides an update on the improvement initiatives related to the OPEX process and use of OPEX at Darlington NGS:

As detailed in the Darlington NGS PROL renewal application (Reference 1), OPG has initiated a number of improvements to the OPEX process and use of OPEX at Darlington NGS. The following improvements have been completed since the application was submitted:

- The OPEX Health Metrics indicators have been revised to challenge status quo for indicators with consistent green scores over a long period. Target score for green, white, yellow and red ranges have also been revised to further improve performance and challenge the fleet for maintaining excellence. Part of the OPEX Health Metrics revision included automation of some Key Performance Indicators related to OPEX resulting in a change for external and internal OPEX reviews. This provides efficiency in completing monthly metrics and visibility to line organizations of where the data is coming from by listing the OPEX station condition records and actions taken. This metric also allows visibility into which departments are taking the actions to help identify trends (declines or improvements). The benefit will provide line organizations the opportunity to check and adjust their behaviours towards implementing OPEX internally and from external sources.
- In addition to adding OPEX items from the weekly CANDU Owners Group (COG) screening package into the Integrated Station Brief meeting package for discussion and understanding of lessons learned, Darlington has also begun adding broader industry Institute of Nuclear Power Operations (INPO) Industry Reporting and Information System (IRIS) reports for key consequential events to the Integrated Station Brief meeting package for discussion. These key consequential events are also communicated to COG to ensure they also get included in the external OPEX screening packages (produced by COG).

2.2 Human Performance Management

Darlington NGS has an effective Human Performance Management Program that meets or exceeds all applicable regulatory requirements and related objectives to enable effective Human Performance through implementation of processes that ensure a sufficient number of licensee personnel are in relevant job areas, have the necessary knowledge, skills, procedures and tools in place to safely carry out their duties.

The following sections provide a description of updates, including information related to CNSC staff's review of OPG's application in Reference 2 and OPG's response to CNSC staff's review in Reference 3, since the application submission in this area. More information on the Human

Performance Management SCA is available in Section 2.2 of the 2025 Licence Renewal Application (Reference 1).

2025 Licence Renewal Application, Section 2.2.1 – Human Performance Program

The following is an update to the Human Performance Program related to Site Event Free Day Resets (SEFDRs):

The effectiveness of the Human Performance Program has resulted in Darlington NGS achieving top industry performance in SEFDRs. Since the submission of the 2025 Licence Renewal Application in Reference 1, there has been one SEFDR that occurred on November 29, 2024.

2025 Licence Renewal Application, Section 2.2.2 – Personnel Training

The following is an overview of refurbishment training in relation to the Systematic Approach to Training:

The impact of engineering changes such as Darlington Refurbishment is systematically analysed, designed, developed, implemented, and evaluated to support job performance. The Training and Qualification processes are based on the N-PROC-TR-0008, *Systematic Approach to Training* process, which are highlighted within procedure N-PROC-MP-0090, *Engineering Change Control Process*.

As part of the Return-to-Service (RTS) protocol, OPG must declare available for service using the Systems Available for Service (SAFS) process to release a Regulatory Hold Point (RHP). In the SAFS reports, as per N-GUID-09701-10017, *Nuclear Refurbishment System Available for Service Package Preparation Guideline* the Nuclear Refurbishment Training department must declare that modifications on the system have been assessed, and where the assessment identified the need for specified training, it has been developed and delivered.

Furthermore, a RTS Training Report is another protocol deliverable for release of a RHP which documents the training required and the progress of training. These reports are provided to CNSC staff and document requirements for staff training. The reports describe the training needs, compliant with the Systematic Approach to Training, which ensures Darlington employees are properly trained and qualified to support surveillance and operation during a Refurbishment outage, the RTS period of the outage, and when the unit resumes commercial operation.

CNSC staff rigorously complete compliance inspections of Refurbishment activities and have confirmed that OPG's RTS training strategy (Type II Inspection Report DPRD-2018-00863), satisfies all OPG Systematic Approach to Training requirements and thus provides a fully auditable and encompassing process.

2025 Licence Renewal Application, Sections 2.2.2 (Personnel Training) and 2.2.3. (Personnel Certification)

Section 2.2.2 – Personnel Training

The following is an overview of the certification training full scale simulators in relation to refurbishment training:

OPG's Simulator Training program maintains two referenced Unit 2 Darlington NGS Full Scope Training Simulators at the Darlington Learning Centre (DLC) and the Pickering Learning Centre (PLC). The DLC Simulator maintains a hybrid configuration, with a Unit 1 configuration for secondary side updated Turbine Generator Controls and Turbine Trip Parameters and the primary side remaining as modelled after Unit 2 (consistent across all Units). The PLC Simulator currently maintains the original referenced Unit 2 and is targeted to be modified to align with the hybrid configuration of the DLC Simulator in 2025. The Darlington NGS Unit 2 upgrade for the Turbine Generator Controls is currently targeted for 2027. Once the modification is complete on Unit 2, the DLC and PLC simulators will reflect the Unit 2 reference configuration.

Any simulator changes required as part of the Darlington Refurbishment Project have been installed with relevant sustainment details being captured in revision control and work management repositories as per N-PROC-TR-0023, *Simulator Quality Assurance*. There are no deficiencies nor system-health issues that could negatively impact certification training on either the DLC or PLC simulator.

The PLC simulator is used for initial certification training and examination. The DLC simulator is used for certified operator training and requalification testing.

Section 2.2.3 – Personnel Certification

The following provides additional information regarding Trainers and Examiners qualification requirements as per the personnel certification program:

Training Qualification Document, N-TQD-602-00001, *Nuclear Trainer Training and Qualification Description*, and Qualification Guide N-QG-602-00001, *Operator Training Instructor Qualification Guide*, serve to identify the training and qualification requirements for OPG staff who conduct Initial Certification Training, Initial Certification Examinations and Requalification Tests at Darlington NGS.

Such persons are normally previously or currently certified at Darlington NGS. OPG training governance also includes a provision for qualifying persons as Authorization Training Instructors and Examiners in cases where the person was not previously certified at Darlington NGS.

N-QG-602-00001 provides the detailed qualification requirements for Authorization Training Instructors, Initial Certification Examiner and Requalification Testing Examiners.

Persons who were previously or currently certified at Darlington NGS are granted a hard credit as applicable, by virtue of their having completed the initial certification training program as outlined in either:

- N-TQD-101-00001, *Authorized Nuclear Operator Initial Training and Qualification Description,*

- N-TQD-102-00002, *Nuclear* Shift Manager/Control Room Shift Supervisor Initial Training and Qualification Description, or
- N-TQD-105-00005, *Darlington Unit 0 Control Room Operator (CRO) Initial Training and Qualification Description*.

During their period of certification, these persons must also satisfy the continuing certification training requirements per N-TQD-103-00001, *Nuclear Certified Personnel Continuing Training and Qualification Description*.

For persons who were not certified at Darlington NGS, knowledge may be gained through completion of a Mentored Training Program. The training requirements of the Mentored Training Program will be dependent on the entry-level qualifications of each candidate. The program can take up to 40 weeks and allows the person to develop technical competence for plant operation. The program will be complemented by regular written evaluations and on-shift experience.

The Mentored Training Program serves to provide assurance that those examiners who were not previously certified at Darlington NGS are fully familiar with the knowledge and skill requirements of the persons being examined.

Persons seeking qualification as Initial Certification Examiners or Requalification Testing Examiners must also hold qualification as a Full-Scope Simulator Instructor.

Before becoming qualified as examiners, the individual must also satisfy the other requirements specified in CNSC-EG1, Rev.0: *Requirements and Guidelines for Written and Oral Certification Examinations for Shift Personnel at Nuclear Power Plants,* CNSC-EG2, Rev.0: *Requirements and Guidelines for Simulator-based Certification Examinations for Shift Personnel at Nuclear Power Plants*, and CNSC document: *Requirements for the Requalification Testing of Certified Shift Personnel at Nuclear Power Plants,* Revision 2. These include:

- Familiarity with the assessment techniques used during testing on a full scope simulator;
- Familiarity with the criteria and guidelines for simulator-based certification examinations;
- For Lead Examiners, On-the Job training as an examiner.

Each of the regulatory requirements is addressed by the detailed qualification requirements specified in N-QG-602-00001 and reflected in the structure of the Training Information Management System.

The Table below is an update to Table 3 of the 2025 Licence Renewal Application in Reference 1 for Certified Staff at Darlington NGS:

Table 1: Certified Staff at Darlington Nuclear (December 5, 2024)

Certified Position	Number of Certified Staff	Number of Trainees
Shift Manager and Control Room Shift Supervisor	26	27
Authorized Nuclear Operator	64	6
Unit 0 Control Room Operator	19	0
Responsible Health Physicist	5	0

Section 2.2.5 – Fitness for Duty

The following provides an update to fitness for duty regarding the implementation of REGDOC-2.2.4, Fitness for Duty, Vol. II: Managing Alcohol and Drug Use, Version 3:

As documented in the 2025 Licence Renewal Application in Reference 1, OPG has implemented programmatic elements to comply with certain aspects of REGDOC-2.2.4. 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 worker's holding Safety-Critical Positions at high-security nuclear facilities. This decision was appealed by the Unions', and while awaiting the outcome of the appeal which was heard in January 2024, all licensees, including OPG, were restricted from implementing the pre-placement and random testing requirements. On November 6, 2024, the Federal Court of Appeal issued their decision to uphold the Federal Court ruling on the validity of the pre-placement and random alcohol and drug testing requirements mandated by REGDOC-2.2.4.

Further communication to OPG on implementation timelines is pending from the CNSC (Reference 7).

2.3 Operating Performance

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

The following sections provide a description of updates, including information related to CNSC staff's review of OPG's application in Reference 2 and OPG's response to CNSC staff's review in Reference 3, since the application submission in this area. More information on the Operating Performance SCA is available in Section 2.3 of the 2025 Licence Renewal Application (Reference 1).

Section 2.3.2 – Procedures

The following is additional information regarding Electronic Based Procedures:

The Electronic Based Procedures (Computer Based Procedures) project is an Information Technology initiative.

Human Factors Engineering (HFE) Specialists provided some HFE support for this initiative whereby HFE Specialists were involved in providing input to the Request for Proposal, provided Ease-of-Use evaluation criteria for the evaluation of potential proponents, participated in the evaluation / ranking of the proponents, attended project meetings, and identified HFE issues/concerns throughout the project. In addition, the HFE Specialists researched best practices for Computer Based Procedures and participated in the analysis of results from the Computer Based Procedures pilot that collected data from both procedure performers and authors.

Development of the Electronic Based Procedures follows existing governance and processes as per procedure N-PROC-AS-0028, *Development, Review and Approval of Technical Procedures*.

Technical reviews of the draft procedures include a review automated functionality. Once issued, a PDF of the Electronic Based Procedure would be stored in the Approved Information Management System and would be available in the same formats as the current procedures.

The implementation of the project is still ongoing. A limited subset of procedures is being developed as a trial currently limited to Main Control Room panel checks and Operator Test Procedures. To date, no Electronic Based Procedures have been issued at Darlington NGS.

Section 2.3.5 – Safe Operating Envelope

The following is additional information regarding OPG's Safe Operating Envelope (SOE) Improvement Project:

The SOE program at Darlington NGS has undergone continuous improvements driven by internal and external inspections and audits. As a continuous improvement opportunity, the Darlington NGS SOE Improvement Project was initiated to iteratively improve the SOE over time. As part of this initiative, OPG self-identified an opportunity to provide further clarity to the technical basis of some existing Operational Safety Requirements (OSRs) safety limits and availability requirements. The review is now complete of the SOE documents (e.g. OSRs) and operational documents (e.g. Abnormal Incident Manuals). Any enhancements noted in the review of the SOE documentation are being processed through OPG's document change management process and notifications will be made to the CNSC, where applicable, as per Regulatory requirements. The review supported the recent closure of a CNSC staff inspection item.

2.4 Safety Analysis

Darlington NGS has an effective Safety Analysis program which meets or exceeds all applicable regulatory requirements and related objectives. The program ensures the maintenance of the safety analysis that supports the overall safety case for the facility. It also ensures there is demonstrated acceptability of the frequency and consequences of design-basis and beyond design basis events, with the ability of protective systems and emergency mitigating equipment to adequately control power, cool the fuel and contain or limit any radioactivity that could be released from the plant.

The following sections provide a description of updates, including information related to CNSC staff's review of OPG's application in Reference 2 and OPG's response to CNSC staff's review in Reference 3, since the application submission in this area. More information on the Safety Analysis SCA is available in Section 2.4 of the 2025 Licence Renewal Application (Reference 1).

2025 Licence Renewal Application, Section 2.4.1 – Deterministic Safety Analysis

The following provides additional information regarding OPG software governance and requirements for deterministic safety analysis:

The primary objectives of performing Deterministic Safety Analysis are to confirm that the design of the Nuclear Power Plant meets design and safety requirements, and to derive or confirm operational limits and conditions that are consistent with the design and safety requirements. Furthermore, Deterministic Safety Analysis must confirm that the structures, systems, and components, in combination with plant procedures and operator actions, are effective in fulfilling their safety functions and keeping the releases of radioactive material from the plant below acceptable limits.

The governing document for nuclear safety analysis is N-PROG-MP-0014, *Reactor Safety Program*, which defines the organizational responsibilities and key program elements for management of issues related to Deterministic Safety Analysis.

Software used for Deterministic Safety Analysis falls under the scope of Scientific, Engineering and Safety Analysis software classification which is governed by N-PROG-MP-0006, *Software*. The software program complies with CSA N286-12, *Management System Requirements for Nuclear Facilities* and CSA N286.7-16, *Quality Assurance of Analytical, Scientific, and Design Computer Programs for Nuclear Power Plants*.

N-STD-MP-0008, *Development, Qualification and Use of Scientific, Engineering, and Safety Analysis Software*, provides requirements for development, qualification and use of Scientific, Engineering and Safety Analysis software in design, analysis or support of the continued operation of OPG Nuclear stations. Special emphasis is placed on software that falls within the scope defined by CSA N286.7-16.

2025 Licence Renewal Application, Section 2.4.2 – Hazard Analysis

The following provides additional information regarding OPG's plans to address the construction and future operation of Darlington New Nuclear Project (DNNP) BWRX-300 in the hazard analysis for Darlington NGS:

Hazard Analysis for Darlington NGS is performed in compliance with REGDOC-2.4.2, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants*. NK38-REP-03611-10043, *Hazards Screening Analysis – Darlington*, was last updated in 2019 as part of the 5-year update cycle for the Darlington NGS PSAs.

OPG is currently updating the Darlington NGS Hazard Screening Analysis (HSA) for the 2025 Darlington NGS PSA updates. The scope of work for this HSA update includes the potential hazards that will arise from the construction activities taking place on the DNNP site. This updated HSA will be provided to CNSC staff as part of the 2025 Darlington NGS PSA submissions in compliance with the REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants.*

The potential operational hazards from the DNNP BWRX-300 operation have not been considered for this round of the 2025 Darlington NGS update. OPG will perform a HSA to assess the impact of operational hazards from BWRX-300 operation on the Darlington NGS site when the BWRX-300 operational details and detailed design are available. The impact of DNNP operational hazards on Darlington NGS will be included in the scope of the next Darlington NGS PSA, provided the required inputs are available.

Climate Change

Based on CNSC staff's request in Reference 2 and OPG's subsequent response in Reference 3, the following is an update of the process of conducting a climate change assessment of Darlington NGS:

Since the submission of the 2025 Licence Renewal Application (Reference 1), OPG Nuclear is adapting their methodology to align with the Electric Power Research Institute (EPRI) *Climate Vulnerability Assessment Guidance for Nuclear Power Plants*. As a result, Darlington NGS will also follow this guidance recommendation and has provided an update to CNSC staff via Reference 8.

To summarize, Darlington NGS intends to perform a forward-looking climate risk assessment using the EPRI guidance and has acquired site-specific climatic indicators to identify possible vulnerabilities and develop strategies, if required, to ensure the nuclear assets are resilient to potential future changes in climate. The plan is to identify climate-related hazards followed by an assessment that evaluates the exposure of different components of the plant to these hazards which will lead to a vulnerability assessment where the interactions of the exposed assets and the climate-related hazards are considered to understand the potential impact on nuclear safety. Finally, a risk analysis is to be used to prioritize adaptation strategies considering the available adaptive capacity.

2025 Licence Renewal Application, Section 2.4.3 – Probabilistic Safety Analysis

The following provides additional information regarding the Darlington NGS Probabilistic Safety Assessment:

As per the requirements of REGDOC-2.4.2, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants* and REGDOC 3.1.1, *Reporting Requirements for Nuclear Power Plants,* OPG performs updates of the Darlington NGS PSA every 5-years. As part of these updates, OPG also prepares a PSA summary report which is released to both the CNSC and the general public. The PSA summary report contains a summary of the methods used to prepare the different PSAs, identifies the changes made with respect to the previous update, and provides the results of the PSAs.

The results of the latest PSA for Darlington NGS from the 2020, *Darlington NGS Probabilistic Safety Assessment Summary Report*, NK38-REP-03611-10072-R002, are provided in the Table below:

Table 2: Results of 2020 Darlington NGS PSAs from NK38-REP-03611-10072-R002

Model	Severe Core Damage Frequency (occurrences per reactor year)	Large Release Frequency (occurrences per reactor year)
Internal Events At-Power	1.7E-06	7.9E-07
Internal Events Outage	4.7E-07	4.6E-07
Internal Fire At-Power	2.8E-05	9.1E-06
Seismic At-Power	7.4E-06	7.4E-06
Internal Flooding At-Power	4.9E-08	1.3E-08
High Wind At-Power	1.9E-06	1.7E-06
Non-Reactor Sources	N/A	7.1E-08
OPG Safety Goal	1E-04	1E-05
OPG Administrative Safety Goal	1E-05	1E-06

Appendix B of OPG's 2025 Licence Renewal Application (Reference 1), provides additional details on specific systems such as the functional and performance requirements, nuclear safety requirements, and projects and modifications on each system or various components within the system. For each 5-year update cycle, a project freeze date is identified, and all design changes and operational changes which have been made to the plant as of the freeze date are modelled in the PSA. The 2020 Darlington NGS PSA had a project freeze date of December 31, 2018. Any changes to the plant, which have been implemented since then and until the 2025 Darlington NGS PSA freeze date of December 31, 2023, will be captured in the 2025 Darlington NGS PSA, and the impact on the Severe Core Damage Frequency and Large Release Frequency will be quantified.

The following provides additional information regarding the Darlington NGS PSA and the Darlington Refurbishment Project:

The Darlington Refurbishment Project incorporated several Safety Improvement Opportunities (SIOs) to improve plant safety. The following SIOs were credited in the 2020 Darlington NGS PSA:

- Shield Tank Overpressure Protection;
- Powerhouse Steam Venting System;
- Third Emergency Power Generator;
- Installation of Emergency Mitigation Equipment;
- Emergency Service Water make-up to the Heat Transport System.

Following the implementation of these SIOs, there was a significant decrease in the Severe Core Damage Frequency and Large Release Frequency. The results of the 2020 Internal Events At-Power PSAs, which incorporated the SIOs, can be seen in the table below, along with the results from the 2015 PSA, which did not contain credit for the SIOs.

Table 3: Results of the 2015 and 2020 Darlington NGS Internal Events At-Power PSAs

Model	**Severe Core Damage Frequency (occurrences per reactor year)**	**Large Release Frequency (occurrences per reactor year)**
2015 Internal Events At-Power PSA	2.3E-06	1.0E-06
2020 Internal Events At-Power PSA	1.7E-06	7.9E-07
Percent Risk Reduction Between 2015 and 2020	26%	21%

To confirm the assignment of probabilities in the PSA appropriately represents SIO changes for each unit, sensitivity cases are run. The 2020 Darlington NGS PSAs ran sensitivity cases to assess the Severe Core Damage Frequency and Large Release Frequency for the station in various refurbishment configurations. In these sensitivity cases, the SIOs were credited for units in post-refurbishment states and were not credited for units in pre-refurbishment states. The 2025 Darlington NGS PSAs will model all four units in post refurbishment state as the baseline and will run sensitivity cases for any units in refurbishment outage during the 5-year cycle.

2.5 Physical Design

Darlington NGS has an effective program to maintain its design basis which meets or exceeds all applicable regulatory requirements and related objectives. The program ensures that Structures, Systems and Components meet and maintain their design basis given new information arising over time and taking changes in the external environment into account.

The following sections provide a description of updates, including information related to CNSC staff's review of OPG's application in Reference 2 and OPG's response to CNSC staff's review in Reference 3, since the application submission in this area. More information on the Physical Design SCA is available in Section 2.5 and Appendix B of the 2025 Licence Renewal Application (Reference 1).

2025 Licence Renewal Application, Section 2.5.2 – Site Characterization

The following provides additional information regarding the Darlington NGS Flood Hazard Assessment:

OPG plans to evaluate the potential cumulative impact of the Darlington New Nuclear Project (DNNP) on Darlington NGS flood hazard assessment once the detailed design of DNNP is available. In 2014, OPG performed and documented a detailed hydrological assessment for Darlington NGS and issued NK38-REP-03610-0566868, *External and Construction Hazard Screening and Assessment for Darlington Campus Plan Aggregate Modifications: External Flooding Addendum* in 2015 to document the potential cumulative impact of the Campus Plan modifications (from the Darlington NGS Refurbishment project) on nuclear safety with respect to external hazards. The addendum was revised in 2017 to reflect the latest campus plan.

In 2022, a flood hazard assessment for the DNNP site was prepared (NK054-REP-02730-00001, *BWRX-300 DNNP Development Flood Hazard Assessment*). This assessment identified flood hazards at the DNNP site due to natural and human-induced hydrological and meteorological events internal and external to the site, including simultaneous combinations of these events.

2025 Licence Renewal Application, Section 2.5.5.2 – Environmental Qualification of Equipment)

The following provides additional information regarding Environmental Qualification requirements:

Darlington Environmental Qualification (EQ) assessments and Preventive Maintenance program addresses the station life for all environmentally qualified equipment and inherently includes extended commercial operation. N-PROG-RA-0006, *Environmental Qualification* addresses operation for the entire life of the plant, which is as per REGDOC-2.5.2, *Design of Reactor Facilities: Nuclear Power Plants* and CSA N290.13, *Environmental qualification of equipment for nuclear power plant*s and is captured under Section 1.1, *Program Requirements.* Section 1.1 also ensures that documentation and demonstration of qualification is maintained current with the plant licensing basis.

2025 Licence Renewal Application, Section 2.5.5.3 – Electromagnetic Interference

The following provides an update on the status of the revision of the OPG guidelines for Electromagnetic Compatibility:

OPG has guidelines in place for Electromagnetic Compatibility testing in conjunction with the Engineering Change Control process. The guidelines provide design engineering teams with International Electrotechnical Commission standards and test levels to consider in their design and testing requirements for instrumentation and electrical equipment. This allows for the mitigation of potential Electromagnetic Interference issues, and appropriately considers the criticality and safety classification of the System Structures and Components.

Since submission of the 2025 Licence Renewal Application (Reference 1), the OPG guidelines for Electromagnetic Compatibility have been revised to take into account:

- Guidance from Electric Power Research Institute TR-102323, *Guidelines for Electromagnetic Interference Testing in Power Plants*; and,
- Updates to the International Electrotechnical Commission 61000 series, *Electromagnetic Compatibility*, of standards.

2025 Licence Renewal Application, Section 2.5.5.6 – Reactor and Reactor Coolant Systems Nuclear Design and Core Nuclear Performance

Update on Nuclear Design and Core Nuclear Performance

The following provides an update regarding the Cobalt-60 modification:

There is a permanent core design change to replace existing adjuster rods with cobalt adjusters of similar reactivity worth in all units. A recent amendment to the PROL allows Darlington NGS to operate with cobalt adjuster rods to generate the Cobalt-60 radioisotope (Reference 4). This modification will be first commissioned in Unit 1 return to service.

2025 Licence Renewal Application, Appendix B – B.17, Plant Auxiliary Systems – Water Treatment Plant

The following provides an update regarding the available for service date of the new Demineralized Water Plant:

The new Demineralized Water Plant currently has a target available for service date of the end of Q4-2024.

2.6 Fitness for Service

The Darlington NGS fitness for service program ensures 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 Darlington NGS remain available, reliable, effective and consistent with design, analysis and quality control measures.

The following sections provide a description of updates, including information related to CNSC staff's review of OPG's application in Reference 2 and OPG's response to CNSC staff's review in Reference 3, since the application submission in this area. More information on the Fitness for Service SCA is available in Section 2.6 of the 2025 Licence Renewal Application (Reference 1).

2025 Licence Renewal Application, Section 2.6 – Fitness for Service

The following provides additional information regarding Darlington NGS Compliance Verification Criteria documents:

The following non-OPG COG documents are Compliance Verification Criteria documents listed in the current Darlington Licence Conditions Handbook, LCH-PR-13.03/2025-R005, Licence Condition 6.1:

- COG-JP-4107-V06-R03, *Fitness-for-Service Guidelines (FFSG) for Feeders in CANDU Reactors*; and,
- COG-07-4089-R02, *Fitness-for-Service Guidelines for Steam Generator and Preheater Tubes*.

The following provides additional information regarding documents supporting the major components Periodic Inspection Program:

The following documents support the major components Periodic Inspection Program:

- I-STD-AS-0003, *Non-Destructive Examination*: this standard ensures that Advanced Inspection and Maintenance conducts Non-Destructive Examination in a planned and controlled manner using approved procedures and qualified personnel, including inspections to support the Periodic Inspection Program and the Sites' PROL in accordance with the applicable CSA Standards.
- N-PROC-MA-0052, *Flaw Dispositioning*: this procedure is to establish generic process and accountabilities for evaluation of CSA N285.4, *Periodic inspection of CANDU nuclear power plant components*, and N285.5, *Periodic inspection of CANDU nuclear power plant containment components*, periodic inspection results and preparation and submission of a disposition to the CNSC, and ensure disposition conditions are not exceeded. This procedure applies to components subject to periodic inspection under CSA N285.4 or N285.5.
- N-REP-31100-10041, *Acceptance Criteria and Evaluation Procedures for Material Surveillance Pressure Tube*: this report provides an outline of measurement and evaluation procedures, references to detailed testing procedures and acceptance criteria for the test results. Clause 12.4 of CSA N285.4 identifies mandatory material surveillance requirements for pressure tubes removed for material property testing.
- N-PROC-MA-0044, *Fuel Channel Life Cycle Management*: this procedure establishes the process to produce the fuel channels life cycle management plan to ensure each nuclear generating Unit maintains a current fuel channel periodic inspection program in accordance with requirements of CSA N285.4, Clause 12, *Fuel Channel Pressure Tubes - Supplementary Inspection*.
- N-PLAN-01060-10007, *Feeders Technical Basis Document*: this document is intended as a companion to N-PLAN-01060-10001, *Feeders Life Cycle Management Plan*. The background information, supporting documentation referenced, underlying rationales supporting the life cycle management plan strategies and fitness for service assessments are included in this technical basis document.

2025 Licence Renewal Application, Section 2.6.3.1 – Systems, Structures or Components-Specific Aging Management Plans

Fuel Channel Aging Management

The following provides additional information regarding fuel channel aging management and CSA N285.8:

The fuel channel life cycle management plan is updated annually to capture new information from outage inspections, research, and operating experience, in addition to activities planned in compliance with CSA N285.4, *Periodic inspection of CANDU nuclear power plant components* and CSA N285.8, *Technical requirements for in-service evaluation of zirconium alloy pressure tubes in CANDU reactors*. With the implementation of the fuel channel life cycle management plan, OPG will continue to demonstrate that aging mechanisms are understood and confirm that component condition remains acceptable via monitoring and inspection for post-refurbishment operation. OPG has committed to the long-term use of CSA N285.8 requirements for pressure tube fitness-for-service evaluations through compliance plan, N-REP-31100-10061, *Compliance Plan for Long-Term Use of CSA N285.8 for In-Service Evaluation of Zirconium Alloy Pressure Tubes*.

2025 Licence Renewal Application, Section 2.6.5 – Periodic Inspection and Testing and Structural Integrity

Darlington NGS CSA N285.7 Periodic Inspection Program

The following provides additional information regarding CSA N285.7:

CSA Standard N285.7, *Periodic inspection of CANDU nuclear power plant balance of plant systems and components* defines the requirements for the periodic inspection of balance of plant pressure-retaining systems, components, and supports that form part of a CANDU nuclear power plant. OPG submitted the Darlington NGS Transition Plan to CNSC staff for the 2021 edition of CSA Standard N285.7 in September 2024; per the timelines in Reference 5, and report NK38-REP-03680-11940, *Darlington NGS Periodic Safety Review (D-PSR): Integrated Implementation Plan*. The Transition Plan provides the plan and schedule for completing the work required for Darlington NGS's compliance with the Standard.

2.7 Radiation Protection

Darlington NGS has an effective Radiation Protection (RP) program that meets or exceeds all applicable regulatory requirements and related objectives. The health and safety of persons is protected through the implementation of the RP program, which ensures that radiation doses are kept below regulatory dose limits and are optimized and maintained As Low As Reasonably Achievable (ALARA). Radiological impacts of plant operation to workers and the public will continue to be of an acceptable level.

The following sections provide a description of updates, including information related to CNSC staff's review of OPG's application in Reference 2 and OPG's response to CNSC staff's review in Reference 3, since the application submission in this area. More information on the Radiation Protection SCA is available in Section 2.7 of the 2025 Licence Renewal Application (Reference 1).

2025 Licence Renewal Application, Section 2.7.2 – Worker Dose Control

The following provides additional information regarding the use of radiation detection instrumentation at Darlington NGS. This includes a description of how these instruments are selected, calibrated, maintained, and monitored for end-of-life, as well as an assessment of any shortcomings associated with the current suite of instruments:

Radiation Protection Equipment and Instrumentation

The process for ensuring approved RP instruments are used, calibrated, maintained and monitored for end of life is documented in N-PROC-RA-0066, *Lifecycle Management of Radiation Protection Instruments* as follows:

Selection of RP instrumentation:

- Only approved RP instruments shall be purchased as listed in N-EL-03425.42-10000, *List of Radiation Protection Instrumentation Approved for Purchase in Ontario Power Generation, Nuclear.* Approved RP instruments for specialized use are listed in N-EL-03425.42-10001, *List of RP Instrumentation for Specialized Use in OPG Nuclear.*
- Requests for the introduction of a new make, model or type of RP instrument requires a completed OPG-FORM-0260, *Change Management Plan*, in accordance with standard OPG-STD-0140, *Managing Change*, that is submitted to the Manager, Health Physics Department for approval. This standard outlines the Change Management approach to ensure changes achieve their intended results, maximize outcomes, and minimize risk. The Health Physics Department-Radiation Protection Programs and Field Support Section (HPD-RPP&FS) prepares an implementation plan that includes development of technical specifications if required, and an evaluation and performance testing against both site-specific conditions and specifications. The plan will ensure that instruments to be used at site have been acceptance tested.

Calibration of RP instrumentation:

- As per instruction N-INS-09071-10009, *Requirements for the Calibration and Maintenance of Radiation Protection Instruments*, all RP instruments, fixed or portable, shall be calibrated at least once a year. Calibrations shall be performed in accordance with procedures approved by the Health Physicist Instrumentation at HPD-RP Programs & Field Support (HPI-FS). Calibration of Fixed Area Alarming Gamma Monitors (FAAGM) and Fixed Area Alarming Tritium Monitors (FAATM) are performed using approved Control Maintenance procedures. An instrument record shall be generated each time an instrument is calibrated and a label indicating the calibration date shall be applied to the instrument. Darlington NGS uses a software solution for tracking of maintenance and calibration of RP instruments through procedures N-PROC-MA-0070, *Calibration of Field Equipment* and N-PROC-MA-0015, *Tool Control*.

Maintenance of RP Instrumentation:

- For each type of RP instrument, the manufacturer's service manual shall be registered as a controlled document in accordance with OPG-PROC-0178, *Controlled Document Management*. All maintenance work shall be performed in accordance with the registered service manual. A maintenance record or Work Report shall be generated each time an instrument is reported defective. RP instruments that have deficiencies noted during pre-operational checks will be identified with a defective instrument tag and removed from service pending repairs. Instruments reported defective shall be calibrated before they are returned to service.

Monitoring RP Instrumentation for End-of-Life:

- Manager Health Physics Department approves the maintenance-related Performance Indicators developed by HPI-FS to monitor the performance of portable RP instrumentation while in service. Performance Indicators are metrics used to track the health of the inventory of RP Instruments in use at OPG for availability and monitoring for end of service life. The indicators are divided into two distinct groups, Health Physics and Maintenance:
    1. Health Physics Indicators deal with the instrument's ability to accurately measure the radiation hazard it is designed to measure.
    2. Maintenance Indicators deal with the instrument's availability for use which is influenced by factors such as mean time between failures and includes managing the instrument inventory at sites. Factors such as cost (time and materials) to keep an instrument in service can also be used to determine service life. A description of performance indicators is referenced in N-INS-03425.41-10002, *Performance Indicators for Radiation Instruments*. HPI-FS collects data on performance and availability of portable RP instruments and prepares monthly Performance Indicator Report on Portable Radiation Instruments. Site HPIs prepare quarterly Fixed Instrument reports that capture the results of instrument sensitivity checks, availability, and detector lifetime. For monitors located at Zone 1 or public domain exit boundaries, challenge testing is performed annually. Deliberate failure tests are performed every 5-years or whenever modifications to the monitor due to hardware, firmware or software changes. Site HPI review Station Condition Records and Work Reports and utilize performance monitoring and self-assessments to identify industry best practices. Copies of Performance Indicator reports are provided to the site Section Manager, ALARA for local trending and to the Manager, RPP&FS, HPD for fleet trending and review to determine if changes to instrument calibration or maintenance are required. Annual reviews are also conducted to identify new instrument purchase requirements and replenishment of spare parts inventory necessary to ensure availability of instruments.
- System Engineers associated with Radiation Protection are assigned to monitor the performance of fixed RP monitoring systems, such as FAAGMs and FAATMs. As documented in procedure N-PROC-MA-0024, *System Performance Monitoring*, System Engineers conduct system monitoring activities in accordance with System Performance Monitoring Plans and initiate remedial actions in accordance with the Performance Monitoring Equipment List. FAAGMs and FAATMs are considered a "Tier 3" system (not production critical) and do not require monitoring in accordance with N-PROC-MA-0024, however they are still subject to all other applicable OPG nuclear programs and processes whereby some monitoring elements may use this procedure as a guide. With respect to FAAGMs, they are monitored on a "level of effort" basis as this Tier 3 system may consider system significance and impact of system failure in combination with:

1. System health history.
2. Chronic or repeat performance issues.
3. Degree of reliability assured by implemented activities in combination of:
    - Preventive, or Predictive Maintenance or Condition Based Monitoring

Therefore, a system performance monitoring plan and system walkdown performance element has been put in place for the FAAGMs.

Shortcomings Associated with Current Suite of Instruments:

- The neutron meters currently in use at Darlington are challenging to use (heavy and bulky) and are limited in quantity and availability. As part of life cycle management, HPD-RPP&FS are currently reviewing and assessing new neutron meters that have improved ergonomics and availability.
- RP identified a need for a portable tritium monitor that could measure airborne tritium concentrations at 5 MPCa or less that was intrinsically safe for use in the Tritium Removal Facility (TRF). HPD-RPP&FS were able to assess, approve and supply intrinsically safe tritium meters capable of measuring low concentrations (1 MPCa) for use in the TRF.
- A project is currently ongoing to replace the FAAGMs and FAATMs that have been in service since the station was built. Replacement is conducted due to the aging of equipment and obsolescence of spare parts.
- HPD-RPP&FS are assessing models of Electronic Personal Dosimeters that can measure neutron dose.

2025 Licence Renewal Application, Section 2.7.3 – Radiation Protection Program Performance

The following provides additional information regarding the outage work program series at Darlington NGS. Included are tables summarizing the major work series that contributed to Collective Radiation Exposure (CRE) values, along with lessons learned and results of self assessments over the current licensing period:

Outage Work Series

The following Table are the outage work program series summary of the ALARA plans contributing to collective dose:

Table 4: Outage – Major Work Series Contributing to Yearly CRE

Year	Outage – Major Work Series
2015	• Feeder Inspections. • Shield Tank Overpressure Protection (STOP) Modifications. • Fuel Channel Inspections.
2016	• STOP Modifications. • Feeder Inspections. • Fuel Channel Inspections.

Year	Outage – Major Work Series
2017	• Single Fuel Channel Replacement. • STOP Modifications. • Feeder Inspections. • Feeder Scanner Replacement. • Fuel Channel Inspections.
2018	• Fuel Channel Inspections. • Reactor Maintenance Support. • Feeder Inspections.
2019	• Feeder Inspections. • Fuel Channel Inspections. • Feeder Channel Replacement.
2020	• Single Fuel Channel Replacement.
2021	• Fuel Channel Inspections (new tooling). • Feeder Inspections. Note: there were two planned outages in 2021 with the major work series above.
2022	• Target Delivery Installation.
2023	• Not applicable – no planned outages.

Lessons Learned from Major Work Series

The following Table provides a summary of the outage work program series lessons learned.

Table 5: Summary of Major Work Series Lessons Learned

Major Work Series	Lessons Learned and Operating Experience	Dose Reduction Trend (adjusted for source term and scope)
Feeder Inspections	Development of remote tooling used for inspection of graylocs and instrument lines to maximize distance from source. Work control enhanced sequencing and logic of inspection locations to minimize platform movements, scaffold modifications, and feeder panel removals. Use of teledosimetry and rovers to minimize number of personnel on the reactor maintenance platform.	Decrease.
Fuel Channels Inspections (Damp Scrape)	In 2018, dose rates and contamination levels on used cutters increased due to deeper axial oxide cuts. Additional Silflex shielding installed on flasks containing cutters to minimize dose to personnel during shipping and transport. Contamination control on the maintenance platform: Installation of additional layers of Dandex to ease decontamination. Ensuring equipment	Measures put in place in 2018 contributed to a decrease trend in dose. In 2021, to accommodate a new sampling strategy, new tooling was used to conduct fuel channel sampling. The dose associated with the initial deployment of the new tooling was higher than expected.

Major Work Series	Lessons Learned and Operating Experience	Dose Reduction Trend (adjusted for source term and scope)
	is wrapped on the maintenance platform prior to craning down to vault floor. Embedding RP staff into inspection crews on the same shifts to improve effectiveness of mock-up training.	Through mock-up and proficiency improvement, the dose associated with the inspection remained consistent campaign over campaign. The method of manual fuel channel inspections are being replaced by automated machine delivery scrape in future post-refurbishment outages. Therefore, exposure to staff is expected to be significantly reduced.
STOP Modifications	Scaffold and platform installation and removal assessments improved (more detailed pictures and floor plans) to minimize rework and adjustment during execution. Temporary shielding improvements: Installation of scaffold shield wall to facilitate hanging of temporary shielding to reduce work area dose rates on the STOP platform. Heavy duty carabiners used for quicker installation and easier manipulation. Pre-fabrication of piping outside containment to minimize exposure time.	The STOP modification incorporated lessons learned from previous campaigns, and area dose rates were optimized using shielding strategy based on lessons learned from initial execution. The dose trends are comparable to each campaign after considering source term performance of each unit.
Single Fuel Channel Replacement	Specific and detailed access restrictions were established, based on extensive beam surveys to prevent unplanned exposures during open beam conditions. Procedural updates to ensure garter springs locations are monitored and controlled during removal to prevent exposure to personnel.	Decrease.
Feeder Scanner Replacements	Additional temporary shielding on Emergency Coolant Injection lines directly above feeder scanner pit to minimize work area dose rates. Pre-fabrication and connection of cables outside containment to minimize exposure time.	Decrease.

ALARA Self-Assessments

The following Table provides the ALARA self-assessments, documenting a summary of recommendations, actions and benefits.

Table 6: ALARA Self-Assessments

Self-Assessment	Recommendations & Actions	Details/Benefits (Actions are complete)
1	Revise damp scrape RP Coordinator assist plan. Addition to daily dose report: D2O trench level and status.	To improve contamination control practices during execution and demobilization. To bring awareness to outage organization on contributors to containment tritium levels and request assistance from Operations to drain.
2	Horizontal Flux Detectors and Liquid Injection Shutdown System shielding improvements. Emergency Coolant Injection shielding installation.	To improve Horizontal Flux Detectors and Liquid Injection Shutdown System shielding strategy to maximize shielding coverage. Continue to track progress on project to install magnetic steel bands permanently on all units to facilitate magnetic shielding installation and removal.
3	Implement the Rapid Access Program. Personal Contamination Events trending above year-to-date recovery plan.	Improved software for access control, streamlines process and qualification checks. Workgroup oversight during outages for tasks involving heavily contaminated equipment.
4	Electronic Personal Dosimeter dose alarm event mitigation. Contamination control.	Teledosimetry communication improvements and protocols. Dose alarm operating experience in continuing training. Mentoring of maintenance supervision to assess and recognize work with elevated contamination risk and utilize independent oversight as applicable to maintain ALARA.

2025 Licence Renewal Application, Section 2.7.4 – Radiological Hazards Control

Planning for Unusual Situations:

The following provides additional information regarding the RP provisions during unusual situations at Darlington NGS:

The category areas in the Table below document RP provisions for planning for unusual situations.

Table 7: RP Provisions for Planning for Unusual Situations

Category Area	Radiation Protection Provisions
Access Controls	• Assembly Areas for personnel accounting to help ensure personnel exposures are minimized from radiological hazards associated with incident area(s).

Category Area	Radiation Protection Provisions
	• Number of site support personnel strategically managed through Resource Deployment Manager in Site Management Centre to ensure number of potential personnel exposures are minimized. • Site ingress and egress considerations based on weather conditions, radiological conditions, and timing to any planned radiological release.
Habitability Controls	• Routine (hourly) radiation surveys conducted to establish habitability. • Eating and drinking provisions under the direction of Health Physics Manager. • Alarming gamma monitors alert personnel of changing radiological conditions.
Communication Systems	• Updates between Health Physics Manager in the Site Management Centre and Health Physics Director in the Corporate Emergency Operations Facility. • Communication available through direct landline, cell phone, third party web platform, fax, or dedicated beyond design basis accident telecommunication system and radio equipment.
Radiation Monitoring Capabilities	• Redundancy in exit radiation monitors for personnel. • Live-time transmitting gamma and tritium monitoring; hourly surveys obtained, reviewed, and transmitted. • Routine in-plant surveys for gamma dose rate, airborne tritium, and airborne particulate conducted by in-plant survey team at strategic locations, including corridors, airlocks, heat transport pump rooms, and other areas as directed by the Shift Manager. • Chemistry lab includes capabilities for analyzing airborne samples for radioiodine. • Gaseous Fission Product system includes sensitivity and alarms to key radionuclides associated with fuel defects.
Portable Emergency Response RP Equipment and Instrumentation	• Multiple D2O spill cabinets available throughout the plant for optimized spill response. • Dedicated portable gamma instruments poised for use (includes capabilities for high range detection and extension probe for increased distance). • Standalone dosimetry devices available for use when the standard services are unavailable or when directed by Shift Manager or Health Physics Manager. • N-PROC-RA-0040, *Maintenance and Testing of OPG Nuclear Emergency Response Organization Facilities and Equipment* includes addition site instructions to manage RP equipment checks supporting assembly area cabinets, in-plant survey team cabinets, off-site survey team, and Transportation Emergency Response Plan.
Radiation Personal Protection Equipment	• N-PROC-RA-0025, *Selection of Radiation Personal Protection Equipment* is followed to the extent practical.

Category Area	Radiation Protection Provisions
	• Provisions for radiation personal protective equipment under emergent work documented with use approvals required by Responsible Health Physicist.

Retube Waste Processing Building

The following provides additional information regarding the scope of decommissioning and demobilization of the Retube Waste Processing Building and its contents.

OPG Refurbishment RP decommissioning project groups have initiated preliminary discussions regarding the scope of decommissioning and demobilization of the Retube Waste Processing Building and its contents. As part of the ALARA process under program N-PROG-RA-0013, *Radiation Protection* and procedure N-PROC-RA-0027, *Radioactive Work Planning, Execution and Close Out,* an assessment of the impact on the health and safety of persons will be performed as part of N-PROC-RA-0027, Section 1.9.3, *"ALARA Plans".* Dose estimation is part of the planning process as well as identifying opportunities to reduce dose in specific tasks.

Darlington Worker Dose

The following Table provides additional information regarding worker dose data requested by CNSC Staff in Reference 9. This data has not historically been collected through the Nuclear Power Plant Personnel report.

Table 8: Worker Dose Data for a Nuclear Energy Worker

Regulatory Limit for a NEW	Dose Statistic for a NEW	2015	2016	2017	2018	2019	2020	2021	2022	2023
500 mSv/year	Average[2] skin dose (mSv)	1.24	1.47	3.31	2.75	1.97	1.28	3.76	3.04	2.84
	Maximum skin dose (mSv)	18.59	9.27	19.45	19.25	12.49	9.89	20.18	20.43	20.92
500 mSv/y	Average[2] extremity dose (mSv)	2.15	2.01	4.38	3.56	2.44	1.53	4.33	3.19	3.05
	Maximum extremity dose (mSv)	29.23	17.57	40.49	183.24	69.97	19.31	31.53	20.43	26.05
150 mSv/y (prior to Nov 2020)[1] 50 mSv/y (after Nov 2020)	Average[2] Lens-of-Eye dose (mSv)	N/A	N/A	N/A	N/A	N/A	N/A	3.75	3.0	2.8
	Maximum Lens-of-Eye dose (mSv)	N/A	N/A	N/A	N/A	N/A	N/A	19.95	19.4	20.2

Regulatory Limit for a NEW	Dose Statistic for a NEW	Previous Regulatory Dose Period*: 01 January 2016 – 31 December 2020 (mSv)	Current Regulatory Dose Period*: 01 January 2021 – 31 December 2025 (mSv) (provide dose to date)[4]
100 mSv effective dose over a 5-year regulatory dose period	Maximum individual effective dose for a NEW at the DNGS	52.19	67.4
	Average[2] individual effective dose for a NEW at the DNGS	5.11	6.82

[1] Prior to 2020 for a Nuclear Energy Worker (NEW) the regulatory eye dose limit was 150 mSv per annum. OPG did not record eye dose prior to 2020 as annual total effective dose was used as a limiting factor.
[2] Average value is calculated based on non-zero doses.
[3] Dose reported above is based on OPG's dosimetry year, not calendar year.
[4] Calculated based on doses from 2021 - Q2 2024.

2025 Licence Renewal Application, Section 2.7.4.1 – Enhancements and Methods for Improved Radiological Hazards Control

The following provides additional information regarding the initiatives and changes to enhance RP/ALARA performance at the Darlington NGS for the proposed licensing period:

OPG is undertaking various opportunities in an effort to reduce worker exposures and keeping collective doses ALARA. This includes, but is not limited to, the following initiatives and programs:

New Type of Channel Closure Plugs

OPG is utilizing a new type of channel closure plugs, effectively managing channel leakage during various Primary Heat Transport operating states during unit outages, effectively containing tritiated water within the Primary Heat Transport system and lowering vault tritium.

Enhanced Fuel Channel Inspection Techniques

Enhancing fuel channel inspection techniques by utilizing a Rapid Deployment System including Advanced Non-Destructive Examination (ANDE) inspections, ANDE replication (contingency) and Machine Delivered Scrape. The ANDE system is used to perform volumetric and dimensional inspection and replication of selected fuel channel flaws, while the Machine Delivered Scrape system is to take pressure tube samples using the Circumferential Wet Scrape Tool. Utilizing these systems will greatly reduce worker exposure by eliminating ice plug work inside feeder cabinets and eliminate workers performing channel inspection in front of the reactor face. The added benefit of eliminating formation of channel ice plugs will also aid tritium recovery within containment by maximizing performance on the Vault Vapour Recovery System.

Radionuclide Characterization

The objective of a radionuclide characterization program is to determine the radionuclide distribution of contamination at Darlington NGS by nuclide speciation. This process is useful to confirm that the assumptions made in the dosimetry program and contamination control and monitoring program are justified. Darlington NGS is required to undertake a routine radionuclide characterization program at a minimum every 5-years. This includes new buildings, sites, plant modifications (such as isotope production) or reactors where radionuclide materials are anticipated and may result in airborne radiological hazards during work activities. This is to manage any new radiological source term and the associated radiological hazard/risks. The associated instruction is N-INS-09071-10019, *Radionuclide Characterization at OPG Nuclear Facilities*.

Emergency Coolant Injection Steel Band Modifications

The last set of Emergency Coolant Injection bands, to facilitate shielding, will be installed in Unit 3 by 2026 during the planned maintenance outage. Expected dose savings from this initiative will continue to benefit staff accessing the 111m elevation and working/traversing near the Emergency Coolant Injection lines.

Moderator D2O Supply Line Cut and Cap Modification

This modification is expected to terminate accumulation of radionuclides within the Horizontal Flux Detectors and Liquid Injection Shutdown System heavy water bellows, in the Shutdown System 2 bunker. Project preparation is currently underway. When instituted, expected dose savings from the initiative will benefit all personnel performing maintenance on Shutdown System 2 components inside containment during outages.

Additional Initiatives:

- As part of the ALARA program, outage activity transport monitoring surveys will continue on planned outages. Source term characterization surveys are completed as part of the ALARA program requirement to trend potential changes in radionuclide composition. The Site ALARA Committee acts as an oversight entity on site CRE performance and ensuring actions are in place for continued dose reduction efforts and meeting industry CRE goals.
- The tritium oversight committee provides weekly updates on site tritium performance. Its mandate is to place priority and focus on maintaining station's tritium recovery systems, as well as keeping station and public dose ALARA. The committee is currently tracking tritium initiatives such as key component replacement to restore fueling facilities auxiliary areas Vault Vapour Recovery System and TRF availability. The team also assesses the deployment of portable tritium recovery devices as applicable.
- The Darlington RP Department meets on a quarterly basis with site CNSC personnel and CNSC RP specialists from Ottawa to review and discuss RP related topics such as:
    - RP Performance Indicators – monthly metrics.
    - Ongoing and new initiatives.
    - Outage performance and preparation for upcoming outages.
    - Planned updates/changes related to RP procedures.
    - Review of action items and outstanding items from previous meetings.
    - Additional Items – Station Condition Records, trend reports and Operating Experience.
    - Self-Assessments and nuclear oversight audits.
- Darlington NGS provides the necessary information and support for various requests during CNSC audits, including inspections such as Type I, Type II, Desktop and field inspections as well as compliance assessments. These audits are often conducted numerous times over a given licensing period. The scope of the audits involves OPG's response, correction, and/or closure to CNSC observations and findings related to RP matters.
- OPG is an active member of COG and participates in Peer Team meetings to exchange lessons learned and best practices from industry peers. The COG Peer Team also establishes various working level task teams to align industry best practices.

2.8 Conventional Health and Safety

OPG is committed to preventing workplace injuries and ill health, and continuously improving employee health and safety performance. The goal of OPG's Conventional Health and Safety program is to ensure a healthy and injury-free workplace by managing risks resulting from the activities, products, and services associated with OPG's Darlington NGS operations.

The following sections provide a description of updates since the application submission in this area. More information on the Conventional Health and Safety SCA is available in Section 2.8 of the 2025 Licence Renewal Application (Reference 1).

2025 Licence Renewal Application, Section 2.8.1.1 – Accident Frequency Rate

The following provides an update on the Darlington NGS Accident Frequency Rate statistics:

The Accident Frequency is the sum of the fatalities, lost-time injuries and medically treated injuries multiplied by 200,000 person hours worked at a Nuclear Power Plant, per exposure hours.

OPG's commitment to continuously improve performance is reflected by setting challenging targets for safety performance metrics. Darlington NGS has continually tightened its target rate for disabling injuries, and its safety performance has been below (better than) target since 2019 to Q3 2024. The figure below provides an update to Figure 21 of the 2025 Licence Renewal Application (Reference 1) to include the Q3 2024 data.

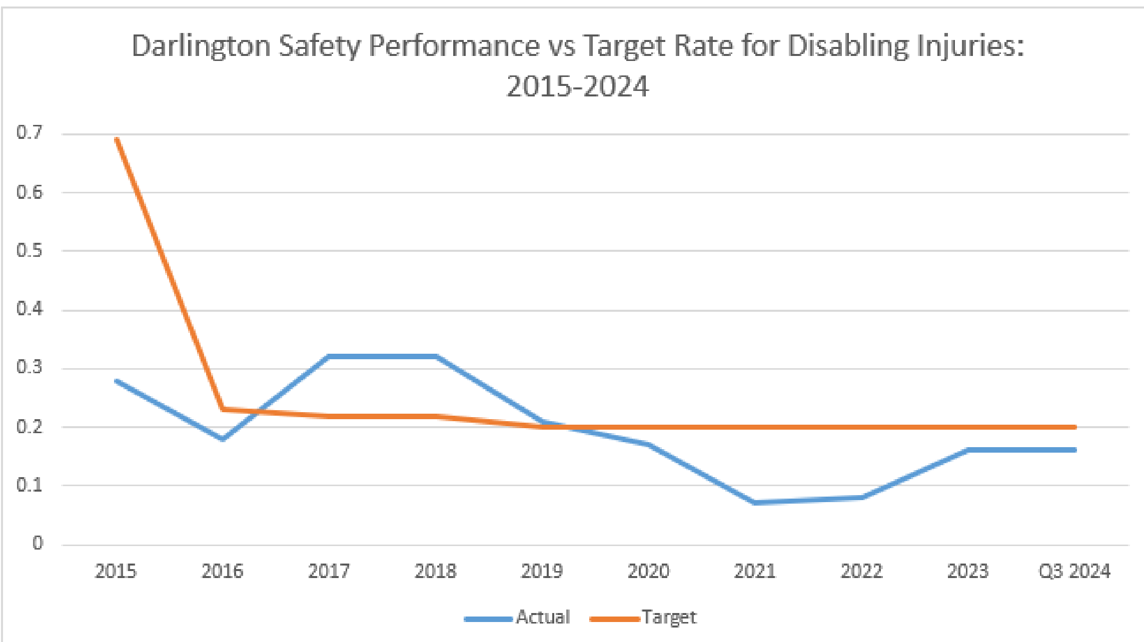


Figure 2: Darlington NGS – Accident Frequency Rate 2015-Q3 2024

2025 Licence Renewal Application, Section 2.8.1.2 – Industrial Safety Accident Rate (ISAR)

The following provides an update on the Darlington NGS Industrial Safety Accident Rate statistics:

The ISAR is a frequency rate based on the number of lost-time injuries for Nuclear Power Plant (NPP) personnel per 200,000 hours worked (excluding contractors).

The Darlington NGS has upheld a consistent record of zero lost time injuries from 2019 up to Q3 2024. The figure below provides an update to Figure 22 of the 2025 Licence Renewal Application (Reference 1) to include the Q3 2024 data.

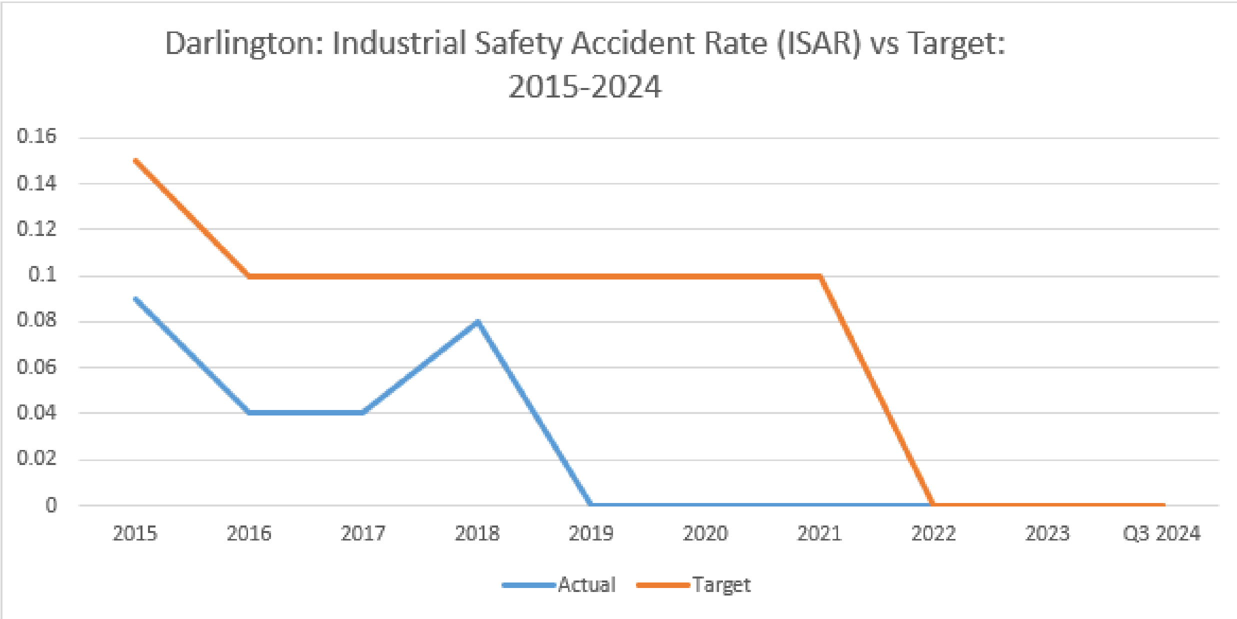


Figure 3: Darlington NGS – Industrial Safety Accident Rate (ISAR) vs. Target 2015-Q3 2024

2025 Licence Renewal Application, Section 2.8.1.3 – Accident Severity Rate (ASR)

The following provides an update on the Darlington NGS Accident Severity Rate statistics:

The ASR is the number of days lost multiplied by 200,000 person hours worked at a Nuclear Power Plant, per exposure hours.

Darlington NGS has upheld a consistent record of zero lost time injuries, resulting in no lost time days up to Q3 2024 since 2019. The figure below provides an update to Figure 23 of the 2025 Licence Renewal Application (Reference 1) to include the Q3 2024 data. There are no targets set for ASR.

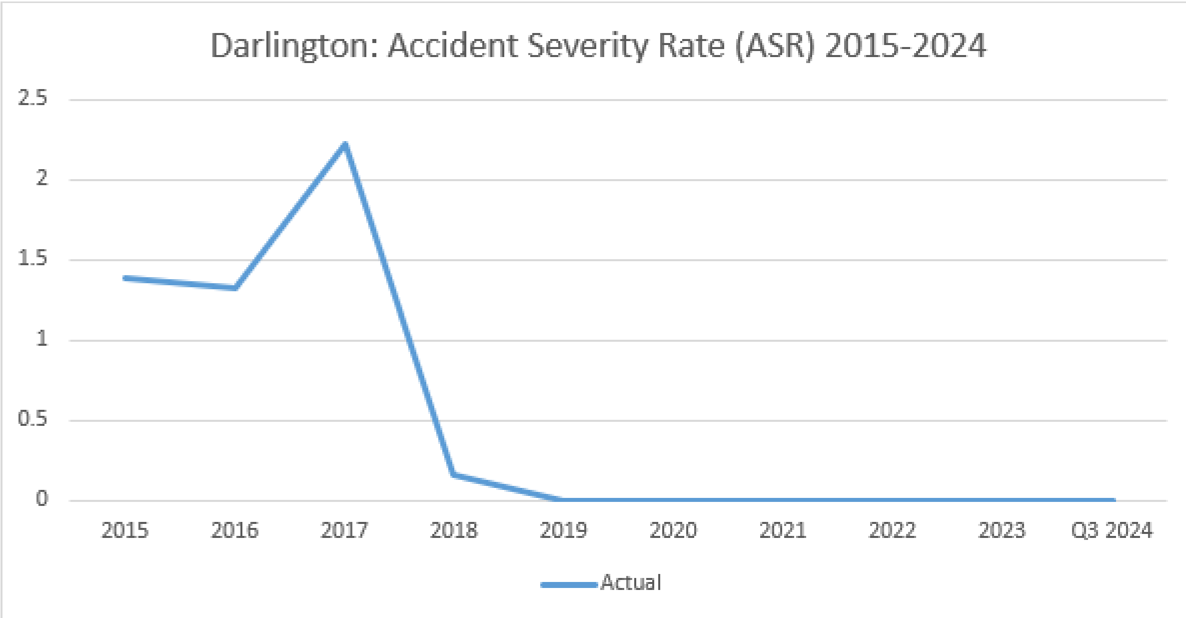


Figure 4: Darlington NGS – Accident Severity Rate (ASR) 2015-Q3 2024

2025 Licence Renewal Application, Section 2.8.1.4 – Serious Injury Incidence Rate (SIIR)

The following provides an update on the Darlington NGS Serious Injury Incidence Rate statistics:

The SIIR is defined as the number of work-related accidents for all OPG employees that result in serious injuries or fatalities, per 200,000 person-hours worked. This metric focuses on more serious injuries, assists in maintaining attention on high-consequence hazards, and accounts for the actual injury instead of the type of medical treatment.

Darlington NGS SIIR has remained at zero since the introduction of the new safety performance metric in 2020 up to Q3 2024.

2025 Licence Renewal Application, Section 2.8.1.5 – Timely Completion of Safety Corrective Actions (TCSCA)

The following provides an update on the Darlington NGS Timely Completion of Safety Corrective Actions Annual Comparison:

TCSCA aims to prioritize completion of safety related actions in a timely manner. TCSCA is the percentage of corrective actions, arising from safety events, that are completed on or before the initial due date (zero extensions).

Darlington NGS consistently demonstrates its commitment to prioritizing safety-significant work since the introduction of the leading indicator metric in 2019. Darlington NGS has performed better than target since the introduction of the metric and maintained 100% for the past 4-years. The figure below provides an update to Figure 24 of the 2025 Licence Renewal Application (Reference 1) to include Q3 2024 data.

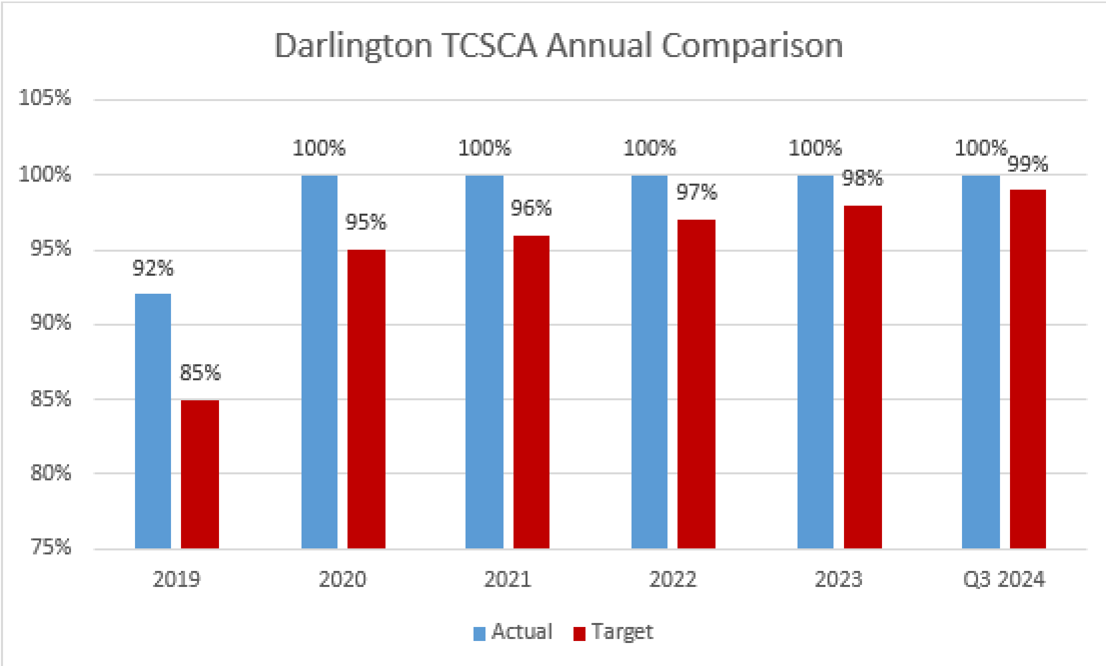


Figure 5: Darlington NGS – TCSCA Annual Comparison

2.9 Environmental Protection

OPG's comprehensive environmental protection programs aim to continually minimize impacts from the station operation on the environment and human health. This is achieved by ensuring that there are multiple barriers in place to control and minimize emissions to the environment and to ensure emissions are monitored.

The following sections provide a description of updates, including information related to CNSC staff's review of OPG's application in Reference 2 and OPG's response to CNSC staff's review in Reference 3, since the application submission in this area. More information on the Environmental Protection SCA is available in Section 2.9 of the 2025 Licence Renewal Application (Reference 1).

2025 Licence Renewal Application, Section 2.9.1 – Environmental Management System

The following is an update on the status of OPG's ISO Environmental Management System 14001 re-certification:

OPG maintains an Environmental Management System (EMS) that implements the requirements of OPG's Environmental Policy and is consistent with the International Organization for Standardization (ISO) 14001, *Environmental Management System Standard.*

OPG successfully obtained a renewed ISO 14001 EMS certificate following a recertification audit in 2024. The renewed certificate is valid for 3-years and expires July 4, 2027.

2025 Licence Renewal Application, Section 2.9.1.2 – Regulatory Compliance

The following provides an update on Darlington NGS environmental infractions during the licence period:

The Darlington NGS site operates under numerous environmental regulations governing plant operations. The primary regulators from an environmental perspective are the CNSC, Fisheries and Oceans Canada, Environment and Climate Change Canada, and the Ministry of the Environment, Conservation and Parks.

At OPG, infractions are regulatory non-compliances that have moderate potential for regulatory actions and/or involvement. There have been four additional infractions since the application was submitted, bringing the total to 13 infractions (as of September 30, 2024) for the current licence period. Most of these infractions were related to Environmental Compliance Approvals.

2025 Licence Renewal Application, Section 2.9.2 – Environmental Risk Assessment

The following is an update on the status of the 2024 Darlington Environmental Risk Assessment (ERA) Addendum:

OPG has prepared an Addendum to the 2020 ERA to support the renewal of the Darlington NGS PROL. D-REP-07701-00002 R000, *2024 Environmental Risk Assessment Addendum for the Darlington Nuclear Site*, serves as an interim update to the 2020 ERA ahead of the next routine ERA update in 2026. The 2024 ERA Addendum was submitted to CNSC staff in September 2024 (Reference 10) with a subsequent update in Reference 11, and focuses on activities that occurred during the years 2020 to 2022 (including some of 2023, where data was available at the time of preparation).

The 2020 ERA concluded that the Darlington NGS site is operating in accordance with approved limits and measures are taken to ensure regulatory compliance is maintained. The 2024 ERA Addendum confirms that the Darlington NGS site continues to be operating in a manner that is protective of human and ecological receptors residing in the surrounding area. The 2020 ERA is available on www.opg.com and the 2024 ERA Addendum will also be posted online.

OPG is committed to engaging with the Williams Treaties First Nations (WTFNs) and a summary of key issues raised by Indigenous Nations and communities during engagement sessions is included in the 2024 ERA Addendum. OPG shared the 2024 ERA Addendum report with Indigenous Nations and communities ahead of submission to CNSC staff and although no feedback has been provided to date, OPG will incorporate any feedback into future assessments as appropriate. OPG continues to work with Indigenous Nations and communities to develop comprehensive and ongoing engagement, including invitations to participate in monitoring activities.

2025 Licence Renewal Application, Section 2.9.4 – Effluent and Emission Control

The following provides additional information regarding OPG governance addressing regulatory requirements:

Section 6 of the *Class I Nuclear Facilities Regulations* requires that an application for a licence to operate a Class I nuclear facility shall contain the following information:

(i) *the proposed location of points of release, the proposed maximum quantities and concentrations, and the anticipated volume and flow of releases of nuclear substances and hazardous substances into the environment, including their physical, chemical and radiological characteristics.*

(j) *the proposed measures to control releases of nuclear substances and hazardous substances into the environment*

The information required by section 6 (i) is summarized in NK38-PLAN-03480-10001, *Darlington Effluent Monitoring Plan* (for nuclear substances). As discussed in subsection 2.9.4.1 of the 2025 Licence Renewal Application (Reference 1), NK38-PLAN-03480-10001 is developed as a requirement of N-STD-OP-0031, *Monitoring of Nuclear and Hazardous Substances in Effluents*, and addresses design requirements, reporting requirements, and sampling/analytical procedures use, in alignment with CSA N288.5, *Effluent Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills*. Subsection 2.9.4.1 of Reference 1 provides additional details on the objectives of the effluent monitoring program.

For hazardous substances, the following documents are relevant:

- Darlington Environmental Compliance Approval #0585-D4KP24.
- The annual OPG Written Summary Report, submitted to the Ministry of the Environment, Conservation and Parks, and provided to the CNSC, provides the emission summary tables and summarizes the year-to-year changes in Emission Summary and Dispersion Modelling. The Darlington Nuclear 2023 Written Summary Report was provided to CNSC staff in September 2024.

In addition, details on radiological emissions to air can be found in the following documents, which have been submitted to the CNSC:

- D-REP-07701-00001-R002, *2020 Environmental Risk Assessment for the Darlington Nuclear Site* (Reference 12).
- D-REP-07701-00002-R000, *2024 Environmental Risk Assessment Addendum for the Darlington Nuclear Site* (Reference 10).
- N-REP-03443-10031*, 2023 Results of Environmental Monitoring Programs for Darlington and Pickering Nuclear* (Reference 13).

Regarding the information required by section 6 (j), CNSC staff requested additional details on treatment systems and other control technologies to control releases of nuclear and hazardous substances (Reference 2). Examples of treatment technologies used at Darlington NGS include:

- Radiological substances in water: Active liquid waste system, ion exchange, filtration.
- Radiological substances in air: Tritium immobilization system, vapour recovery system, portable driers, High Efficiency Particulate Air (HEPA) filters, High Efficiency Carbon Adsorber (HECA) filters.
- Conventional substances in water: Ion exchange, filtration, aeration, chemical addition, inactive drainage lagoon system aeration and detention time, dichlorination system, oily-water separator.

- Conventional substances in air: HEPA filters, HECA filters.

Further information on treatment systems and other control technologies to control releases of nuclear and hazardous substances is contained in the following documents:

- D-REP-07701-00001-R002, *2020 Environmental Risk Assessment for the Darlington Nuclear Site* (Reference 12); and,
- D-REP-07701-00002-R000, *2024 Environmental Risk Assessment Addendum for the Darlington Nuclear Site* (Reference 10).

2025 Licence Renewal Application, Section 2.9.4.1 – Radiological Emissions to Air and Water

Environmental Action Levels

The following provides an update on the Action Level for Noble Gases:

Table 15, *"Darlington Nuclear – Action Levels for Environmental Releases"* of the 2025 Licence Renewal Application (Reference 1) identified the Action Level for Noble Gases as 3.29×10^{12} Becquerel/week. The correct value is **3.30×10^{12}** Becquerel/week.

2025 Licence Renewal Application, Section 2.9.4.2 – Conventional Emissions

The following provides an update on conventional emissions during the licence period as a result of site operations:

Ozone-Depleting Substances

Ozone-depleting substances are used in refrigeration systems. Refrigerant leaks to air are minimized through routine inspections and maintenance of equipment. Ozone-depleting substances releases between 10 kg and 100 kg are reported to Environment Canada in semi-annual halocarbon release reports. Since the information in the application was gathered, Darlington NGS has experienced one additional Ozone-depleting substances release bringing the total number of releases during the licence period to seven.

2025 Licence Renewal Application, Section 2.9.4.3 – Groundwater Protection and Monitoring Program

The following provides a summary of the 2023 Darlington Nuclear groundwater monitoring program results:

The overall goal of the Darlington NGS Groundwater Protection Program is to protect the quality and quantity of groundwater by minimizing interactions with the environment from activities associated with the site, allowing for effective management of its groundwater resource. To meet this overall goal, the Darlington NGS site has a Groundwater Monitoring Program to provide timely data confirming that uncontrolled releases are not occurring and, if uncontrolled releases do occur, to signal when and where.

The NK38-REP-10140-10036, *2023 Darlington Nuclear Groundwater Monitoring Program Results* is now available on opg.com along with the GIS map for the public to access. Information from NK38-REP-10140-10036 is provided below as a supplement to the 2022 data discussed in the 2025 Licence Renewal Application (Reference 1).

Water level elevation data collected as part of the Darlington NGS site's annual Groundwater Monitoring Program has shown that groundwater flow patterns remained consistent over the licensing period. The 2023 inferred shallow groundwater contour map is provided in the figure below (NK38-REP-10140-10036, *2023 Darlington Nuclear Groundwater Monitoring Program Results*). Outside of the protected area, groundwater generally is inferred to flow from the north to the south, towards Lake Ontario. Inside the protected area and in the vicinity of the powerhouse, groundwater is inferred to flow west and north towards the Forebay. Further south of the powerhouse, groundwater is inferred to flow toward Lake Ontario.

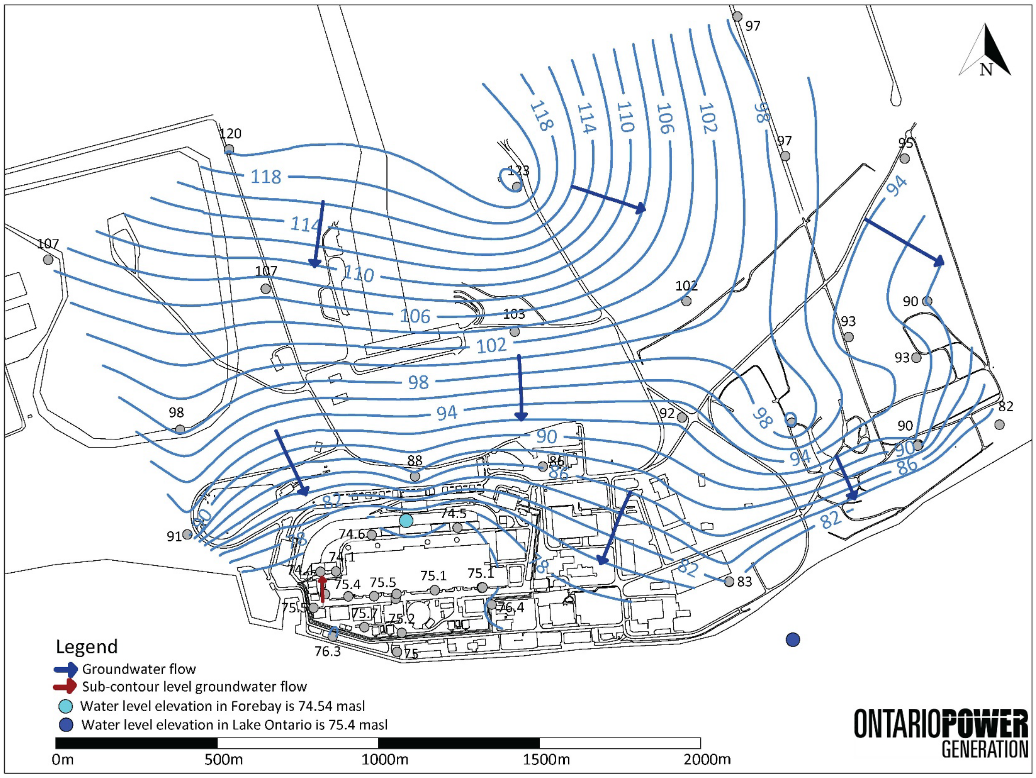


Figure 6: 2023 Inferred Shallow Groundwater Contour Map

In 2023, the majority of perimeter monitoring wells reported tritium concentrations below the method detection limit. Municipal drinking water samples collected from downstream water supply plants as part of the annual OPG Environmental Monitoring Program were well below the Ontario Drinking Water Quality Objective for tritium of 7,000 Bq/L.

2025 Licence Renewal Application, Section 2.9.4.4 – Spill Management Program

The following provides an update on environmental spills at Darlington NGS during the licence period:

At OPG, spills are classified as either Category A (Very Serious), Category B (Serious), Category C (Less Serious), or Category D (Exempted of Potential Spills). Spills are identified, classified, and reported following OPG-PROC-0041, *Environmental Event Identification, Classification, and Reporting*.

During the current licence term, there were no Category A or B spills. As of September 30, 2024, there were 16 recorded Category C spills. Although reportable, the majority of these spills were minor in nature with no expected impact to the environment.

2025 Licence Renewal Application, Section 2.9.5 – Protection of People

The following provides updated public dose data for the licence period:

The effective dose limit for members of the public as set out in the *Radiation Protection Regulations*, is 1,000 μSv/year. Figure 28 from the 2025 Licence Renewal Application (Reference 1) has been updated below to include the 2023 public dose data. As shown in the logarithmic scale in the figure below, the annual dose to the public from operation of the Darlington NGS site is a very small fraction of the annual legal dose limit.

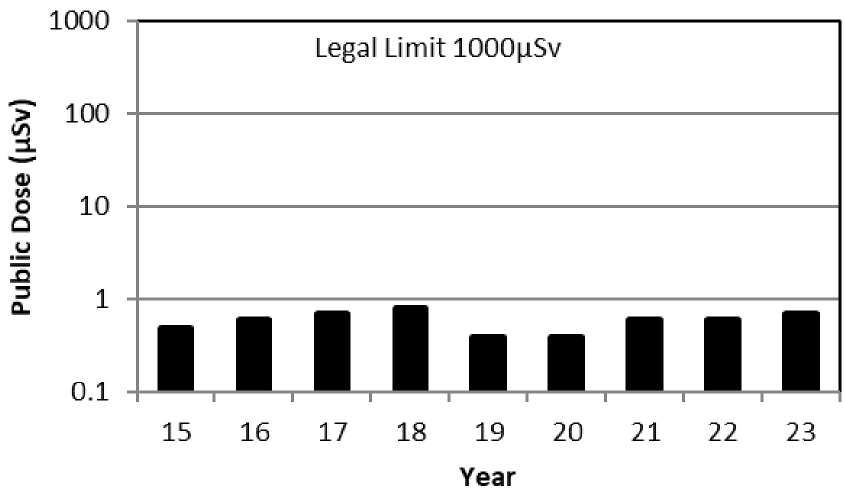


Figure 7: Public Dose Limits

2025 Licence Renewal Application, Section 2.9.7 – Thermal Plume

The following provides additional information on the thermal plume studies to be conducted under the Integrated Implementation Plan (IIP):

The Darlington NGS refurbishment follow-up monitoring program required a study of condenser cooling water plume temperatures to verify that the activities would not adversely affect the survival of round whitefish eggs laid in the plume. Temperature monitoring was conducted in the plume and at a reference location in the winter of 2017/2018.

The results of the thermal plume study documented in NK38-REP-07250-00001, *Darlington Refurbishment Follow-Up Monitoring Program: Thermal Plume Monitoring 2017-2018*, showed that the predicted effect of the plume ranged from a relative survival gain of 0.1% to a loss of 0.4%. This is a negligible effect that is not biologically significant and well below the 10% loss threshold that CNSC requires OPG to implement further mitigation measures. It was concluded that the operation of the site during the refurbishment period has not resulted in an adverse condition to the survival of round whitefish eggs laid in the plume. This confirms the prediction made in the Environmental Assessment, and no additional mitigation measures or monitoring are required during the refurbishment period.

With respect to next steps, per Environmental Assessment follow-up program activity IIP-EA-012, OPG will conduct thermal monitoring following the restart of all reactors from refurbishment. As per past practice, a summary of thermal monitoring activities will be provided in the annual Environmental Monitoring Program report. In addition, OPG will report on monitoring data collected during the Continued Operation phase and assess likely effects on the survival of round white fish embryos. OPG recognizes that monitoring activities and data are of interest to Indigenous Nations and communities and will continue to engage and share monitoring studies and data with Indigenous Nations and communities.

2.10 Emergency Management and Fire Protection

Darlington NGS has effective nuclear, conventional and fire emergency preparedness and response programs that meet or exceeds regulatory requirements and related objectives. Emergency preparedness measures and fire protection response capabilities are in place at Darlington NGS to prevent and mitigate the effects of nuclear and hazardous substances releases, both onsite and offsite, and fire hazards to protect workers, the public and the environment.

The following sections provide a description of updates, including information related to CNSC staff's review of OPG's application in Reference 2 and OPG's response to CNSC staff's review in Reference 3, since the application submission in this area. More information on the Emergency Management and Fire Protection SCA is available in Section 2.10 of the 2025 Licence Renewal Application (Reference 1).

2025 Licence Renewal Application, Section 2.10.2.1 – Emergency Preparedness Program

The following provides an update on Indigenous Engagement with respect to Emergency Preparedness:

Since May 2024, Enterprise Emergency Management has attended Framework Meetings with each of the Michi Saagiig First Nations to provide programmatic updates, and an overview of OPG's emergency response exercises, drills and programs. As part of the discussion, OPG learned more about the Nations' interest in future engagement opportunities in emergency response exercises and drills. Additional meetings and further engagement are expected to continue into 2025 based on feedback from participants.

Provincial Nuclear Emergency Response Plan

The following provides an update on the Provincial Nuclear Emergency Response Plan (PNERP):

The PNERP, last revised in 2017, is undergoing a revision by Emergency Management Ontario to align with international best practices. The review and update of the PNERP began in 2021 and is ongoing. The Province plans to conduct a public consultation process, to be completed by March 2025, with the objective of obtaining a Cabinet approved PNERP in 2025.

2025 Licence Renewal Application, Section 2.10.3.1 – Fire Protection Program

Annual Plant Condition Inspection Report

The following provides an update on the Annual Plant Condition Inspection report:

The latest 2024 Annual Plant Condition Inspection for Darlington NGS was completed by an independent, qualified third-party vendor. The vendor reported that there was sufficient evidence to conclude that the OPG Fire Protection Program was being followed and effectively maintained to ensure compliance with the applicable requirements of CSA N293-12 (R2017), *Fire protection for nuclear power plants*, National Fire Code of Canada, and National Building Code of Canada. The 2024 Annual Plant Condition Inspection was completed in July 2024.

2025 Licence Renewal Application, Section 2.10.3.2 – Refurbishment

The following provides additional information on the term Controlling Authority, with respect to Combustible Material Safety:

The Controlling Authority term is defined as the person who is "*Evaluating Combustible Material Safety (CMS) permits and working with SME reviewers and permit owners to approve or reject the CMS permit request*".

Additional information and detailed roles of the Controlling Authority are documented in Section 2.6, *CMS Controlling Authority (CA) or delegate* of N-PROC-RA-0054, *Minimization, Control and Combustible Material Safety Within the Site*. The Controlling Authority is a person who has control over the CMS permit process and is responsible to complete the following tasks (Section 2.6):

- Evaluates and dispositions CMS permit applications.
- Reviews and processes all CMS permits. Identifies CMS Permit Applications for Subject Matter Expert reviews in accordance with N-INS-09070-10001, *Combustible Material Safety*.
- Acts as Fire Protection Subject Matter Expert, and review Fire Protection requirements including ensuring adherence to requirements of:
    - CSA N293;
    - National Building Code of Canada; and,
    - National Fire Code of Canada.
- Engages work groups to ensure plant CMS program information is accurate.
- Maintains a database of all current and in force permits.
- Identifies issues in the CMS permit process that may impact Emergency Response Team response and notifies response staff of unusual hazards that may require specific emergency response plans or augmented fire protection features to ensure risk is adequately assessed and controlled.

2.11 Waste Management

The objective of the Darlington NGS Waste Management program is to ensure that adequate provisions are in place to limit the generation of radioactive and conventional waste and if created, control/manage its handling, storage, and disposal. This is done in an effort to ensure the safety of workers and the public; and continuously improve environmental performance in support of OPG's Environmental Policy.

The following section provides a description of updates since the application submission in this area. More information on the Waste Management SCA is available in Section 2.11 of the 2025 Licence Renewal Application (Reference 1).

2025 Licence Renewal Application, Section 2.11.2.2 – High Level Waste

The following provides clarification on the number of fuel bundles that are produced each year at Darlington NGS:

Approximately, 22,000 used fuel bundles are produced by Darlington NGS each year. Used fuel is stored in the Irradiated Fuel Bays for a minimum of 10-years before being transferred into Dry Storage Containers and safety stored at the Darlington Waste Management Facility.

2025 Licence Renewal Application, Section 2.11.3 – Waste Minimization

The following provides an update on OPG's progress in meeting its annual radioactive waste diversion targets:

Darlington NGS has implemented initiatives to focus on radioactive waste minimization and segregation. Waste minimization is a shared responsibility amongst all Darlington NGS employees. It consists of spreading awareness to all waste generators on the proper handling and segregation of waste, and implementing proper guidelines, instructions, and procedures. Waste minimization and segregation is part of work planning processes. Waste generators are to follow the concept of *"Reduce, Reuse, Recycle".*

OPG calculates Low Level Waste (LLW) diversion metrics on a monthly basis. As reported in the 2025 Licence Renewal Application (Reference 1), a total of 6161 m^3 of LLW was diverted in 2023, with washable Personal Protective Equipment being the biggest contributor at 3136 m^3. As of July 2024, nearly 2320 m^3 of LLW was diverted from radioactive waste. The YTD 2024 radioactive waste diversion rate is 64.8%, with a station target of 64%. Washable Personal Protective Equipment remain the largest contributor to waste diversion, contributing 1685.8 m^3 (approximately 73%).

2.12 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 updates, including information related to CNSC staff's review of OPG's application in Reference 2 and OPG's response to CNSC staff's review in Reference 3, since the application submission in this area. More information on the Security SCA is available in Section 2.12 of the 2025 Licence Renewal Application (Reference 1).

2025 Licence Renewal Application, Section 2.12 – Security

The following provides additional information regarding Threat Risk Assessment, including provisions to assess security risk during abnormal operations and emergency situations:

The Threat Risk Assessment program is a strategic process governed by standard OPG-STD-0063, *Security Threat Vulnerability and Risk Assessment* for the evaluation of physical security in accordance with *Nuclear Security Regulations* Section 7.5. Nuclear Security Program N-PROG-RA-0011, *Nuclear Security,* implementing instructions contain the tactical directions to implement during abnormal operations and/or emergency situations to ensure continual compliance within the *Nuclear Security Regulations* as a whole. The implementing instructions documented in N-PROG-RA-0011 provide guidance for abnormal operations and emergency situations such as: detection, assessment and compensatory measures, defensive strategy, search, access and egress control.

Abnormal operations and or emergency situations are also covered under implementing instructions from:

- OPG-PROG-0035, *Enterprise Security*; and,
- OPG-PROG-0030, *Emergency Management Program*.

2025 Licence Renewal Application, Section 2.12.1 – Facilities and Equipment

The following provides additional information regarding the training provided to Nuclear Security Officers on sealed source security at Darlington NGS:

Initial sealed source training is provided during Basic Tactical Officer Course training and tracked under Performance Elements (PELs):

- PEL 79948, *PNGS Security PA Emergency Response;*
- PEL 79949, *DNGS Security PA Emergency Response; and,*
- PEL 70885, *Drill & Tabletop.*

OPG incorporated and completed sealed source security program familiarization during the annual 2024 Nuclear Security Officer maintenance training that took place January to February 2024.

2025 Licence Renewal Application, Section 2.12.3 – Security Practices

The following provides additional information regarding the criteria/cultural observations used by OPG to assess the Nuclear Safety and Security Culture trait of vigilance and how that informs security culture:

OPG defines the trait of vigilance as ‘Being attentive for unusual observations, specifically in the cyber world and in people’s behaviors’. The Continuous Behavioral Observation Program ensures all supervisors can successfully:

1. Recognize why managing insider threats and early detection of potential risks is an important part of the security program.
2. Recognize the supervisor's accountability in managing insider threats, and the importance and impact of timely intervention.

3. Identify common reasons for and types of behaviors that warrant attention and response.
4. Recognize how to effectively observe, assess and respond appropriately to behaviors that warrant attention and response.
5. Identify processes and support networks available to assist actions being taken.

Since 2023, OPG has been performing an annual vigilance campaign focused on a variety of topics that are selected through trends. For the 2024 vigilance campaign, topics included:

- Driving (speeding, awareness, worker fatigue, safe driving);
- Vital Area expectations (access control and tailgating); and,
- Powerhouse door expectations.

Additionally, vigilance is assessed as part of the Nuclear Safety and Security Culture Assessments conducted at Darlington NGS at least every 5-years. As part of the survey for this assessment, staff are asked to rate the following statements on a 7-point scale:

- I know what types of conditions or behaviours I am required to report for nuclear security reasons.
- People here are security-conscious to the point where they would be likely to notice and report behaviours in individuals which might indicate a nuclear security concern.
- The standards and procedures for the security of information and information systems, including electronic information, are clear and easy to follow.
- Classification and control measures are understood and used by staff to protect sensitive information.
- Almost everyone here believes that cyber challenges and attacks are a real and serious threat to nuclear security.
- I know how to report a nuclear security concern.
- Almost everyone here respects the nuclear security barriers and physical controls such as monitors, screening and physical checks.
- Managers consistently communicate the importance of nuclear security and help to maintain a high level of alertness.

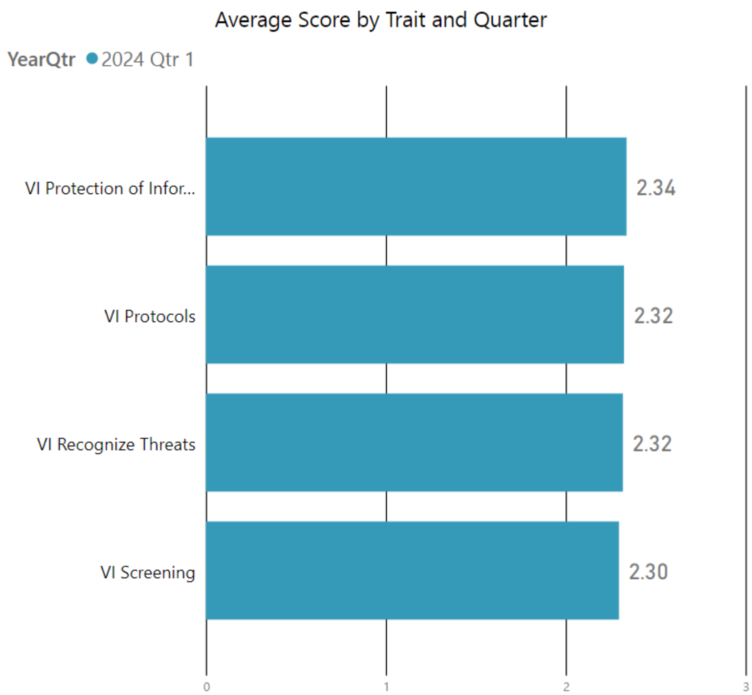
Results from the 2021 assessment indicate that vigilance is healthy. Preliminary results from the assessment in 2024 indicate that vigilance is healthy and continues to improve.

Vigilance attributes are also assessed by staff on an annual basis as part of continuous monitoring where they are asked to rate the following attributes on a 3-point scale.

- VI.1 Recognize Threats: Staff members identify and question unusual indications and occurrences, and report them to management, as soon as possible, using established processes. When unsure of the security significance of these events or observations, staff seek guidance.
- VI.2 Protection of Information: Classification and control measures are understood and used by staff to protect sensitive information.
- VI.3 Protocols: Staff follow security and cyber security protocols to minimize risk.

- VI.4 Screening: Screening processes match the risks and threats associated with specific roles and responsibilities.

For 2024, all of the vigilance attributes have been rated as strengths by station staff (i.e. greater than 2.2) as shown in the figure below.



SCALE:
<1.8 = Improvement Opportunity
1.8 – 2.2 = Acceptable
>2.2 = Strength

Figure 8: Nuclear Safety and Security Culture Monitoring Panel Data for Vigilance 2024

2.13 Safeguards and Non-proliferation

Darlington NGS has an effective Safeguards and Non-Proliferation program that ensures compliance with Canada's international safeguards obligations arising from the Canada/International Atomic Energy Agency (IAEA) safeguards agreements as well as other measures arising from the Treaty on the Non-Proliferation of Nuclear Weapons.

The following sections provide a description of updates since the application submission in this area. More information on the Safeguards and Non-proliferation SCA is available in Section 2.13 of the 2025 Licence Renewal Application (Reference 1).

2025 Licence Renewal Application, Section 2.13 – Safeguards and Non-Proliferation

The following provides an update on inspections performed by the IAEA since 2016 to 2024 YTD:

Throughout the current Darlington NGS licence, the OPG Safeguards program was successful in meeting all international Safeguards and Non-Proliferation agreements.

Since 2016 to 2024 YTD, Darlington NGS achieved a 95% satisfactory inspection result with only one unsatisfactory occurrence in mid-2024. The one unsatisfactory result was from a Short Notice Random Inspection. The event is non-reportable to the CNSC as per the requirements of REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants*. A corrective action plan is in progress.

2025 Licence Renewal Application, Section 2.13.4 – Safeguards Equipment, Containment, and Surveillance

The following provides an update on reportable events to the CNSC related to Safeguards Equipment, Containment and Surveillance:

From 2012 to 2024 there were a total of six events reportable to the CNSC related to Safeguards Equipment, Containment and Surveillance. In each case, immediate action was taken to resolve the condition. Where practical, reoccurrence control actions were implemented following the event.

2.14 Packaging and Transport

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

Information on the Packaging and Transport SCA is available in Section 2.14 of the 2025 Licence Renewal Application (Reference 1).

3.0 Facility-Specific Information

The following information is provided as updates to facility-specific information, supplementary to the information provided in Darlington NGS's May 2024, Power Reactor Operating Licence Renewal Application (Reference 1). The relevant section which is being updated is referenced to this document, referred to as the *"2025 Licence Renewal Application"*.

3.1 Tritium Removal Facility

The Tritium Removal Facility (TRF) and Heavy Water Management Building (HWMB) reduces the tritium content of heavy water inventories for Darlington NGS and all Ontario CANDU reactors. This is accomplished through distillation, ion exchange and particulate filtration as well as extraction and immobilization of the tritium isotope for storage in a secure vault. The reduction of tritium reduces the radiation dose to OPG personnel and minimizes the tritium emissions to the environment. The facility also maintains isotopic purity requirements for heavy water at Darlington NGS. Maintaining isotopic purity of heavy water helps with the fission process by slowing down neutrons and therefore optimizing fuel burn-up.

The following sections provide a description of updates since the application submission in this area. More information on the TRF is available in Section 3.1 of the 2025 Licence Renewal Application (Reference 1).

The following updates apply to the TRF and HWMB:

From 2015 to November 2024, the TRF has removed approximately 158.6 million Curies (5.87e+18 Bq) of tritium.

During the current licence term, the HWMB (West Annex) was commissioned and placed into service. For clarification, this has increased OPG's heavy water storage capacity by 2100 Mgs (1900 Mgs of reactor-grade heavy water plus 200 Mgs of down-graded heavy water). The addition of this facility allows for flexibility with refurbishment, Pickering end-of-commercial operation/refurbishment activities as well as support for Bruce Power's Major Component Replacement activities.

The life extension date for the TRF should have been indicated as 2055 rather than 2060.

3.2 Refurbishment

The Darlington NGS refurbishment project is a multi-year, multi-phase, project that is enabling Darlington NGS to continue safe and reliable operation through 2055. The project includes the replacement of life-limiting critical components, the completion of upgrades to meet regulatory requirements, and the rehabilitation of components in Darlington NGS's four units.

The following sections provide a description of updates since the application submission in this area. More information on the Darlington NGS refurbishment project is available in Section 3.2 of the 2025 Licence Renewal Application (Reference 1).

The following figure provides an update to Figure 32 of Reference 1:

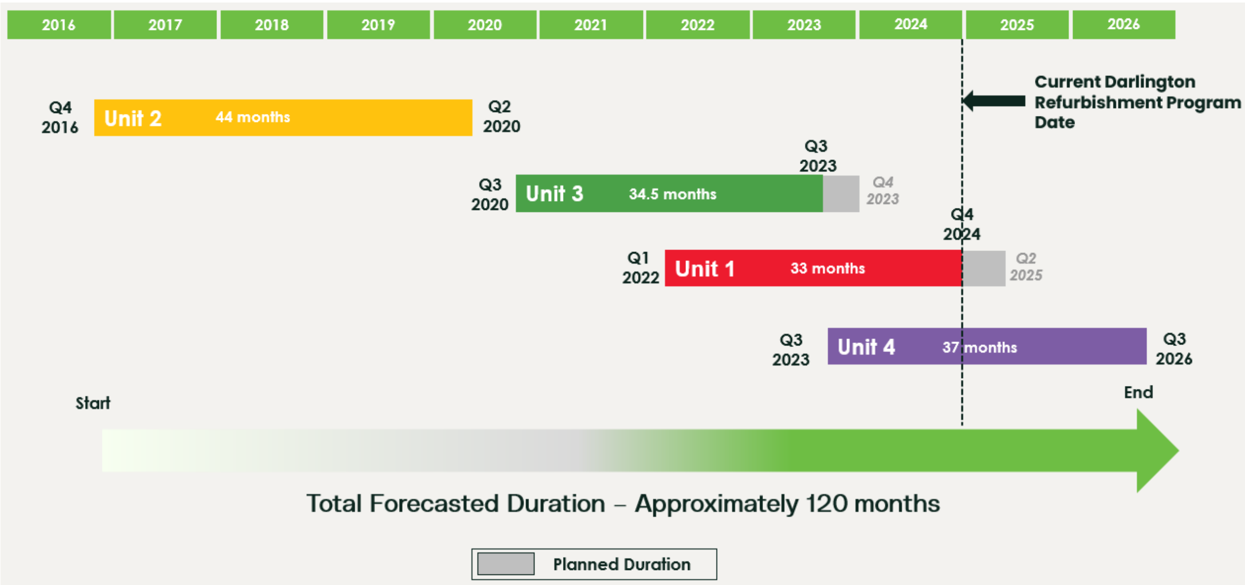


Figure 9: Refurbishment Progress

The following provides an update on the status of Unit 1 and Unit 4 refurbishment:

Update to Unit 1 Status

Unit 1 was successfully returned to service on November 27, 2024, 140 days ahead of the public commitment, following the completion of 53 Systems Available for Service declarations which supported Unit 1 return to service activities and the removal of all the Restart Control Hold Points (RCHPs) and Regulatory Hold Points (RHPs) as outlined below:

- RCHP 1, Moderator Fill, was completed on December 23, 2023.
- RCHP 2, Fuel Load, was completed on April 28, 2024. This also marks the completion RHP 1, a significant milestone in the return to service process.
- RCHP 4, Primary Heat Transport Fill, was completed on May 31, 2024.
- RCHP 3, Bulkhead Removal, was completed on August 10, 2024.
- RCHP 5, Guaranteed Shutdown State Removal, was completed on September 13, 2024. This also marks the completion of RHP 2.
- RCHP 6, Increase Reactor Power > 1%, was completed on October 10, 2024. This also marks the completion of RHP 3.
- RCHP 8, Increase Reactor Power > 35%, was completed on November 15, 2024. This also marks the completion of the final RHP 4.
- RCHP 9, Unit Available for Commercial Service, was completed on November 27, 2024. This also marks the completion of the final RCHP.

Overall, Unit 1 was completed with marked performance improvements and efficiencies versus Unit 3 with a 20% reduction in Medically Treated Injuries, 3% reduction in Collective Radiation Exposure and 80% reduction in quality events.

Update to Unit 4 Status

Unit 4 refurbishment commenced on July 19, 2023, shortly after the return to service of Unit 3, and is the last of four units undergoing refurbishment at Darlington NGS. Refurbishment activities are progressing on schedule, safely and successfully with completion of the Calandria Tube Removal in September 2024. The unit is progressing through the reassembly segment (3rd segment), forecasting completion in Q3 2025, and the overall schedule is on track to be returned to service in Q3 of 2026.

2025 Licence Renewal Application, Section 3.2.1 – Major Projects and Improvements

The following provides an update on the Integrated Implementation Plan (IIP):

While the primary focus of refurbishment is the replacement of the reactor core components, there has also been a considerable number of initiatives and improvements completed to ensure Darlington NGS's continued safe operation. These improvements are outlined in the IIP and focus on enhancing the station's safety and reliability.

The IIP presents the scope and schedule for the implementation of actions resulting from environmental assessments, integrated safety reviews, addressing code gaps, component condition assessments, and integrated aging management programs. Overall, 570 of 622 of the IIP refurbishment and continuing operation commitments have been completed up to December 12, 2024.

2025 Licence Renewal Application, Section 3.2.2 – Conventional Safety Performance

The following provides an update on Conventional Safety Performance statistics:

At the end of Q3 2024, the Program reported a 12-month rolling average Total Recordable Injury Frequency (TRIF) of 0.19 against its internal target of 0.40, reflecting six medically treated injuries, year to date in 2024.

As of Q3 2024, the Program is approaching over 56 million hours worked with one Lost Time Injury, which occurred in May 2019.

2025 Licence Renewal Application, Section 3.2.3 – Radiological Safety Performance

The following provides an update on Radiological Safety Performance statistics:

Table 9 provides an update of Table 26 in Reference 1 regarding the year-to-date summary to the end of Q3 of the radiological safety performance and includes both OPG and vendor employees. The statistics are specific to Refurbishment only. Due to the nature of the work, such as reactor component replacements, a higher person-mSv dose is expected compared to the Station statistics. The actual dose continues to be lower than the forecasted targeted dose, representing a lower radiological exposure.

Table 9: Radiological Safety Performance

	2021 Year End		2022 Year End		2023 Year End		2024 End of Q3	
	Actual	Target	Actual	Target	Actual	Target	Actual	Target
Unit 3 Collective Radiation Exposure (person-mSv)	10280	13790	3370	6330	550	950	N/A	N/A
Unit 1 Collective Radiation Exposure (person-mSv)	N/A	N/A	7220	9840	4751	5000	1340	2360
Unit 4 Collective Radiation Exposure (person-mSv)	N/A	N/A	N/A	N/A	4269	4750	8966	11850

3.3 Periodic Safety Review

The Darlington Periodic Safety Review (D-PSR) was completed in accordance with Licence Condition 3.4 of Darlington NGS PROL 13.03/2025. The D-PSR is a subsequent review which builds on previous OPG Integrated Safety Review (ISR)/PSR work such as: (1) the Pickering PSR2 (programmatic components applicable to Darlington NGS) and (2) the Darlington NGS ISR, performed in support of refurbishment and life extension. The D-PSR was conducted in accordance with the D-PSR Basis Document, NK38-REP-03680-11844, *DNGS Periodic Safety Review Basis Document*, and the requirements of CNSC regulatory document REGDOC-2.3.3, *Periodic Safety Reviews*. The planning basis for the D-PSR covers the period of operation of Darlington NGS units from November 2025 to November 2035.

The following sections provide a description of updates since the application submission in this area. More information on the D-PRS is available in Section 3.3 of the 2025 Licence Renewal Application (Reference 1).

2025 Licence Renewal Application, Section 3.3.5 – D-PSR Results

The following provides an update on the D-PSR IIP:

As discussed in the 2025 Licence Renewal Application (Reference 1), the D-PSR IIP contains 17 IIP Actions with scheduled completion dates ranging from Q4 2023 to Q4 2028. As of Q3 2024, four IIP actions have been completed and CNSC closure has been requested.

3.4 Isotope Irradiation Program

Darlington NGS Power Reactors are utilized to support the radioisotope industry in both the medical and food safety fields. Darlington NGS's support for safe production of isotopes includes the planned production of Cobalt-60 (Co-60), Molybdenum-99 (Mo-99), Yttrium-90 (Y-90) and Lutetium-177 (Lu-177) with a potential for additional growth in this fast-changing and life-saving field. For example, Darlington NGS has recently submitted a letter of intent to the CNSC for a PROL amendment to install Target Delivery Systems on additional units (Reference 14).

The following sections provide a description of updates since the application submission in this area. More information on the Darlington NGS isotope irradiation program is available in Section 3.4 of the 2025 Licence Renewal Application (Reference 1).

Cobalt-60 (Co-60)

In April 2023, OPG submitted an application to the Commission to amend the Darlington NGS PROL in order to produce Co-60, an isotope used in medical device sterilization and in food production. About 40% of the world's single-use medical devices, such as syringes, gloves, implants and surgical instruments, are irradiated and sterilized with Co-60. Similar to its use in sterilizing medical devices, Co-60 is useful in sterilization of food products, removing pathogens and parasites.

The Commission amended the Darlington NGS PROL in June 2024 (CNSC Record of Decision DEC 24-H101 – Reference 4). With this licence amendment, Co-60 production is planned to start with the initial harvest expected in 2028.

Yttrium-90 (Y-90) and Lutetium-177 (Lu-177)

On February 26, 2024, OPG submitted an application to the Commission to amend the Darlington NGS PROL to allow for the production of the medical radioisotopes Y-90 and Lu-177 using the Target Delivery System currently installed for the production of Molybdenum-99 (Mo-99) (Reference 15).

Overall, the reliability of Darlington NGS's CANDU reactors and expanding the breadth of ways that isotopes can be generated will be a key component to strengthening the radioisotope supply chain for the coming decades. A Commission hearing for this application is scheduled for spring 2025.

4.0 Update to Indigenous Engagement

The following information is provided as updates, supplementary to the information provided in Darlington NGS's May 2024, Power Reactor Operating Licence Renewal Application, Section 4.2 (Reference 1).

In this section, OPG provides an overview of updates since May 2024 regarding:

- OPG's Reconciliation Action Plan;
- Engagement activities that have occurred with Indigenous Nations and communities,
- Summary of comments and concerns received to date from Indigenous Nations and communities; and
- Anticipated engagement activities into 2025.

4.1 Reconciliation Action Plan

In July 2024, OPG released an updated version of the company's Reconciliation Action Plan, which was originally launched in the fall of 2021. The refreshed plan recaps OPG's progress on Reconciliation Action Plan goals through 2021-23 and shares OPG's outlook for 2024 and beyond. Some key highlights and achievements include:

- Since 2022, OPG has reached $198 million in Indigenous contract awards and $39.4 million in equity distributions to our Indigenous partners.
- Mentoring Plus spaces offered to Indigenous employees in an effort to promote their career path development.
- Developing and initiating roll out of an Indigenous Relations 101 training program to build Indigenous relations awareness and cultural competence across the organization.
- Overall, in 2023, OPG invested a total of nearly $600,000 in Indigenous initiatives, including a sponsorship for the annual Indspire Awards, which recognize Indigenous excellence.
- In September 2024 OPG was recertified with the Gold Designation from the Canadian Council for Indigenous Business through its Partnership Accreditation in Indigenous Relations Program.

OPG is proud of how far it has come as a company, while recognizing that there is still so much more to do to advance reconciliation. In the spirit of driving change across the industry and holding firm on our commitment to advancing reconciliation, the refreshed Reconciliation Action Plan includes the addition of over 20 new commitments that were developed through internal discussions and input from Indigenous Nations, communities and businesses.

4.2 Summary of Engagement Activities (May to November 2024)

Indigenous Engagement Plan

To guide engagement activities on the 2025 Licence Renewal Application (Reference 1), OPG developed a draft Indigenous Engagement Plan (IEP). In August and September 2024, all

Indigenous Nations and communities identified in the draft IEP received a copy of the IEP for review and comment. Between August to October 2024, OPG continued to follow-up and facilitate opportunities for Indigenous Nations and communities to provide comments on the draft IEP. Through November, OPG worked to update the IEP based on feedback received from Indigenous Nations and communities to date. For Indigenous Nations and communities that provided substantive comments on the IEP, OPG is preparing comment disposition tables to demonstrate how comments did or did not influence the IEP update. OPG anticipates issuing a final working version of the IEP as well as sharing the comment disposition tables in December 2024. The IEP is intended to be a dynamic document and, as such, can continue to be updated, as appropriate, to respond to new comments that come forward from Indigenous Nations and communities and/or any shifts in engagement priorities and needs.

Summary of Engagement Efforts and Activities

In addition to engaging on the draft IEP, OPG has made efforts to share and engage on the content of the Licence Renewal Application (Reference 1). All Indigenous Nations and communities listed in the IEP were provided with a link to the Licence Renewal Application on OPG's website when the draft IEP was initially shared. Additional information about OPG's engagement efforts and activities are further detailed below in Tables 10 and 11.

Table 10: Williams Treaties First Nations (WTFNs) Rights Holders

Community	Summary
Alderville First Nation	• Two (2) meetings on the Licence Renewal Application (June 27, October 24). • Ongoing communications via email, phone and virtual/in-person meetings. • Preliminary concerns on the Licence Renewal Application shared in meetings. • Further engagement planned to explore concerns.
Beausoleil First Nation	• Continued follow-up via email and phone. • No comments on IEP or Licence Renewal Application received to date.
Curve Lake First Nation	• Four (4) meetings on Licence Renewal Application (June 25, August 27, September 24, October 22). • Ongoing communication via email, phone and virtual meetings. • Submitted written comments on the Licence Renewal Application at the end of October 2024. • Submitted written comments on the IEP in October 2024. • Further engagement planned to explore concerns.
Georgina Island First Nation	• Continued follow-up via email and phone. • No comments on IEP or Licence Renewal Application received to date.
Hiawatha First Nation	• Two (2) meetings on Licence Renewal Application (June 25, October 22). • Ongoing communications via email, phone and virtual/in-person meetings.

Community	Summary
	• No comments on the IEP or Licence Renewal Application received to date. • Continued follow-up via email, phone and virtual/in-person meetings will continue.
Mississaugas of Scugog Island First Nation	• Three (3) meetings where Licence Renewal Application was discussed (June 13, August 29, October 10). • Ongoing communication via email, phone and virtual meetings. • Submitted written comments on the IEP in September 2024. • Preliminary concerns on the Licence Renewal Application shared in meetings. • OPG is aware the MSIFN is reviewing the Licence Renewal Application and will be providing comments, but has yet to complete a comprehensive review of the application materials. • Further engagement planned to explore concerns.
Rama First Nation	• Continued follow-up via email and phone. • No comments on IEP or Licence Renewal Application received to date.

Table 11: Indigenous Nations and Communities that are Interested

Community	Summary
Huron-Wendat Nation, Quebec	• Continued follow-up via email. • Requested to be contacted for work involving archaeological assessments. • No comments on IEP or Licence Renewal Application received to date.
Mohawks of Bay of Quinte	• Continued follow-up via email. • No comments on IEP or Licence Renewal Application received to date.
Métis Nation of Ontario Region 8	• One (1) meeting to share information and updates on the Licence Renewal Application (June 10). • No comments on IEP or Licence Renewal Application received to date. • Advised OPG they will reach out if leadership or Regional Consultation Committees express further interest in updates or information on the Licence Renewal Application.
Saugeen Ojibway Nation (comprised of Saugeen First Nation and Chippewas of Nawash Unceded First Nation)	• Continued follow-up via email. • No comments on IEP or Licence Renewal Application received to date.
Six Nations of the Grand River	• Two (2) meetings to share information and updates on the Licence Renewal Application (July 19 and October 18).

	• Preliminary questions on the Licence Renewal Application shared in meetings. • Comments received on the IEP. • No comments on Licence Renewal Application received to date.

Summary of Comments and Concerns

Throughout OPG's engagement efforts, staff have been diligently capturing interests and concerns, asking questions to clarify understanding, sharing information to answer questions raised and work to address comments, as appropriate.

In Table 12 (see below), OPG provides a high-level summary of interests and/or concerns raised by Indigenous Nations and communities to date, including an assessment of status and next steps for engagement. Note that reference to the Application and specific sections refers to the Licence Renewal Application (Reference 1).

Table 12: High Level Summary of Interests and/or Concerns Raised by Indigenous Nations and Communities

Theme	Summary of Interests and/or Concerns	Response, Status and/or Next Steps
Length of Licence Term	• Concerns regarding the requested 30-year licence term and what additional steps are being taken to assure meaningful consultation and engagement over a 30-year period. • Concerns regarding limited engagement with respect to OPG operations aside from licence amendments and extensions and there is an interest in deepening engagement on operations. • A 10-year interval provides the opportunity to delve into operational and environmental subject matter in depth more frequently. A 30-year interval is untested in terms of ensuring adequate engagement and consultation. • Comments regarding international benchmarks for licensing terms and an assessment that 10-20 years is in line with licensing norms in Western countries.	• In OPG's view, the concept of a 30+ year licence is common in the international community. Several nuclear power generating stations around the world have 30+ years to indefinite licence terms. • OPG is confident that not only will the Darlington NGS continue to operate safely and reliably throughout the requested 30-year licence term, but there will continue to be regular opportunities for Indigenous Nations and communities to engage directly with OPG and with the Commission on matters of interest related to the Darlington NGS. OPG is working to pull together information regarding the regulatory oversight mechanisms that will be available during the requested 30-year term to advance the discussion. • OPG also understands that this Application would result in potentially the first 30-year licence in Canada and is aware that there may be questions or concerns about the licence term being requested. • OPG wants to be a leader and is committed to working with Indigenous Nations and communities on how we can demonstrate meaningful engagement under a term of this length. • OPG will continue to engage Indigenous Nations and communities to hear ideas for what an ongoing engagement framework could look like to better collaborate on measures to address them and to understand concerns with the requested 30-year term. • In the meantime, OPG will continue to provide opportunities for engagement with respect to current operations (e.g. Environmental Risk Assessment (ERA) Addendum, 2026 Darlington Nuclear Site ERA, Emergency Management Programs, and other topics based on interest and capacity). OPG and the Michi Saagiig Nations have worked to initiate a Waste Table and are working to initiate an Environment Table to provide an effective forum to address interests that are not site or project specific.
Generation and Storage of Waste	• Questions regarding the volume of waste that will be generated throughout the requested 30-year term. • Concerns regarding the absence of a long-term strategy for storage of low, intermediate and high-level waste and	• OPG has provided a response to the volume of waste that will be generated throughout the requested 30-year term to Indigenous Nations and communities that asked. • OPG recognizes Indigenous Nations and communities have raised concerns about the long-term storage plans and strategy of radioactive waste. With respect to used fuel and intermediate-level waste, OPG is supportive of the

Theme	Summary of Interests and/or Concerns	Response, Status and/or Next Steps
	lack of consent provided for the ongoing operation of waste management facilities at the Darlington site.	Nuclear Waste Management Organization's initiative to advance a permanent and safe storage solution for this waste stream with the willing host communities of Wabigoon Lake Ojibway Nation and the Township of Ignace. For low-level waste, OPG is initiating a process to have two-way dialogue with Indigenous Nations and communities and municipalities on seeking solutions for the proposed eventual siting and disposal of low-level waste. • The Government of Canada is currently undertaking a collaborative process to implement the United Nations Declaration on the Right of Indigenous Peoples (UNDRIP) into Canadian domestic law, through the UNDRIP Act and the Action Plan released in June 2023. While that process to develop practical guidance is ongoing, OPG is not in a position to determine how the concept of free, prior and informed consent might factor into government approval processes. OPG will continue to apply a robust engagement framework which is consistent with our Reconciliation Action Plan, our Indigenous Relations Policy and regulatory and legal requirements.
Reflection of Indigenous Nations & communities in Sections Throughout (Biodiversity)	• Interest in having Indigenous Nations and communities better reflected in certain sections of the Application. • In the Biodiversity section (2.9.1.1), seeking acknowledgement of partnership with Indigenous Nations and communities on biodiversity initiatives as stewards and caretakers of the lands and waters.	• Under OPG's Reconciliation Action Plan, Environmental Stewardship is one of the five main pillars. OPG's goal is to be a trusted partner in environmental stewardship and to collaborate with Indigenous communities on biodiversity conservation initiatives. • OPG acknowledges this specific interest raised and for OPG's ongoing operations at Darlington NGS, OPG understand the importance of deepening our collaboration on biodiversity initiatives with the WTFNs as the stewards and caretakers of the lands and waters.
Reflection of Indigenous Nations & communities in Sections Throughout (Fish Impingement & Entrainment)	• Interest in having Indigenous Nations and communities better reflected in certain sections of the Application. • In the Fish Impingement and Entrainment section (2.9.6), seeking acknowledgement of OPG and the Michi Saagiig WTFN's intent to establish an Environment Table.	• Based on feedback from the Michi Saagiig WTFNs, OPG and the Michi Saagiig WTFNs are taking steps to initiate and establish an OPG-Michi Saagiig Environment Table to support engagement on strategic matters and issues that are non-site specific in nature.

Theme	Summary of Interests and/or Concerns	Response, Status and/or Next Steps
Reflection of Indigenous Nations & communities in Sections Throughout (Emergency Drills and Exercises)	• Interest in having Indigenous Nations and communities better reflected in certain sections of the Application. • In the Emergency Drills and Exercises section (2.10.22), seeking acknowledgement of OPG and Michi Saagiig WTFN's intent to facilitate involvement and participation in OPG's Emergency Drills and Exercises.	• OPG is aware that Indigenous Nations and communities are interested in better understanding and being involved in OPG's emergency response program. In WTFN territory, OPG has recently met with each of the Michi Saagiig Nations to share information about OPG's emergency management program and to better understand the priorities of the Nations for further learning and engagement, including potential engagement opportunities through OPG's Emergency Drills and Exercises. • OPG is committed to further exploring the interests of the Michi Saagiig Nations with respect to emergency management and finding ways to address priorities, interests and concerns as appropriate.
Indigenous Engagement	• Concerns with "Indigenous Engagement" section in the Application being under "Other Matters of Regulatory Interest". • Interest in Indigenous Engagement be a stand-alone section.	• OPG appreciates this concern being brought to our attention. To address this interest and ensure our application materials reflect the unique relationship OPG holds with Indigenous Nations and communities, OPG has made the Indigenous Engagement section of the supplemental into its own section. In addition, OPG will share this feedback with other staff at OPG to ensure this interest is addressed in future applications.
Alert Ready System	• Concerns regarding the "Alert Ready" system not requiring Indigenous specific notifications during an emergency.	• OPG is aware that Indigenous Nations and communities have concerns regarding the notifications required under the current Provincial Nuclear Emergency Response Plan (PNERP) and has encouraged the Nations to engage through the Province's upcoming public consultation process for the PNERP revision. • OPG provides immediate notifications to all required offsite stakeholders under the PNERP to quickly share information pertaining to the event to enable the offsite response to be initiated appropriate to the circumstances, including protective actions and public notifications through those stakeholders with those accountabilities.
Economic Opportunities - Isotopes	• In Section 3.4, *Isotope Irradiation Program*, seeking acknowledgement of Indigenous Nation and communities' interest in economic opportunities associated with Cobalt-60.	• OPG recognizes that Indigenous Nations and communities have communicated an interest in economic opportunities from ongoing operations at Darlington NGS. From OPG's perspective, economic opportunities may include procurement and/or commercial opportunities. • Regarding procurement opportunities, OPG will continue to support fair, competitive, and transparent procurement opportunities aimed at maximizing Indigenous business opportunities at Darlington NGS.

Theme	Summary of Interests and/or Concerns	Response, Status and/or Next Steps
		• OPG is open to continued exploratory discussions to better understand Indigenous Nations' and communities' interest in economic opportunities with respect to isotopes, as appropriate.
Past Grievances	• Comment was received with respect to OPG's assessment that continued operation of the Darlington NGS does not create any new adverse impacts on Aboriginal and/or Treaty rights but does extend the known impacts and the ongoing mitigation efforts. • OPG heard concerns that past grievances with respect to lack of consultation from original construction of the Darlington NGS, and lack of consent from the Michi Saagiig WTFNs, is an unresolved issue.	• At this time, OPG maintains the perspective that the continued operation of Darlington NGS does not create any new adverse impacts on Aboriginal and/or Treaty rights held by local Indigenous Nations and communities but does extend the known impacts and the ongoing mitigation efforts. • OPG continues to engage with Indigenous Nations and communities to understand potential impacts and if additional measures are required to adequately avoid, mitigate or accommodate impacts, as appropriate. • However, OPG acknowledges that legal requirements regarding Indigenous engagement and consultation have evolved significantly since the construction of the Darlington NGS began in the 1980s and that past practices would not meet current standards and expectations. Until the Government of Canada provides practical guidance on how to implement free, prior and informed consent, OPG is not in a position to determine how the concept of free, prior and informed consent might factor into government approval processes.
Two-Way Learning Opportunities	• In Section 4.2.2, *Indigenous Community Meetings*, seeking acknowledgment and OPG's support for two-way engagement opportunities that also include OPG staff and project teams to learn more about Indigenous culture and ways of life to improve engagement outcomes.	• OPG appreciates this interest being brought to our attention. OPG is grateful to have been offered opportunities in the past to attend community visits to support project teams in learning about Indigenous culture and ways of life and will continue to seek out these opportunities. • In addition, OPG will share this feedback with other staff at OPG to ensure this interest is addressed in future applications.
Statement of Rights	• The below statement was provided by the MSIFN for inclusion in this supplemental submission: *Darlington NGS is located within the treaty and traditional lands of the Mississaugas of Scugog Island First Nation (MSIFN), Alderville First Nation (AFN), Curve Lake First Nation (CLFN), and Hiawatha First Nation (HFN), and specifically within the lands known as the "Gunshot Treaty" (1877-1888), a*	• OPG has heard the importance of incorporating and reflecting the voices of the Rights Holders in application documentation and the statement is being provided in this table with that intent and at the specific request of the MSIFN. • OPG is continuing to engage with the MSIFN to understand their perspective regarding both established and asserted rights.

Theme	Summary of Interests and/or Concerns	Response, Status and/or Next Steps
	treaty between the Crown and Anishinaabe peoples including the Michi Saagiig Nations. The Treaty rights associated with the Gunshot Treaty were re-affirmed with the signing of the Williams Treaties Settlement Agreement in 2018 between the Williams Treaties First Nations (WTFNs - the four Michi Saagiig Nations noted above and three Chippewa Nations - the Chippewas of Georgina Island First Nation, Beausoleil First Nation, and Rama First Nation). The Nations were never consulted by the Crown or facility operators when decisions were made to build and operate the Darlington NGS, and decisions to build and operate spent fuel storage facilities in the Treaty lands. *MSIFN, together with the WTFNs, have a long history in this part of Ontario. The WTFNs' Treaty and traditional territory extends from the shore of Lake Ontario in the south, Georgian Bay in the west, the Ottawa Valley in the east, and as far north as the French River. Within these Treaty areas and traditional territory, a priority is the protection and preservation of the lands, waters, wildlife, and fisheries that the First Nations rely on. The waters, and lands under the waters, of Lake Ontario south of the Treaty area lands, are unceded and never legally given up to the Crown through a treaty or other agreement.*	

4.3 Engagement Outlook (2025 and Beyond)

OPG is steadfast in its commitment to supporting meaningful engagement during and after the licencing application process and will work in collaboration with Indigenous Nations and communities to identify approaches to engagement that is considerate of the engagement context and the interests of each Indigenous Nation and community.

In 2025, OPG is excited to launch a new energy education program focused on the questions most frequently asked by Indigenous Nations and communities OPG works with. Called Generation for Generations, this fact-based and accessible educational program takes participants on an energy learning journey through seven stories about Ontario's electricity system and includes an overview of the future of electricity in Ontario.

For ongoing engagement on the Licence Renewal Application, OPG will continue to leverage the Indigenous Engagement Plan that is intended to guide engagement activities on the Licence Renewal Application in an approach that aligns with Indigenous Rights Holders and those who that are interested in learning more about ongoing activities at Darlington NGS.

Through ongoing engagement, OPG will aim to identify concerns and thoughts on the future of the Darlington NGS. OPG has heard preliminary concerns on the Licence Renewal Application from Indigenous Nations and communities and will continue to engage and explore them through future engagement activities in attempt to address or mitigate those concerns, as appropriate.

OPG recognizes the importance of meaningful engagement and building and maintaining meaningful relationships with Indigenous Nations and communities. We are dedicated to ensuring that our engagement efforts are not viewed as a one-time obligation about relicensing, but a commitment to continued and sustained engagement on Darlington NGS operations.

5.0 Additional Matters of Regulatory Interest

The following information is provided as updates to information on additional matters of regulatory interest, supplementary to the information provided in Darlington NGS's May 2024, Power Reactor Operating Licence Renewal Application (Reference 1). The relevant section which is being updated is referenced to this document, referred to as the *"2025 Licence Renewal Application"*.

5.1 Environmental Assessment

The following section provides a description of updates since the application submission in this area. More information on Environmental Assessment (EA) is available in Section 4.1 of the 2025 Licence Renewal Application (Reference 1).

2025 Licence Renewal Application, Section 4.1, subsection Mitigation and Follow-up Activities

The following provides an update on the status of IIP-EA actions:

Since submission of the 2025 Licence Renewal Application (Reference 1), OPG has submitted a request for Commission approval to process a new revision of the *Darlington NGS Integrated Implementation Plan*, NK38-REP-03680-10185 R004. The proposed revision to the IIP includes amendments to IIP-EA-012, *"Aquatic Thermal Study"* and IIP-EA-013, *"Aquatic Impingement and Entrainment Study"* beyond the current IIP timeline (Reference 16). These IIP actions are associated with aquatic studies comprising of actions prior to, throughout and following the completion of the Darlington Refurbishment Project. As the comprehensive schedule for the Darlington Refurbishment project has evolved, the remaining timelines for these aquatic studies require an amendment.

OPG plans to engage with Indigenous Nations and communities on the development of these aquatic studies and subsequently sharing results. In terms of what's coming up first, currently OPG is targeting to develop the sampling plans for impingement and entrainment in 2026.

A summary of all IIP-EA actions is provided in the Table below; these actions and their status was discussed in Section 4.1 of the licence renewal application. An update on the status of IIP-EA-012 and IIP-EA-013 is provided in the Table.

Table 13: Summary of IIP-EA Actions

IIP-EA Action Number	Description	Status / Notes
IIP-EA-001	Offsetting for fish impingement and entrainment losses.	Closed
IIP-EA-002	Demonstrating that the implementation of good industry management practices are effective in minimizing air/soil/water quality effects on humans and biota.	Closed
IIP-EA-003	Reducing traffic disruption during peak periods and maintaining safe traffic	Closed

IIP-EA Action Number	Description	Status / Notes
	conditions both on-site and off-site during the Refurbishment phase.	
IIP-EA-004	Monitoring and consulting municipalities on land-use policies and future developments proposed in the vicinity of the Darlington NGS site with focus on sensitive land uses (e.g. hospitals, schools) which may result in incompatible uses and effects on implementation of the emergency plans.	Closed
IIP-EA-005	(Socio-Economics) relates to informing neighbours and the public of the refurbishment project and on-going activities of the Darlington NGS operations.	Open - This includes annual activities from 2014 to 2025.
IIP-EA-006	(Socio-Economics) relates to minimizing the disruption of recreation facilities and amenities on the Darlington NGS site, which includes maintaining public access to the Waterfront Trail. This will include undertaking a Recreational User Survey of the Darlington NGS site recreation facilities for two seasons in one year after the restart of all reactors and reviewing the survey results.	Open - These activities are anticipated to be completed in 2026.
IIP-EA-007	Protecting and avoiding the potential Van Camp cemetery which has potential archaeological and cultural heritage resource interest.	Closed
IIP-EA-008	Maintaining emergency response procedures to protect the health and safety of people and the environment in the context of specific Accident & Malfunctions scenarios.	Closed
IIP-EA-009	(Accidents & Malfunctions) relates to design modifications for various systems. The open item is for the provision of an alternate and independent supply of water to the primary heat transport system.	Open - This is anticipated to be completed by 2026 (based on the Unit 4 refurbishment outage restart, which is the last refurbishment Unit).
IIP-EA-010	Characterizing the conventional chemical (i.e., non-radiological) parameters present in Darlington NGS effluent streams.	Closed
IIP-EA-011	Confirming the effectiveness of mitigation measures to protect stormwater quality in the area subject to refurbishment activities (i.e., Protected Area).	Closed
IIP-EA-012	(Aquatic) relates to confirming the accuracy of the predictions made in the EA concerning changes in lakewater temperatures in the vicinity of the Condenser Cooling Water (CCW) discharge, and their associated possible	Open – OPG has submitted a request for Commission approval to process a new revision of the IIP, NK38-REP-03680-10185 R004, including amendment of the remaining timelines for these aquatic studies (Reference 16).

IIP-EA Action Number	Description	Status / Notes
	effects on survival rates for round whitefish embryos.	The descriptions and timeline of the current open activities for this IIP objective are to: (1) Conduct thermal monitoring after the restart of all reactors (continued operations phase) and report monitoring data collected during this phase and assess likely effects on the survival of round white fish embryos (proposed target completion by 2030, pending Commission approval); and, (2) If the performance threshold is exceeded, review available mitigation options to determine if additional technically and economically feasible opportunities are available (proposed target completion by 2031, pending Commission approval).
IIP-EA-013	(Aquatic) relates to impingement and entrainment, including characterizing early life stages of fish and macro invertebrates being entrained and fish impinged by station operations, monitoring at a level capable of detecting fish Species at Risk and aquatic species of conservation concern, and determining the total fish and macro invertebrate losses and associated impact.	Open – OPG has submitted a request for Commission approval to process a new revision of the IIP, NK38-REP-03680-10185 R004, including amendment of the remaining timelines for these aquatic studies (Reference 16). An entrainment study assessing impacts to fish and macro invertebrates was conducted in 2015 prior to refurbishment with the submitted report reviewed and approved by the CNSC and Fisheries and Oceans Canada. The open activities for this IIP objective are incorporated into OPG's amended Fisheries Act Authorization (FAA) for Darlington NGS (Reference 17). The combined IIP and FAA open activities are: (1) To prepare a sampling plan for fish impingement and entrainment by 2028 (OPG is currently targeting to complete the individual sampling plans for impingement and entrainment in 2026); and, (2) Pending Commission approval for dates, conduct associated 24-month impingement monitoring in 2027 and 2028, and entrainment monitoring in spring 2027 to spring 2029, and submit reports to Fisheries and Oceans Canada (copied to the CNSC) documenting the findings of each study by March 31, 2030.

IIP-EA Action Number	Description	Status / Notes
		If the performance threshold(s) are exceeded, available mitigation options will be reviewed to determine if additional technically and economically feasible opportunities are available (proposed target completion by 2031, pending Commission approval). A new activity is also proposed to complete the best available technically and economically feasible opportunity to mitigate the impingement and entrainment losses or further reduce the potential for effects (proposed target completion by end of 2026, pending Commission approval).
IIP-EA-014	(Accidents & Malfunctions) relates to updating the station Probabilistic Risk Analysis (PRA) to confirm that the assignment of probabilities appropriately represents the Safety Improvement Opportunity (SIO) changes.	Open - The anticipated completion date of this action is 2026.
IIP-EA-015	Confirming the liquefaction potential of foundation materials in the Protected Area is acceptably low.	Closed

5.2 Financial Guarantee, Nuclear Liability Insurance and Cost Recovery

Information on the Financial Guarantee, Nuclear Liability Insurance and Cost Recovery is available in Section 4.3 of the 2025 Licence Renewal Application (Reference 1).

5.3 Public Information and Disclosure Program

OPG believes in open and transparent communication in a timely manner to maintain positive and supportive relationships and the confidence of key stakeholders and the public. OPG's *Nuclear Public Information Disclosure and Transparency Protocol*, posted on OPG's website, describes our communication principles and information requirements and reporting. Public information and disclosure involves the provision to inform, in a timely and transparent manner, accurate information to stakeholders and the public in the vicinity of OPG's nuclear facilities regarding events, activities and operations. OPG's protocol adheres to regulatory requirements as outlined in CNSC REGDOC-3.2.1, *Public Information and Disclosure*.

The following section provides a description of updates since the application submission in this area. More information on the Public Information and Disclosure Program is available in Section 4.4 of the 2025 Licence Renewal Application (Reference 1).

2025 Licence Renewal Application, Section 4.4.4 – Community Outreach

The following provides additional information regarding OPG's initiatives aimed at educating youth about various forms of electricity generation:

OPG has undertaken a number of initiatives targeting youth of varying ages to share information and provide meaningful dialogue and learning opportunities associated with energy production, the benefits of different forms of electricity generation (including nuclear power) and environmental stewardship. This includes a new program called Electrifying Education which reached over 2,500 school-aged children in our host community since its inception in the fall of 2023.

The following provides an update regarding community engagement:

Each year since 2023, we have engaged with nearly 50,000 members of the public at 30+ Durham Region community events and festivals, and through OPG programming where staff are available to discuss OPG's operations and have open dialogue with the public.

6.0 References

1. OPG letter, A. Grace to C. Salmon, “Darlington NGS – Application for Renewal of the Darlington Nuclear Generating Station Power Reactor Operating Licence 13.03/2025”, May 30, 2024, CD# NK38-CORR-00531-25450.

2. CNSC letter, A. Baig to A. Grace, “Darlington Nuclear Generating Station: CNSC Staff Technical Sufficiency Review of the Application to Renew the Power Reactor Operating Licence”, August 1, 2024, e-Doc# 7334720, CD# NK38-CORR-00531-25589.

3. OPG letter, A. Grace to A. Baig, “Darlington NGS – OPG Response to CNSC Staff Technical Sufficiency Review of the Application to Renew the Power Reactor Operating Licence: Action Item OPG-2024-33652”, August 16, 2024, CD# NK38-CORR-00531-25595.

4. CNSC Record of Decision DEC 24-H101, “Application to Amend Power Reactor Operating Licence PROL-13.03/2025 to Authorize the Production of Cobalt-60 at the Darlington Nuclear Generating Station”, June 5, 2024, e-Doc# 7295750 (PDF), CD# NK38-CORR-00531-25501.

5. OPG letter, A. Grace to A. Mathai, “Darlington NGS – Response to CNSC Staff’s Request for Implementation Plans or Justification for Identified Documents to be Guidance in the Darlington Licence Conditions Handbook”, March 19, 2024, CD# NK38-CORR-00531-25234.

6. OPG letter, A. Grace to A. Mathai, “Darlington NGS – OPG Response to CNSC Staff’s Review of Justifications for Identified Documents to be Guidance in the Darlington Licence Conditions Handbook”, September 27, 2024, CD# NK38-CORR-00531-25642.

7. CNSC letter, A. Mathai and R. Richardson to R. Geofroy and J. Franke, “Darlington NGS and Pickering NGS: Implementation of Sections 5.1 and 5.5 for REGDOC-2.2.4 Fitness for Duty, Volume II: Managing Alcohol and Drug Use, Version 3: Withdrawn Action Item 2023-OPG-27886”, November 7, 2023, e-Doc# 7162560, CD# N-CORR-00531-23850.

8. OPG letter, A. Grace to A. Mathai, “Darlington NGS – OPG Update to CNSC Staff Technical Sufficiency Review of the Application to Renew the Power Reactor Operating Licence: Action Item OPG-2024-33652”, December 4, 2024, CD# NK38-CORR-00531-25777.

9. CNSC email, M. Hitchon to S. Woolley and T. Szewczuk, “CNSC Sufficiency Review Follow-up: Request for New Radiation Protection Dosimetry Data”, September 25, 2024, CD# NK38-CORR-00531-25751.

10. OPG letter, A. Grace to A. Mathai and S. Watt, “Darlington NGS – 2024 Environmental Risk Assessment Addendum for the Darlington Nuclear Site”, September 24, 2024, CD# NK38-CORR-00531-25312.

11. OPG email, A. Bhardwaj to A. Mathai and S. Watt, “Darlington NGS – Update to Revision 00 of the 2024 Environmental Risk Assessment Addendum for the Darlington Nuclear Site”, October 31, 2024, CD# NK38-CORR-00531-25778.

12. OPG email, A. Bhardwaj to N. Greencorn and J. Burta, “Darlington NGS – CNSC Staff’s Prior Written Notification of Document Changes: D-REP-07701-00001-R002, 2020 Environmental Risk Assessment for the Darlington Nuclear Site”, November 2, 2022, CD# NK38-CORR-00531-23774.

13. OPG letter, H. Brown to R. Richardson, A. Mathai, and K. Campbell, “OPG – 2023 Results of Environmental Monitoring Programs for Darlington and Pickering Nuclear”, April 25, 2024, CD# N-CORR-00531-23942.

14. OPG letter, A. Grace to A. Mathai, “Darlington NGS – Letter of Intent for Approval to Install additional Target Delivery Systems (TDSs)”, December 9, 2024, CD# NK38-CORR-00531-25801.

15. OPG letter, A. Grace to C. Salmon, “Darlington NGS – Revised Redacted Application for Amendment to the Darlington NGS Power Reactor Operating Licence 13.03/2025 for Additional Isotope Production”, November 28, 2024, CD# NK38-CORR-00531-25810.

16. OPG letter, A. Grace and B. Vulanovic to C. Salmon, “Darlington NGS Refurbishment – Request for Commission Approval to Revise the Darlington NGS Integrated Implementation Plan (IIP)”, October 17, 2024, CD# NK38-CORR-00531-25116.

17. Fisheries and Oceans Canada letter, S. Eddy to R. Geofroy, “Amendment of Darlington Nuclear Generation Station 14-HCAA-01267-Notice of Amendment”, October 27, 2023, CD# D-CORR-00539.4-00007.

Appendix A: Commonly Used Acronyms

Acronym	Definition	Acronym	Definition
ALARA	As Low As Reasonably Achievable	**ISO**	International Organization for Standardization
ANDE	Advanced Non-Destructive Examination	**ISR**	Integrated Safety Review
CMS	Combustible Material Safety	**LLW**	Low Level Waste
CNSC	Canadian Nuclear Safety Commission	**MSIFN**	Mississaugas of Scugog Island First Nation
COG	CANDU Owners Group	**NGS**	Nuclear Generating Station
CRE	Collective Radiation Exposure	**NSCA**	Nuclear Safety and Control Act
CSA	Canadian Standards Association	**OPEX**	Operating Experience
DNNP	Darlington New Nuclear Project	**OPG**	Ontario Power Generation Inc
DLC	Darlington Learning Centre	**OSR**	Operational Safety Requirements
D-PSR	Darlington Periodic Safety Review	**PEL**	Performance Element
EA	Environmental Assessment	**PLC**	Pickering Learning Centre
EMS	Environmental Management System	**PNERP**	Provincial Nuclear Emergency Response Plan
EPRI	Electric Power Research Institute	**PROL**	Power Reactor Operating Licence
FAAGM	Fixed Area Alarming Gamma Monitor	**PSA**	Probabilistic Safety Assessment
FAATM	Fixed Area Alarming Tritium Monitor	**RCHP**	Restart Control Hold Points
HECA	High Efficiency Carbon Adsorber	**REGDOC**	Regulatory Documents
HEPA	High Efficiency Particulate Air	**RHP**	Regulatory Hold Point
HPD-RPP&FS	Health Physics Department-Radiation Protection Programs and Field Support	**RP**	Radiation Protection
HPI-FS	Health Physicist Instrumentation at HPD-RP Programs & Field Support	**RTS**	Return-to-Service
HFE	Human Factors Engineering	**SAFS**	Systems Available for Service
HSA	Hazard Screening Analysis	**SCA**	Safety and Control Area
HWMB	Heavy Water Management Building	**SEFDR**	Site Event Free Day Resets
IAEA	International Atomic Energy Agency	**SIO**	Safety Improvement Opportunity
IEP	Indigenous Engagement Plan	**SOE**	Safe Operating Envelope
IIP	Integrated Implementation Plan	**TCSCA**	Timely Completion of Safety Corrective Actions
INPO	Institute of Nuclear Power Operations	**TRF**	Tritium Removal Facility
IRIS	Industry Reporting and Information System	**WTFN**	Williams Treaties First Nations

Appendix B: Update to Activities and Nuclear Substances to be Encompassed by the Licence

Activities to be Licensed:

Following the submission of the Darlington NGS PROL Renewal Application (Reference B-1), PROL 13.03/2025 was amended to PROL 13.04/2025 through CNSC Commission Record of Decision – DEC 24-H101 (Reference B-2) to authorize the production of Cobalt-60 at Darlington NGS. The Table below provides an update to the Appendix C of Reference B-1 activities to be licensed.

Table B-1: Activities to be Licensed, Part IV of PROL 13.04/2025

Darlington NGS Power Reactor Operating Licence, PROL 13.04/2025
IV) LICENSED ACTIVITIES: This licence authorizes the licensee to: (i) operate the Darlington Nuclear Generation Station, including equipment for the production of radionuclides identified in (vi) and the Darlington Tritium Removal Facility housed within the Heavy Water Management Building (hereinafter “the nuclear facility”), at a site located in the Municipality of Clarington, in the Regional Municipality of Durham, in the Province of Ontario; (ii) possess, transfer, use, package, manage and store the nuclear substances that are required for, associated with, or arise from the activities described in (i); (iii) import and export nuclear substances, except controlled nuclear substances, that are required for, associated with, or arise from the activities described in (i); (iv) possess and use prescribed equipment and prescribed information that are required for, associated with, or arise from the activities described in (i); (v) possess, transfer, process, package, manage and store the nuclear substances associated with the operation of the Darlington NGS Tritium Removal Facility; (vi) produce, possess, transfer, use, package, manage and store nuclear substances that are required for, associated with, or arise from the activities associated with operations of the Darlington Nuclear Generating station and activities described in (i) associated with production of: (1) Co-60; and (2) Mo-99 (including its decay radionuclides);

Additional activities requested to be licensed include activities associated with the production of isotopes. A request to amend the Darlington NGS PROL to include these activities was submitted in Reference B-3 and is pending Commission decision.

Nuclear Substances:

The following information provides updates, including information related to CNSC staff’s review of OPG’s application in Reference B-4 and OPG’s response to CNSC staff’s review in Reference B-5, since the application submission in this area. More information on nuclear substances is available in Appendix C of the 2025 Licence Renewal Application (Reference B-1).

The maximum quantity is interpreted as the maximum amount that can be accommodated in inventory as per design by Darlington NGS (including the Tritium Removal Facility for its operation). The Table below provides an update (where applicable) to Table 32 in the 2025 Licence Renewal Application (Reference B-1). Data provided are current as of November 2024.

Table B-2: Update to List of Nuclear Substances

Nuclear Substance	Form and Location	Maximum Quantity
Cobalt-60 (note 1)	- adjuster rods of each reactor unit - irradiated rods in spent fuel bays	79.3 MCi (2.93E06 TBq) (note 2)
	- Cobalt-60 bundle in the Irradiated Fuel Bay for calibration of the Cobalt Bundle Measurement System	expected lifetime range: 15 – 35 KCi (555 – 1295 TBq)
Enriched Uranium in Components (e.g. fission chambers)	Solid. Located within the Darlington protected area for use as needed	1.5628 g (note 3)

Notes:

1. Since submission of the 2025 Licence Renewal Application, the Darlington NGS PROL was amended to authorize the production of Cobalt-60 at Darlington NGS. Details on the maximum quantity of Cobalt-60 are provided in Reference B-6, Section 1.6 of Attachment 3.
2. Assumptions: four units operating with 16 Cobalt-60 adjuster rods (AA), one unit AAs irradiated at 1.0 Effective Full Power Years (EFPY), one at 2.2 EFPY, one at 3.0 EFPY, and one at 3.5 EFPY. Additionally assumed is two full Co-60 AA complements irradiated at 3.5 EFPY in spent fuel bays.
3. This is the current inventory. There is no design maximum and inventory may change based on operational needs.

OPG's request to amend the Darlington NGS PROL to allow for the production of the medical radioisotopes Yttrium-90 (Y-90) and Lutetium-177 (Lu-177) using the Target Delivery System currently installed for the production of Molybdenum-99 is pending Commission decision (Reference B-3). The maximum potential quantity of activated Y-90 and activated Lu-177, and information on the form of each radioisotope, is provided in Reference B-3.

The following provides additional information regarding Darlington NGS Source Characterization:

Darlington NGS Source Characterization are captured in the following documents:

Carbon-14 (Table 1)
N-REP-03400.1-10001, *An Estimate of Carbon-14 Inventory at OPG Nuclear Sites: 1971 – 1998*

Filters and IX Resins (Tables 1 to 4)
TRAN-REP-79154-00008, *Characterization of Radioactive Filters and IX Resin for the MPTP-SF & RFTP*

Retube Waste Processing Building (Section 7)
NK38-REP-09701-10326, *Darlington Retube Waste Processing Building - Safety Assessment*

Cobalt-60 (Tables 2 to 11)
NK38-REP-31780-0841462, *Source Parameters for Darlington Cobalt Flask Design Assessment*

Target Delivery System, Mo-99 Isotope Production
NK38-REP-30550-00012, *Target Delivery System System Design ALARA Assessment*

General Darlington Radionuclide Characterization (qualitative only)
N-REP-09071-10014, *Radionuclide Characterization of Smear Samples at DNGS – 2021*

Appendix B References:

B-1. OPG letter, A. Grace to C. Salmon, "Darlington NGS – Application for Renewal of the Darlington Nuclear Generating Station Power Reactor Operating Licence 13.03/2025", May 30, 2024, CD# NK38-CORR-00531-25450.

B-2. CNSC Record of Decision DEC 24-H101, "Application to Amend Power Reactor Operating Licence PROL-13.03/2025 to Authorize the Production of Cobalt-60 at the Darlington Nuclear Generating Station", June 5, 2024, CD# NK38-CORR-00531-25501.

B-3. OPG letter, A. Grace to C. Salmon, "Darlington NGS – Revised Redacted Application for Amendment to the Darlington NGS Power Reactor Operating Licence 13.03/2025 for Additional Isotope Production", November 28, 2024, CD# NK38-CORR-00531-25810.

B-4. CNSC letter, A. Baig to A. Grace, "Darlington Nuclear Generating Station: CNSC Staff Technical Sufficiency Review of the Application to Renew the Power Reactor Operating Licence", August 1, 2024, e-Doc# 7334720, CD# NK38-CORR-00531-25589.

B-5. OPG letter, A. Grace to A. Baig, "Darlington NGS – OPG Response to CNSC Staff Technical Sufficiency Review of the Application to Renew the Power Reactor Operating Licence: Action Item OPG-2024-33652", August 16, 2024, CD# NK38-CORR-00531-25595.

B-6. OPG letter, R. Geofroy to M. Bacon-Dussault, "Darlington NGS – Addendum to the Application for Darlington Nuclear Generating Station Power Reactor Operating Licence 13.03/2025 Amendment for Production of the Cobalt-60 Radioisotope", December 22, 2023, CD# NK38-CORR-00531-25073.

Appendix C: Update to Permits, Certificates and Other Licences

The following Licences have changed in Appendix E of the 2025 Licence Renewal Application (Reference C-1).

Class II Nuclear Facilities and Prescribed Equipment Licence

New:

Class II Irradiator (635), **12861-18-26.8** (replacement for 12861-18-26.7)

Import:

New:

Import Licence, IL-A4-30341.0/2029

No longer in service:

Import Licence, IL-A2-A4-26400.0/2024
Import Licence, IL-A2-A4-26401.0/2024
Import Licence, IL-A2-A4-27029.0/2026

Export:

New:

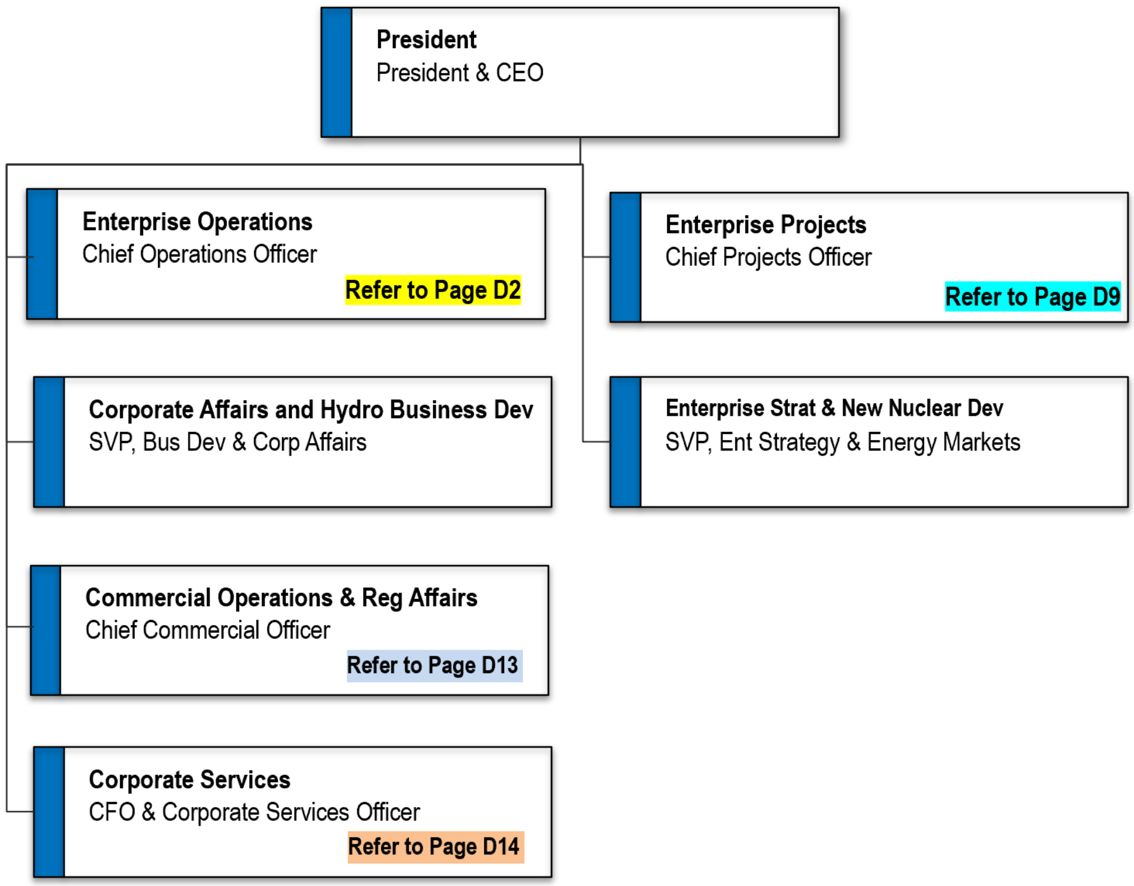
Export Licence, EL-A4-30343.0/2029

Appendix C Reference:

C-1. OPG letter, A. Grace to C. Salmon, “Darlington NGS – Application for Renewal of the Darlington Nuclear Generating Station Power Reactor Operating Licence 13.03/2025”, May 30, 2024, CD# NK38-CORR-00531-25450.

Appendix D: Darlington Organizational Structure (December 5, 2024)

Appendix D: Nuclear Organizations



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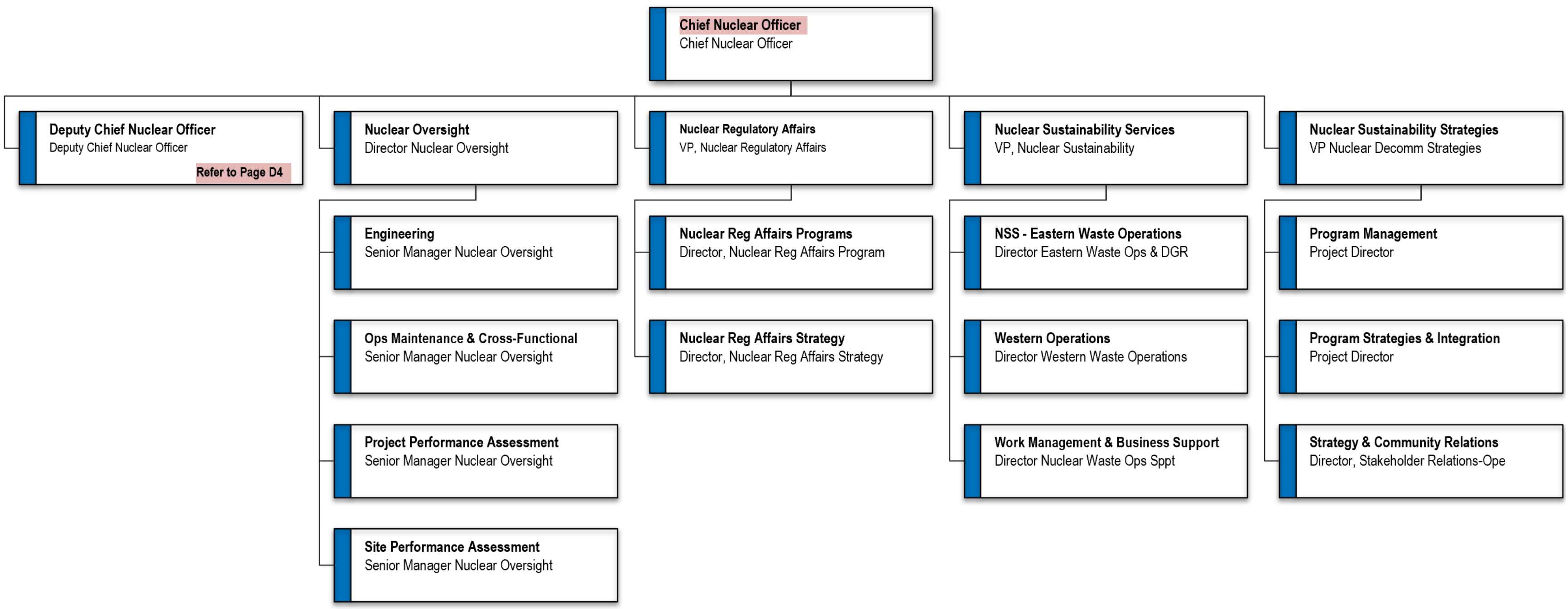
Appendix D: Nuclear Organizations

Highlighted headings indicate expanded view.

- **Enterprise Operations**
  Chief Operations Officer
  - **Chief Nuclear Officer**
    Chief Nuclear Officer
    Refer to Page D3
  - **Enterprise Engineering**
    Chief Enterprise Engineering & CNE
    Refer to Page D6
  - **Enterprise Strategy & Energy Markets**
    SVP, Ent Strategy & Energy Markets
  - **Environment, Health & Safety**
    VP Environment, Health & Safety
  - **Integrated Fleet Management**
    SVP, Integrated Fleet Management
    Refer to Page D12
  - **RG Operations**
    SVP, Renewable Generation

Appendix D: Nuclear Organizations

Highlighted headings indicate expanded view.



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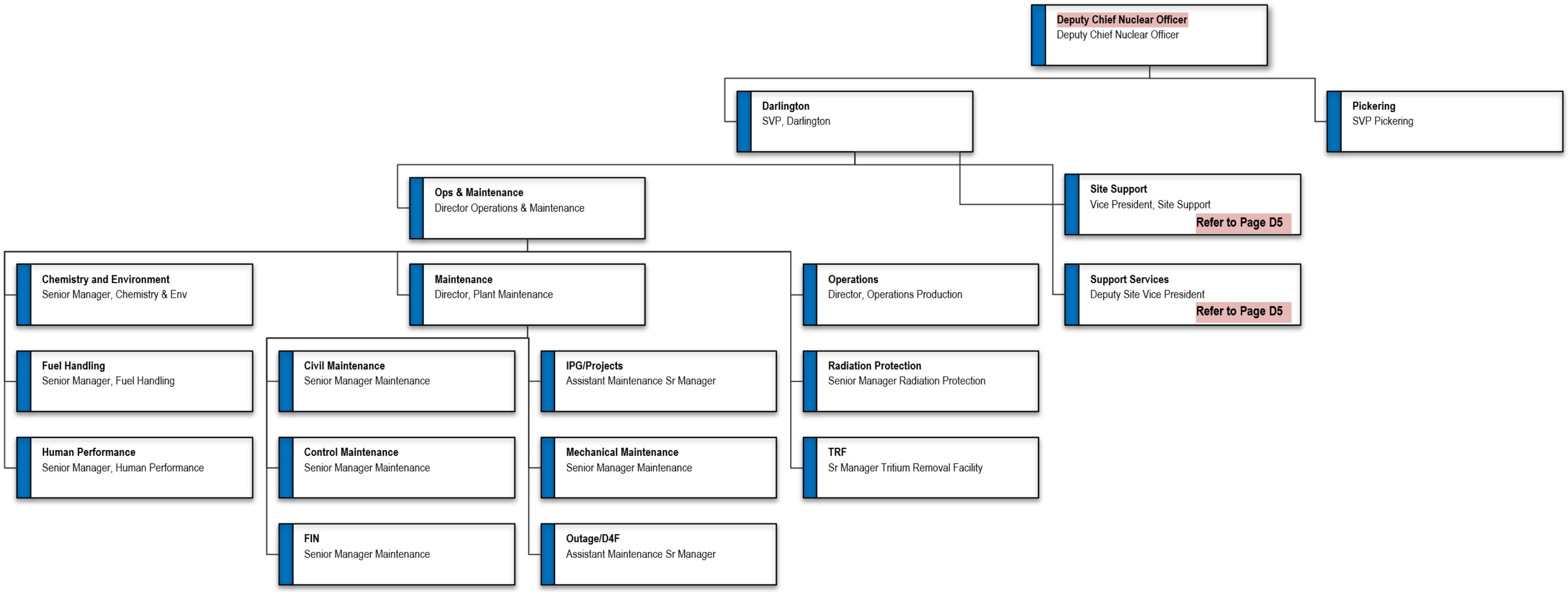
Appendix D: Nuclear Organizations

Highlighted headings indicate expanded view.



Appendix D: Nuclear Organizations

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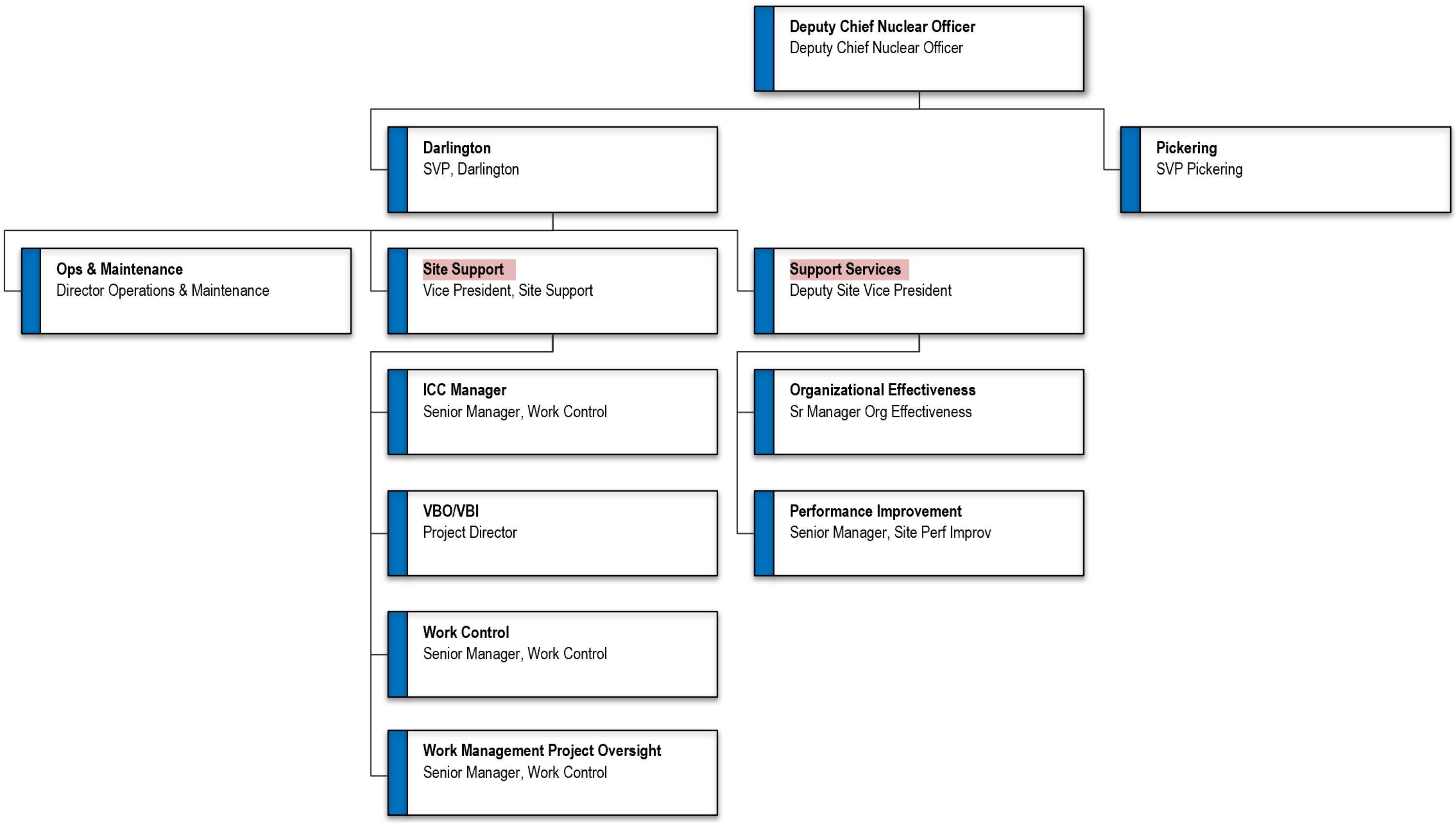


Page D5 of 15

Appendix D: Nuclear Organizations

Highlighted headings indicate expanded view.

- **Enterprise Engineering**
  Chief Enterprise Engineering & CNE
  - **Advanced Inspection and Maintenance**
    VP Advanced Inspection & Maintenance
    Refer to Page D7
  - **Central Engineering**
    VP, Central Engineering
    Refer to Page D7
  - **DNNP U1-4**
    VP New Nuclear Engineering
    Refer to Page D7
  - **Design & Project Engineering**
    VP Design & Project Engineering
    Refer to Page D8
  - **New Nuclear Technologies**
    Director, Design Engineering
    Refer to Page D8
  - **New Nuclear Deployment**
    Director, Design Engineering
    - **New Nuclear Project Engineering**
      Senior Manager Design Engineering
    - **New Nuclear Feasibility & Assessment**
      Senior Manager Design Engineering
    - **Industrial & Commercial Engineering**
      Senior Manager Design Engineering
  - **Nuclear Refurbishment**
    VP Refurbishment Engineering
    - **Pickering Refurb Performance Engineering**
      Director Station Engineering
    - **Pickering Refurbishment**
      Director Engineering Services
    - **Pickering Refurbishment Turbine Generator and Digital Control Computer**
      Senior Manager Engineering
  - **Station Engineering**
    VP Station Engineering
    - **Darlington**
      Director Station Engineering
    - **Equipment Reliability**
      Director Station Engineering
    - **Pickering**
      Director Station Engineering

Appendix D: Nuclear Organizations

Highlighted headings indicate expanded view.

- **Enterprise Engineering** — Chief Enterprise Engineering & CNE
  - **Advanced Inspection and Maintenance** — VP Advanced Inspection & Maintenance
    - **Conventional Systems** — Director, AIM Work Management
    - **Inspection Technology & Development** — Dir, IRI Engineering & Projects
    - **Nuclear Systems** — Director,Ops & Reactor Maintenance
  - **Central Engineering** — VP, Central Engineering
    - **Engineering Strategy & Support** — Director, Plant Reliability
    - **Nuclear** — Director Engineering Services
    - **Nuclear Safety** — Director Nuclear Safety
    - **Renewable Generation (RG)** — Director Eng Services
    - **RG Station Engineering** — Director Station Engineering
  - **DNNP U1-4** — VP New Nuclear Engineering
    - **DNNP U1** — Director, Design Engineering
    - **DNNP U2-4** — Director, Design Engineering
  - **Design & Project Engineering** — VP Design & Project Engineering — Refer to Page D8
  - **New Nuclear Technologies** — Director, Design Engineering — Refer to Page D8
  - **New Nuclear Deployment** — Director, Design Engineering — Refer to Page D6
  - **Nuclear Refurbishment** — VP Refurbishment Engineering — Refer to Page D6
  - **Station Engineering** — VP Station Engineering — Refer to Page D6

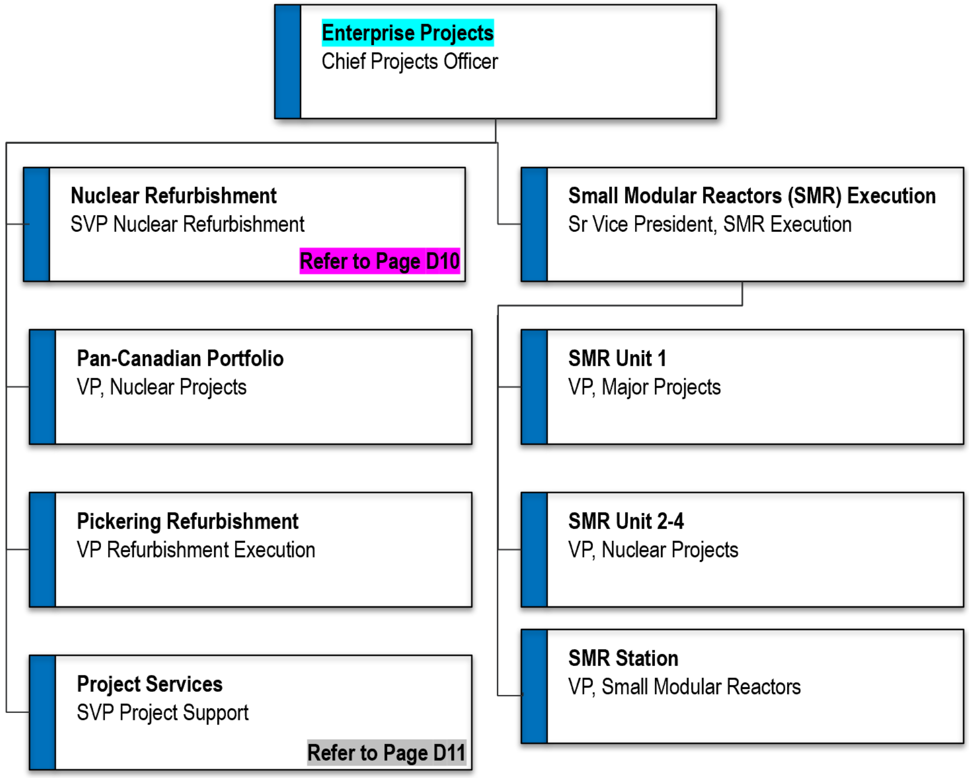
Appendix D: Nuclear Organizations

Highlighted headings indicate expanded view.

- **Enterprise Engineering**
  Chief Enterprise Engineering & CNE
  - **Advanced Inspection and Maintenance**
    VP Advanced Inspection & Maintenance
    Refer to Page D6
  - **Central Engineering**
    VP, Central Engineering
    Refer to Page D6
  - **DNNP U1-4**
    VP New Nuclear Engineering
    Refer to Page D6
  - **Design & Project Engineering**
    VP Design & Project Engineering
    - **Darlington Design Engineering**
      Director, Design Engineering
    - **Pickering Design Engineering**
      Director, Design Engineering
    - **Project Engineering**
      Director, Design Engineering
    - **Projects Design**
      Director, Design Engineering
  - **New Nuclear Technologies**
    Director, Design Engineering
    - **Technology Reviews & Studies**
      Manager Engineering
    - **Technology Development/OEM Interface**
      Senior Manager Design Engineering
  - **New Nuclear Deployment**
    Director, Design Engineering
    Refer to Page D6
  - **Nuclear Refurbishment**
    VP Refurbishment Engineering
    Refer to Page D6
  - **Station Engineering**
    VP Station Engineering
    Refer to Page D6

Appendix D: Nuclear Organizations

Highlighted headings indicate expanded view.



Appendix D: Nuclear Organizations

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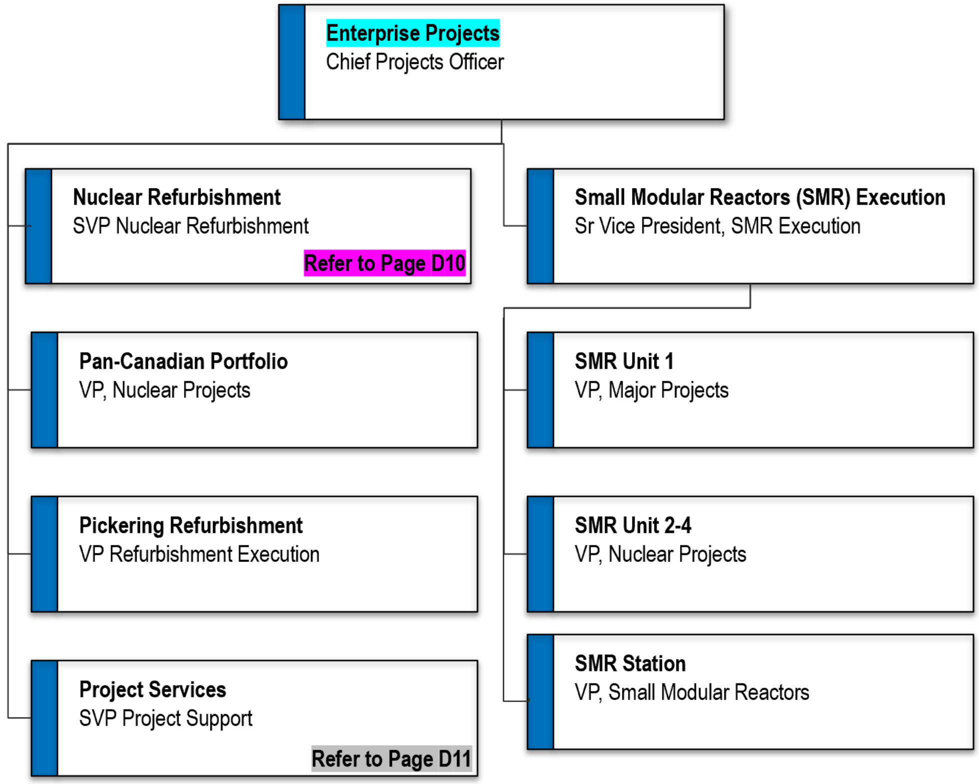

Appendix D: Nuclear Organizations

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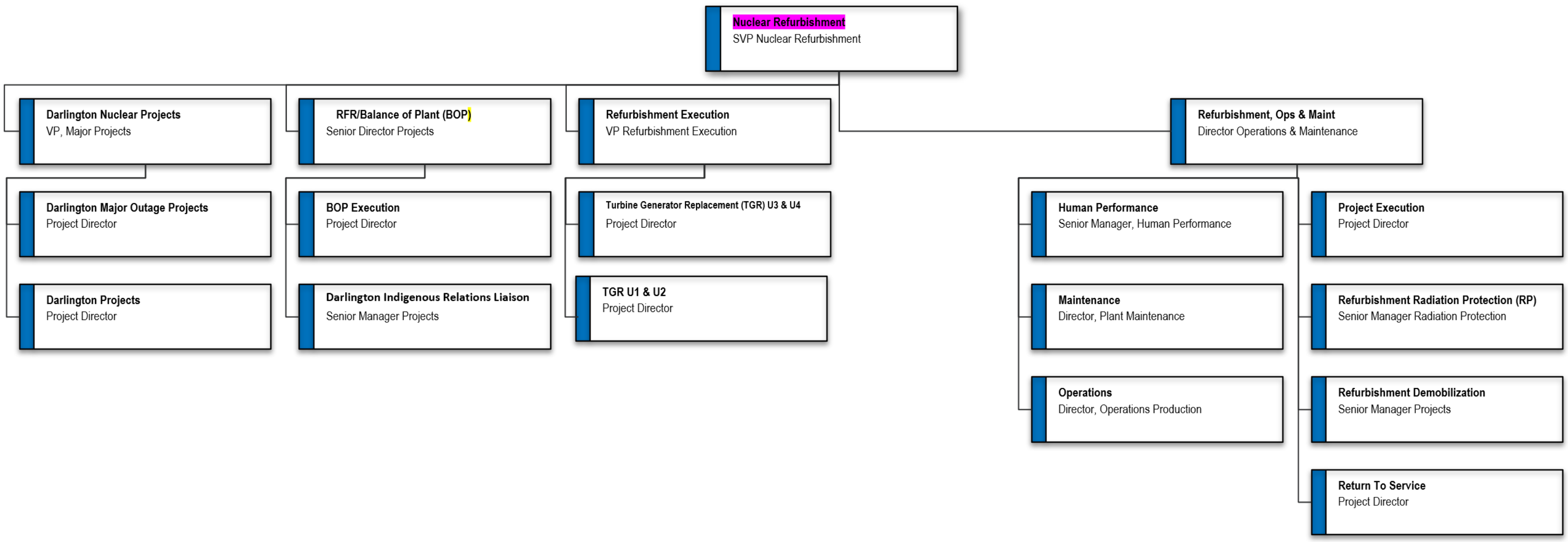

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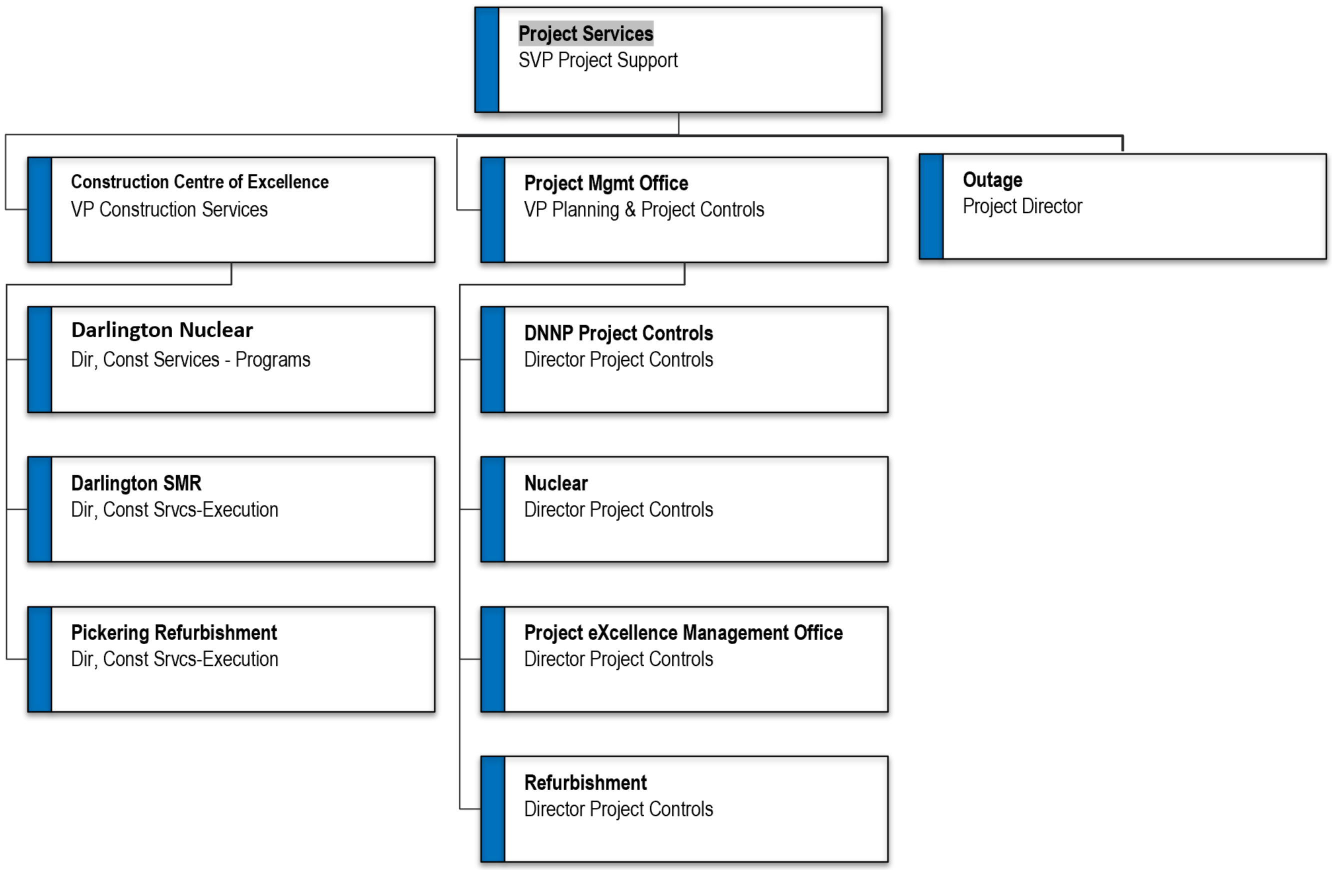
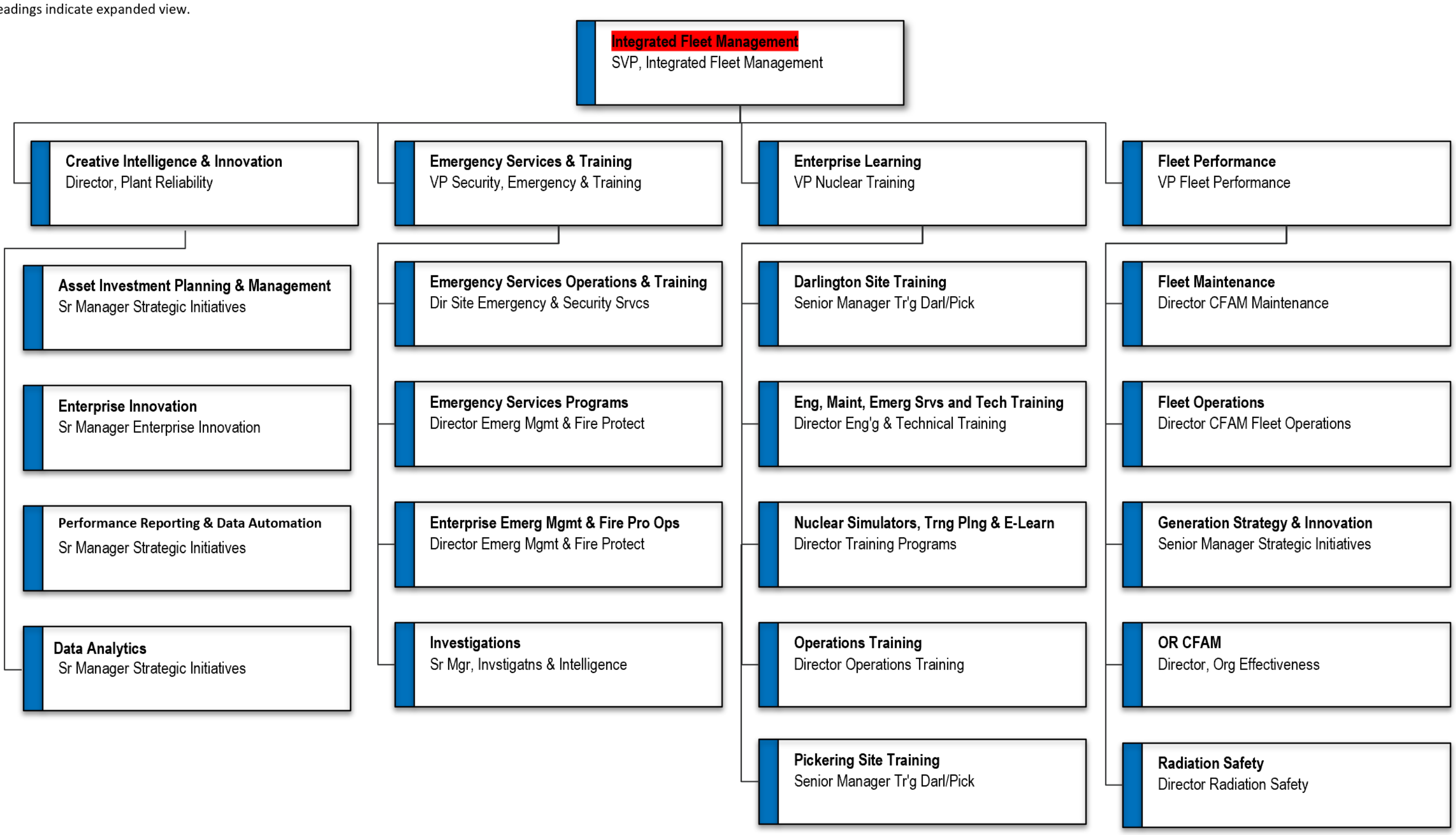
Appendix D: Nuclear Organizations

Highlighted headings indicate expanded view.



Appendix D: Nuclear Organizations

Highlighted headings indicate expanded view.



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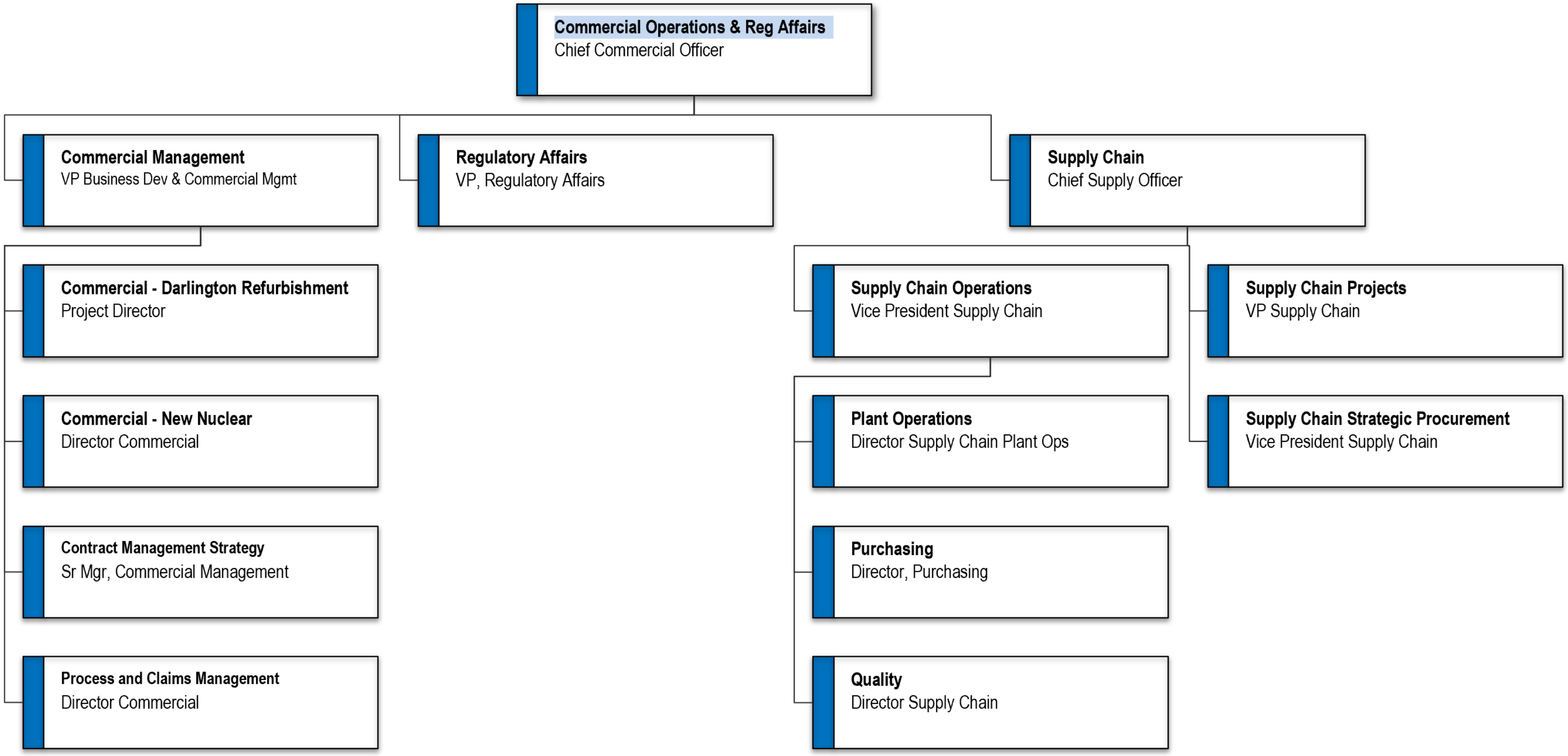
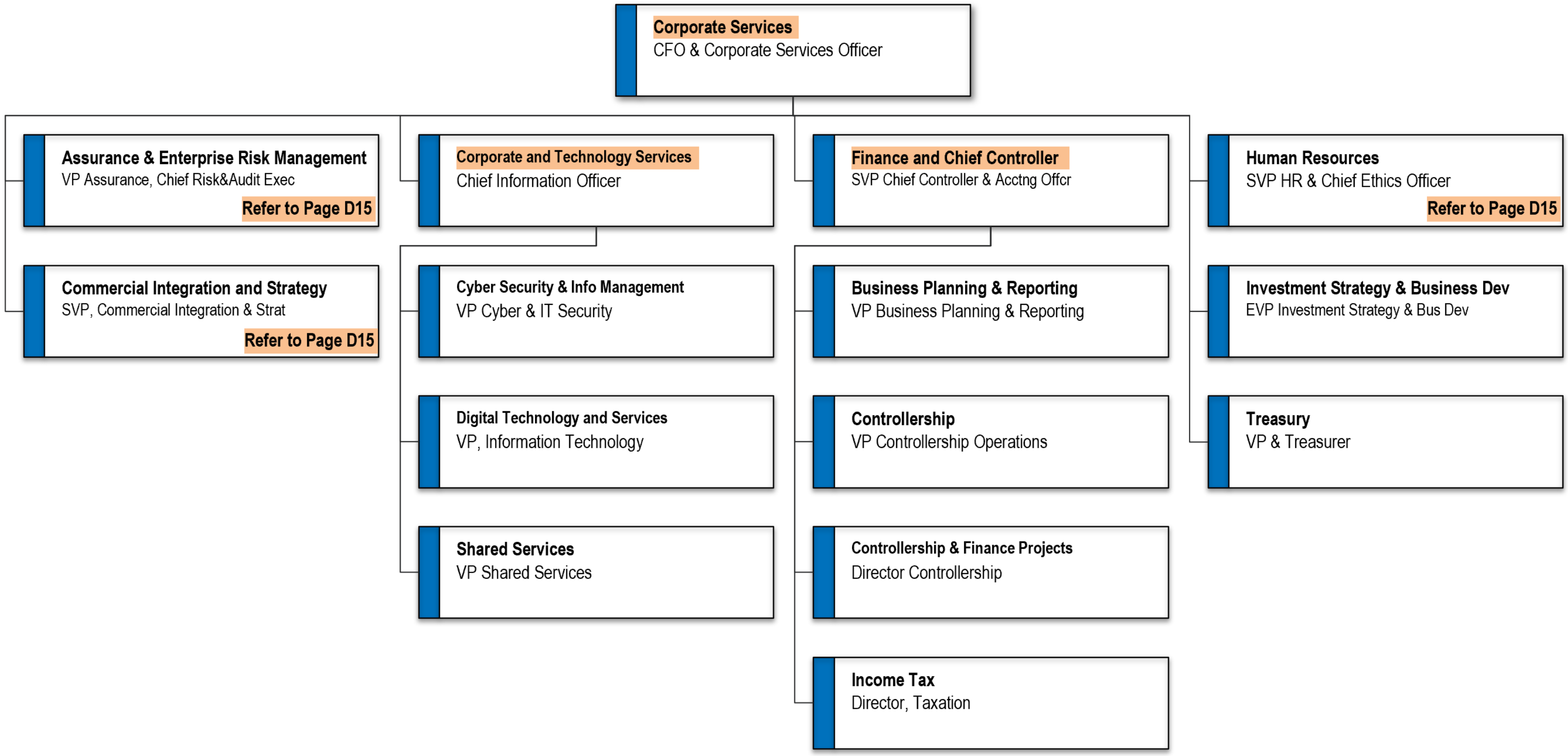
Appendix D: Nuclear Interfacing Organizations

Highlighted headings indicate expanded view.



Appendix D: Nuclear Interfacing Organizations

Highlighted headings indicate expanded view.



Appendix D: Nuclear Interfacing Organizations

Highlighted headings indicate expanded view.

- **Corporate Services** — CFO & Corporate Services Officer
  - **Assurance & Enterprise Risk Management** — VP Assurance, Chief Risk&Audit Exec
    - **Enterprise Risk Management** — Director Enterprise Risk Management
    - **Internal Audit** — Director Internal Audit
  - **Commercial Integration and Strategy** — SVP, Commercial Integration & Strat
    - **Corporate Development** — VP, Transaction Finance & Strategy
    - **Nuclear Liability/Strat Init** — Director, Management Reporting
    - **Regulatory Finance** — Director Regulatory Finance
  - **Corporate and Technology Services** — Chief Information Officer — Refer to Page D14
  - **Finance and Chief Controller** — SVP Chief Controller & Acctng Offcr — Refer to Page D14
  - **Human Resources (HR)** — SVP HR & Chief Ethics Officer
    - **HR Operations** — VP, Human Resources Operations
    - **Labour Relations** — Vice President, Employee & Labour Relat
    - **Workplace Experience and Real Estate** — VP Workplace Experience & Real Estate
  - **Investment Strategy & Business Dev** — EVP Investment Strategy & Bus Dev
  - **Treasury** — VP & Treasurer


OPG
Excellence
Commit
to better


OPG
Inclusion
Commit
to us all


OPG
Innovation
Commit
to what
could be


OPG
Integrity
Commit
to truth


OPG
Safety
Commit
to care

Summary of Regulatory Commitments, Regulatory Obligations and Regulatory Management Actions Made/Concurrence Requested

CD# NK38-CORR-00531-25844 P

Submission Title: **Darlington NGS – Supplemental Update in Support of the Power Reactor Operating Licence Renewal Application**

Regulatory Commitments (REGC):

No.	Description	Date to be Completed
	None	

Regulatory Management Action (REGM):

No.	Description	Date to be Completed
	None	

Regulatory Obligation Action (REGO):

No.	Description	Date to be Completed
	None	

Concurrence Requested: None.

ONTARIO POWER GENERATION

Allan Grace
Senior Vice President
Darlington Nuclear

1 Holt Road, Bowmanville ON L1C 3Z8 Tel: 905-260-1505 allan.grace@opg.com

OPG Proprietary

May 30, 2024

CD# NK38-CORR-00531-25450 P

Ms. C. Salmon
Commission Registrar
Canadian Nuclear Safety Commission
P.O. Box 1046
280 Slater Street
Ottawa, Ontario, K1P 5S9

Dear Ms. C. Salmon:

Darlington NGS – Application for Renewal of the Darlington Nuclear Generating Station Power Reactor Operating Licence 13.03/2025

The purpose of this letter is to submit to the Canadian Nuclear Safety Commission (CNSC) Ontario Power Generation Inc.'s (OPG) application for renewal of the Darlington Nuclear Generating Station (NGS) Power Reactor Operating Licence, PROL 13.03/2025, which expires on November 30, 2025.

OPG requests a 30-year licence renewal from December 1, 2025 to November 30, 2055.

OPG is an Ontario-based electricity generation company whose principal business is the generation and sale of electricity in Ontario. OPG head office is located at 700 University Avenue, Toronto, Ontario, M5G 1X6.

The management and control of operation of the Darlington NGS and the nuclear substances, prescribed equipment, and associated prescribed information, are the overall responsibility of Mr. Allan Grace, Senior Vice-President.

The Darlington NGS facility consists of four nuclear reactors designed, constructed and operated primarily to produce electrical power. Darlington NGS also includes the Tritium Removal Facility (TRF) housed within the Heavy Water Management Building. The TRF is designed, constructed, and operated to reduce the tritium levels in heavy water inventories.

In 2016, Darlington commenced station refurbishment activities consisting of the replacement, upgrades and the rehabilitation of critical components, which will allow for safe and reliable station operation through 2055. The Refurbishment Project is more than two-thirds complete in its 10-year execution phase, realizing strong safety, quality and schedule performance. Units 2 and 3 were successfully refurbished and returned to service and are operating at full capacity. Units 1 and 4 refurbishments are continuing with a targeted returned to service in Q2 of 2025 (prior to licence renewal) and Q3 of 2026, respectively.

This licence renewal application has been prepared in accordance with the requirements of the *Nuclear Safety and Control Act* and the associated Regulations. This submission is also being made as per the requirements and guidance in Regulatory Document REGDOC-1.1.3, *Licence Application Guide: Licence to Operate a Nuclear Power Plant* and in accordance with the additional instructions provided by CNSC staff in Reference 1.

In Reference 1, CNSC staff also requested, for identified Canadian Standards Association (CSA) standards and CNSC REGDOCs, that OPG provide implementation plans or justification for the CSA standards or REGDOCs to be used as guidance in the Darlington Licence Conditions Handbook. OPG provided this information in Reference 2.

For ease of use, Attachment 1 provides a *"Licence Renewal Application Matrix – Applicable Regulations",* to assist CNSC staff in locating specific information within the application.

Attachment 2 provides the *"Darlington Nuclear Generating Station Power Reactor Operating Licence Renewal Application"* describing the 14 Safety and Control Areas, facility-specific information, additional matters of regulatory interest, OPG's programs, station performance during the current licence period and planned improvements.

The information provided within this licence application demonstrates that OPG is qualified to carry on the licensed activities to operate a Class I nuclear facility 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.

OPG is committed to the safe and reliable operation of the Darlington NGS and continues to meet the requirements of the *Nuclear Safety and Control Act* and the associated Regulations.

Should you require any further information, please contact Ms. Aditi Bhardwaj, Senior Manager, Darlington Regulatory Affairs, at 289-387-2110.

Sincerely,

Allan Grace
Senior Vice President
Darlington Nuclear
Ontario Power Generation Inc.

Attach.

cc: CNSC Site Supervisor – Darlington
A. Viktorov - Ottawa
A. Baig - Ottawa
forms-formulaires@cnsc-ccsn.gc.ca
registry-greffe@cnsc-ccsn.gc.ca

References:

1. CNSC Letter, A. Mathai to R. Geofroy, "Application Requirements for Renewal of the Darlington Nuclear Generating Station Power Reactor Operating Licence", April 10, 2024, e-Doc# 7058965, CD# NK38-CORR-00531-24688.

2. OPG Letter, A. Grace to A. Mathai, "Response to CNSC Staff's Request for Implementation Plans or Justification for Identified Documents to be Guidance in the Darlington Licence Conditions Handbook", March 19, 2024, CD# NK38-CORR-00531-25234.

ATTACHMENT 1

OPG letter, A. Grace to C. Salmon, "Darlington NGS: Application for Renewal of the Darlington Nuclear Generating Station Power Reactor Operating Licence 13.03/2025"

CD# NK38-CORR-00531-25450 P

Licence Renewal Application Matrix – Application Regulations

(6 pages)

Attachment 1

Table 1: Licence Renewal Application Matrix – Applicable Regulations

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

Section	Regulatory Requirement	Location in Submission
General Nuclear Safety and Control Regulations		
LICENCES - General Application Requirements		
3 (1)	An application for a licence shall contain the following information: (a) the applicant's name and business address;	Cover letter
	(b) the activity to be licensed and its purpose;	Appendix C
	(c) the name, maximum quantity and form of any nuclear substance to be encompassed by the licence;	Appendix C
	(d) a description of any nuclear facility, prescribed equipment or prescribed information to be encompassed by the licence;	Section 1.1
	(e) the proposed measures to ensure compliance with the *Radiation Protection Regulations*, the *Nuclear Security Regulations* and the *Packaging and Transport of Nuclear Substances Regulations, 2015*	Sections 2.7, 2.12 and 2.14
	(f) any proposed action level for the purpose of section 6 of the *Radiation Protection Regulations*;	Sections 2.7 and 2.9
	(g) the proposed measures to control access to the site of the activity to be licensed and the nuclear substance, prescribed equipment or prescribed information;	Section 2.12
	(h) the proposed measures to prevent loss or illegal use, possession or removal of the nuclear substance, prescribed equipment or prescribed information;	Sections 2.12 and 2.13
	(i) a description and the results of any test, analysis or calculation performed to substantiate the information included in the application;	Section 1.1 and 2.4
	(j) the name, quantity, form, origin and volume of any radioactive waste or hazardous waste that may result from the activity to be licensed, including waste that may be stored, managed, processed or disposed of at the site of the activity to be licensed, and the proposed method for managing and disposing of that waste;	Section 2.11, Appendix C and Appendix D
	(k) the applicant's organizational management structure insofar as it may bear on the applicant's compliance with the Act and the	Section 2.1

Section	Regulatory Requirement	Location in Submission
	regulations made under the Act, including the internal allocation of functions, responsibilities and authority;	
	(l) a description of any proposed financial guarantee relating to the activity to be licensed; and	Section 4.3
	(m) any other information required by the Act or the regulations made under the Act for the activity to be licensed and the nuclear substance, nuclear facility, prescribed equipment or prescribed information to be encompassed by the licence.	Throughout
3 (1.1)	The Commission or a designated officer authorized under paragraph 37(2)(c) of the Act, may require any other information that is necessary to enable the Commission or the designated officer to determine whether the applicant (a) is qualified to carry on the activity to be licensed; or	See Table 2 in this Attachment 1.
	(b) will, in carrying on that activity, make adequate provision for the protection of the environment, the health and safety of persons and the maintenance of national security and measures required to implement international obligations to which Canada has agreed.	Sections 2.7, 2.8, 2.9, 2.10, 2.12, 2.13
LICENCES – Application for Renewal of Licence		
5	An application for the renewal of a licence shall contain (a) the information required to be contained in an application for that licence by the applicable regulations made under the Act; and	Throughout
	(b) a statement identifying the changes in the information that was previously submitted.	Throughout
OBLIGATIONS – Representatives of Applicants and Licensees		
15	Every applicant for a licence and every licensee shall notify the Commission of (a) the persons who have authority to act for them in their dealings with the Commission;	OPG Letter “OPG – Persons Authorized to Act on Behalf of OPG in Dealings with the CNSC and Senior Leadership Positions with Responsibility for Safety”, March 25, 2024, N-CORR-00631-23968.
	(b) the names and position titles of the persons who are responsible for the management and control of the licensed activity and the nuclear substance, nuclear facility, prescribed	Cover letter; also OPG Letter “OPG – Persons Authorized to Act

Section	Regulatory Requirement	Location in Submission
	equipment, or prescribed information encompassed by the licence; and	on Behalf of OPG in Dealings with the CNSC and Senior Leadership Positions with Responsibility for Safety", March 25, 2024, N-CORR-00631-23968.
	(c) any change in the information referred to in paragraphs (a) and (b), within 15 days after the change occurs.	OPG will continue to provide the required information.
Class I Nuclear Facilities Regulations		
LICENCE APPLICATIONS – General Requirements		
3	An application for a licence in respect of a Class I nuclear facility, other than a licence to abandon, shall contain the following information in addition to the information required by section 3 of the *General Nuclear Safety and Control Regulations*: (a) a description of the site of the activity to be licensed, including the location of any exclusion zone and any structures within that zone;	Section 1.1
	(b) plans showing the location, perimeter, areas, structures and systems of the nuclear facility;	Section 1.1
	(c) evidence that the applicant is the owner of the site or has authority from the owner of the site to carry on the activity to be licensed;	Section 1.1
	(d) the proposed management system for the activity to be licensed, including measures to promote and support safety culture;	Section 2.1
	(d.1) the proposed human performance program for the activity to be licensed, including measures to ensure workers' fitness for duty.	Section 2.2
	(e) The name, form, characteristics and quantity of any hazardous substances that may be on the site while the activity to be licensed is carried on;	Appendix D
	(f) the proposed worker health and safety policies and procedures;	Section 2.8
	(g) the proposed environmental protection policies and procedures;	Section 2.9
	(h) the proposed effluent and environmental monitoring programs;	Section 2.9
	(i) if the application is in respect of a nuclear facility referred to in a paragraph 2(b) of the Nuclear Security Regulations, the information required by section 3 of those Regulations;	Section 2.12
	(j) the proposed program to inform persons living in the vicinity of the site of the general nature and characteristics of the anticipated effects	Section 4.4

Section	Regulatory Requirement	Location in Submission
	on the environment and the health and safety of persons that may result from the activity to be licensed; and	
	(k) the proposed plan for the decommissioning of the nuclear facility or of the site.	Section 2.11
LICENCE APPLICATIONS – Licence to Operate		
6	An application for a licence to operate a Class I nuclear facility shall contain the following information in addition to the information required by section 3: (a) a description of the structures at the nuclear facility, including their design and their design operating conditions;	Sections 1.1 and 2.5
	(b) a description of the systems and equipment at the nuclear facility, including their design and their design operating conditions;	Section 2.5
	(c) a final safety analysis report demonstrating the adequacy of the design of the nuclear facility;	Section 2.4
	(d) the proposed measures, policies, methods and procedures for operating and maintaining the nuclear facility;	Sections 2.3, 2.6
	(e) the proposed procedures for handling, storing, loading and transporting nuclear substances and hazardous substances;	Sections 2.5, 2.6, 2.11, 2.14
	(f) the proposed measures to facilitate Canada's compliance with any applicable safeguards agreement;	Section 2.13
	(g) the proposed commissioning program for the systems and equipment that will be used at the nuclear facility;	Section 3.2
	(h) the effects on the environment and the health and safety of persons that may result from the operation and decommissioning of the nuclear facility, and the measures that will be taken to prevent or mitigate those effects;	Sections 2.7, 2.8, 2.9, 2.11
	(i) the proposed location of points of release, the proposed maximum quantities and concentrations, and the anticipated volume and flow rate of releases of nuclear substances and hazardous substances into the environment, including their physical, chemical and radiological characteristics;	Section 2.9
	(j) the proposed measures to control releases of nuclear substances and hazardous substances into the environment;	Section 2.9
	(k) the proposed measures to prevent or mitigate the effects of accidental releases of nuclear substances and hazardous substances on the	Section 2.10

Section	Regulatory Requirement	Location in Submission
	environment, the health and safety of persons and the maintenance of national security, including measures to (i) assist off-site authorities in planning and preparing to limit the effects of an accidental release, (ii) notify off-site authorities of an accidental release or the imminence of an accidental release, (iii) report information to off-site authorities during and after an accidental release, (iv) assist off-site authorities in dealing with the effects of an accidental release, and (v) test the implementation of the measures to prevent or mitigate the effects of an accidental release;	
	(l) the proposed measures to prevent acts of sabotage or attempted sabotage at the nuclear facility, including measures to alert the licensee to such acts;	Section 2.12
	(m) the proposed responsibilities of and qualification requirements and training program for workers, including the procedures for the requalification of workers; and	Section 2.2
	(n) the results that have been achieved in implementing the program for recruiting, training and qualifying workers in respect of the operation and maintenance of the nuclear facility.	Section 2.2
Nuclear Security Regulations		
LICENCE APPLICATION – Licence in Respect of Category I or II Nuclear Material or a Nuclear Facility		
3	An application for a licence in respect of Category I or II nuclear material, other than a licence to transport, and an application for a licence in respect of a nuclear facility referred to in paragraph 2(b) shall contain the following information in addition to the information required by section 3 of the *Nuclear Substances and Radiation Devices Regulations* or sections 3 to 8 of the *Class I Nuclear Facilities Regulations*, as applicable: (a) a copy of the arrangements referred to in section 35;	Section 2.12
	(b) the site plan referred to in section 16;	Sections 1.1 and 2.5
	(c) a description of the proposed security equipment, systems and procedures;	Section 2.12

Section	Regulatory Requirement	Location in Submission
	(d) a description of the proposed on-site and off-site communications equipment, systems and procedures;	Section 2.12
	(e) a description of the proposed structure and organization of the nuclear security officer service, including the duties, responsibilities and training of nuclear security officers;	Section 2.12
	(f) the proposed plan and procedures to assess and respond to breaches of security; and	Section 2.12
	(g) the current threat and risk assessment.	Section 2.12

Table 2: Licence Application Matrix – Additional Matters of Regulatory Interested Identified by CNSC

No.	Item	Location in Submission
1	Environmental assessment	Section 2.9 and 4.1
2	Indigenous engagement	Section 4.2
3	Cost recovery	Section 4.3
4	Financial guarantees	Section 4.3
5	Improvement plans and significant future activities	Section 1.5
6	Licensee public information program	Section 4.4
7	Nuclear Liability insurance	Section 4.3

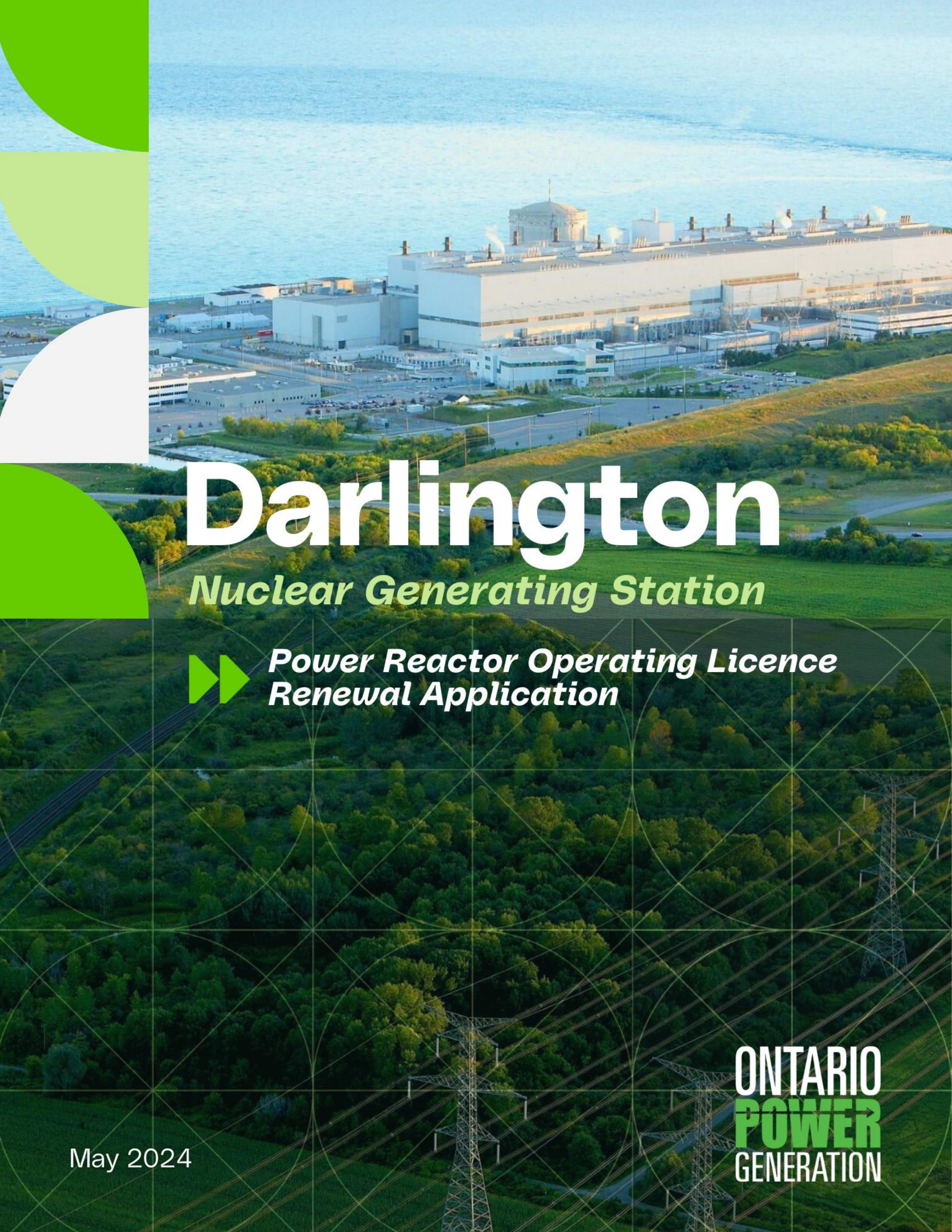
ATTACHMENT 2

OPG letter, A. Grace to C. Salmon, “Darlington NGS: Application for Renewal of the Darlington Nuclear Generating Station Power Reactor Operating Licence 13.03/2025”

CD# NK38-CORR-00531-25450 P

Darlington Nuclear Generating Station Power Reactor Operating Licence Renewal Application

(320 pages)



Darlington

Nuclear Generating Station

Power Reactor Operating Licence Renewal Application

May 2024

ONTARIO POWER GENERATION

Land Acknowledgement

The lands and waters on which the Darlington Nuclear Generating Station (NGS) is situated are the treaty and traditional territory of the Michi Saagiig and Chippewa Nations, collectively known as the Williams Treaties First Nations.

Darlington NGS is within the territory of the Gunshot Treaty and the Williams Treaties of 1923. These Treaty Rights were reaffirmed in 2018 in a settlement with Canada and the Province of Ontario.

Ontario Power Generation Inc. (OPG) respectfully acknowledges that the Williams Treaties First Nations are the Rights holders, stewards, and caretakers of these lands and the waters that touch them, and that they continue to ensure their health and integrity for generations to come.

As a company, OPG remains committed to developing positive and mutually beneficial relationships with the Williams Treaties First Nations.

Executive Summary

Ontario Power Generation Inc. (OPG) requests authorization from the Canadian Nuclear Safety Commission (CNSC) for renewal of the Darlington Nuclear Generating Station (NGS) Power Reactor Operating Licence (PROL) 13.03/2025 for a 30-year licence term from December 1, 2025 to November 30, 2055.

This application demonstrates that OPG will continue to safely operate the Darlington NGS while meeting the requirements of the *Nuclear Safety and Control Act* (NSCA) and associated Regulations. OPG will continue its licensed activities and make 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.

Darlington NGS is a top quartile performing nuclear power plant, with more than three decades of experience operating experience. OPG has a strong reputation for safe and reliable operations and has earned community support and trust in the communities in which we operate. The requested 30-year licence timeline coincides with station operational objectives achieved through our refurbishment of the Darlington NGS units.

OPG values the relationships it has built with Indigenous Nations and communities, our stakeholders and members of the public, and is committed to continued collaboration and engagement regarding ongoing operations to support a cleaner environment while meeting the electricity needs of the province of Ontario.

To ensure Indigenous Nations and communities, stakeholders and members of the public have opportunities to engage with the Commission regarding Darlington NGS operations over a 30-year licence term, OPG welcomes opportunities to address both in-person (oral) and written interventions at any future Commission proceeding concerning Darlington NGS, such as Regulatory Oversight Report (ROR) reviews and licence amendment requests.

Safety and Control Areas

This licence renewal application provides the information required to demonstrate that OPG meets or exceeds the applicable requirements of the NSCA and the associated Regulations.

The application is structured in accordance with the CNSC Safety and Control Areas (SCAs). To ensure that licensees in Canada meet all of their regulatory requirements and expectations, the CNSC assess how well licensees are complying with these requirements. The CNSC base their evaluations on 14 SCAs, broadly sorted into three functional areas: Management, Facility and Equipment, and Core Controls and Processes.

This application highlights strengths and achievements in each SCA and updates information since the last licence application, including improvements made or planned, to support operation through the end of the requested licence term.

Darlington Refurbishment

The Darlington NGS Refurbishment Project is one of Canada's largest clean energy infrastructure projects consisting of the replacement of life-limiting critical components, the completion of upgrades to meet applicable regulatory requirements, and the rehabilitation of components. This project allows for safe and reliable plant operation through 2055.

In the final quarter of 2023, several major milestones of the Refurbishment Project were completed, including Unit 1 reactor reassembly and the continuation of Unit 4 refurbishment execution including the beginning of reactor disassembly – the final unit at Darlington NGS to do so. The full Darlington NGS Refurbishment Project is more than two-thirds complete in its 10-year execution phase, realizing strong safety, quality and schedule performance. Darlington NGS Units 2 and 3, each successfully refurbished and previously returned to service in June 2020 and July 2023 respectively; are operating at full capacity.

The refurbishment of Units 1 and 4 are forecasted to be returned to service in Q2 of 2025 (prior to licence renewal) and Q3 of 2026 respectively.

Tritium Removal Facility

The Darlington NGS Tritium Removal Facility (TRF) supports maintaining low tritium levels at all Ontario Canada Deuterium Uranium reactors. The TRF has removed over 157 million Curies (5.8e+18 Bq) of reactor heavy water tritium from these facilities since 2015.

Reliability improvements and life cycle management activities will be incorporated into each of a number of planned TRF outages to ensure the facility will support operation of the Darlington NGS through the next 30 years.

Station Safety and Reliability

During the current licence term, Darlington NGS continued to demonstrate strong safety performance. OPG has received the Electricity Canada President's Award of Excellence for Employee Safety – Generation, 9 times in the last 10 years. The award recognizes OPG's achievement of being in the top quartile for both total recordable injury frequency and lost time injury severity rates.

Station reliability has remained strong due to investments and improvements made over the current licensing period. Significant improvements were achieved in Fuel Handling Reliability, Work Protection and Equipment Reliability.

Some accomplishments that contributed to safety and reliability since 2015 include the implementation of new emergency mitigating equipment and connection points, a containment filtered venting system, two auxiliary shutdown cooling pump installations, establishment of the monitoring & diagnostics centre as well as installation of a third Emergency Power Generator (EPG) and replacement of the existing two EPGs.

Through ongoing investments, innovations and the efforts of our employees, Darlington NGS is exhibiting strong safety and operational performance. This track record is a testament to the diligence and passion for excellence that all personnel are committed to on a daily basis in support of the safe and reliable operation of the station. Every day we demonstrate safety through our operations. This is supported by on site CNSC personnel who ensure that we meet rigorous requirements and standards. Public and environmental safety is more than a top priority; it is part of who we are.

Darlington NGS continues to operate safely as evidenced by CNSC assessments of findings from compliance verification activities in each of the 14 CNSC SCAs. These ongoing assessments support the fact that Darlington NGS made adequate provisions for the protection of the health, safety and security of persons and the environment during this licensing period.

Periodic Safety Review

In support of continued long-term operation, and as required by the current Darlington NGS licence, a Periodic Safety Review (PSR) was completed to confirm the design, condition and operation of the Darlington NGS supports continuing commercial operation from 2025 to 2035.

Per the PSR process, OPG submitted a PSR basis document, safety factor reports, a global assessment report and an Integrated Implementation Plan (IIP) for the implementation of safety enhancements. The Darlington NGS PSR-IIP required by the current licence and to support this licence renewal, was accepted by the CNSC in Q1 2024.

During the proposed 30-year licence term, OPG will perform PSR and associated IIP updates at an approximate 10-year frequency.

Isotopes

OPG plans to utilize Darlington NGS reactors to support the commercial production of medical and industrial isotopes, such as Cobalt-60 (Co-60), Molybdenum-99 (Mo-99) and Yttrium-90 (Y-90).

OPG has been producing Co-60, a critical isotope used in medical device sterilization and in food production, at Pickering NGS for decades. Pending regulatory approvals, OPG is planning to expand its Co-60 production capability using all four Darlington NGS units, easing the current shortages of Co-60 in the global market.

OPG and its strategic partners, are planning to harvest Mo-99, using a first-of-a-kind Target Delivery System (TDS), in Darlington NGS Unit 2. This TDS system allows for target capsules to be inserted into the reactor core for irradiation to safely produce medical isotopes. These isotopes are used in more than 40 million medical procedures each year, helping to detect illnesses like cancer and heart disease.

Additionally, pending regulatory approvals, the TDS on Darlington NGS Unit 2 will be used to irradiate Yttrium-89 (Y-89) target capsules to produce Y-90, a widely used medical isotope around the world in non-invasive treatments to destroy cancer cells and shrink tumours.

With advancements in medical and industrial sectors, OPG is investing in innovative technologies to expand isotope production capabilities into valuable resources that benefit our society.

Equity Diversity & Inclusion

OPG prides itself in being a leader. Whether it be in safety, operations, project execution, or innovation, OPG strives to be anything but average on its journey to a net-zero future.

Being a leader starts with building a diverse and inclusive workforce, one that is reflective of the people of Ontario. To this end, in 2021, OPG launched a 10-year Equity, Diversity, and Inclusion (ED&I) strategy to guide the journey towards ED&I excellence. The ED&I strategy is organized into focus areas that will drive the strategy, attract, retain, and connect with workers and listen to and serve the community. Numerous initiatives and strategies have been identified across the company that will help advance the priorities of the focus areas. A few recent examples include:

- Completion of employment systems review of policies, practices and employee experiences to identify systemic barriers to equity.
- Giving leaders metrics and tools for more equitable succession planning.
- Identification and support of education programs (e.g. Skills Ontario, First Robotics).

Through our ED&I strategy, OPG is committed to becoming a global ED&I best practice leader by 2030.

In March 2023, OPG was named one of Canada's Best Diversity Employers. Half of OPG's executive leadership is comprised of individuals belonging to designated groups, including women and racialized people.

Climate Change

OPG is driving to be a net-zero company by 2040, and to act as a catalyst for a net-zero carbon economy by 2050.

In 2020, OPG released its first-ever climate change plan. The four-phase action plan contains ambitious goals that guide the promise to be a catalyst for efficient, economy-wide decarbonization and economic renewal, while protecting the environment. The plan commits to:

- Add clean power.
- Continue to invest in all generating asset-based climate vulnerabilities.
- Innovate through new technology investments such as Small Modular Reactors (SMRs).
- Continue to lead decarbonization in Ontario and share expertise.

Nuclear power is essential in attaining greenhouse gas emission reduction targets. Having analyzed the electricity and energy needs of Ontario, the Independent Electricity System Operator has concluded that a mix of technologies, including nuclear, will be needed in Ontario.

The Darlington NGS plays a significant role in our climate change plans via the Refurbishment Project, currently underway, and the investment in the plan for new SMRs at the Darlington NGS site.

Indigenous Engagement

OPG acknowledges the Aboriginal and/or Treaty rights of Indigenous Nations and communities as recognized in the Constitution Act, 1982 and regularly undertakes engagement with Indigenous Nations and communities with established Aboriginal and/or Treaty rights proximate to the site. OPG also engages with Indigenous Nations and communities that express interest in its sites and operations.

OPG is committed to engaging with Indigenous Nations and communities regarding nuclear operations. OPG recognises that meaningful engagement begins with relationship-building, the establishment of trust and is committed to respect, openness and transparency in building these relationships. In the context of this specific application, OPG is committed to building an engagement plan with Indigenous Nations and communities to increase collaboration and deepen engagement with respect to the Darlington NGS. OPG's intent is to develop a framework for both the licence renewal application process as well as ongoing engagement after a licensing decision is made. OPG is steadfast in its commitment to supporting meaningful engagement during and after the licencing application process, and will work in collaboration with Indigenous Nations and communities to build the engagement plans.

OPG's Indigenous Relations Policy provides a framework for engaging with Indigenous peoples and providing support for community programs and initiatives while respecting Aboriginal and/or Treaty rights which are recognized and affirmed under s. 35 of Constitution Act, 1982. Some initiatives include:

- OPG has established several Framework Agreements with Indigenous Nations and communities to support regular engagement.
- Invitations provided to several Indigenous Nations and communities to engage on this licence renewal application.
- Ongoing meetings with Indigenous Nations and communities to discuss station operations and performance and other priority topics from the communities.
- All the local Indigenous Nations and communities are invited to participate in the Canadian Centre for Nuclear Sustainability and its Indigenous Advisory Council.
- Creation and participation in the Indigenous Opportunities Network, an OPG community-centred program aimed to increase the representation of Indigenous workers at OPG and within the broader energy sector.

OPG is committed to taking concrete and measurable actions to advance reconciliation with Indigenous peoples and to regularly report on the company's activities and progress in achieving established goals. In the fall of 2021, OPG launched its Reconciliation Action Plan (RAP). The RAP is a public document that serves as a roadmap to reconciliation and the 2021 edition included many specific actions and commitments with clear deliverables and timelines spanning between 2022 and 2031.

An annual RAP report was published in the fall of 2022 noting that the first-year goals were achieved. The RAP will be updated in Q2 2024 and will include reporting of 2023 results along with many new commitments developed through internal discussions and input from Indigenous Nations, communities, and businesses.

OPG's employees remain committed to advancing our Reconciliation journey. We will continue to listen, learn, and build momentum to meet our ambitious goals.

Public Engagement and Communications

OPG values the relationships it has with local communities, the public and all of its stakeholders. OPG fosters open and ongoing communications through a comprehensive public outreach program (Public Information and Disclosure Protocol).

The program ensures public communications are informative, timely and accurate; and material information is disclosed in accordance with applicable legal and regulatory requirements. Information is communicated in a number of ways based on audience identification, their interests, perception of risk; and their preferred means of communication. This ensures clear understanding of nuclear operations, activities and projects to allow the public to make informed objective decisions through readily accessible information, open dialogue and opportunities to have concerns addressed.

OPG's relationship with the local community remains strong due to ongoing open engagement and sustainable partnerships with Indigenous Nations and communities, and community stakeholders. Community stakeholders include, government, media, business leaders, educational institutions, interest groups, and community organizations.

Conclusion

In summary, this licence renewal application contains sufficient information to demonstrate that OPG meets all the requirements of the NSCA and associated Regulations and demonstrates that OPG:

- Is qualified to carry on the activities to be licensed; and,
- Will, in carrying on that activity, make adequate provision for the protection of the environment, the health and safety of persons and the maintenance of national security and measures required to implement international obligations to which Canada has agreed.

OPG has demonstrated strong safety and reliability performance at the Darlington NGS during the current licence term resulting in many significant achievements. With the improvements and future activities planned as outlined in this application, OPG is confident the Darlington NGS can continue to operate safely and reliably through 2055.

OPG is committed in their support of continued, meaningful dialogue with Indigenous Nations and communities and members of the public, during the requested licence term to ensure concerns are addressed.

OPG therefore requests the CNSC to authorize the renewal of the Darlington NGS PROL for a 30-year term from December 1, 2025 to November 30, 2055.

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1.0 Darlington NGS Licence Renewal – Introduction

Ontario Power Generation Inc. (OPG) is responsible for approximately half of the electricity generation in the province of Ontario and operates two nuclear generating stations in the province. Darlington Nuclear Generating Station (NGS) is a four-unit facility responsible for generating over 20 percent of Ontario's electricity needs, which is enough energy to power two million homes. Darlington NGS also includes the Tritium Removal Facility (TRF), which reduces the tritium levels in heavy water inventories.

OPG is applying to the Canadian Nuclear Safety Commission (CNSC) for renewal of the Darlington NGS Power Reactor Operating Licence (PROL) 13.03/2025 which expires on November 30, 2025. OPG is requesting a 30-year licence term of the Darlington NGS PROL from December 1, 2025 to November 30, 2055. This licence renewal application has been prepared in accordance with the requirements of the *Nuclear Safety and Control Act* (NSCA) and its associated Regulations. The application has also applied the requirements and guidance contained in CNSC regulatory document REGDOC-1.1.3, *Licence Application Guide: Licence to Operate a Nuclear Power Plant*. OPG will continue to carry on the licensed activities and make 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.

Since its start of commercial operation in 1990, Darlington NGS has proven to be a safe, reliable and important source of energy for the province of Ontario while meeting the constant and growing energy needs. The dedicated team of professionals who operate and maintain the station have consistently demonstrated their commitment to safety and excellent performance.

Our reactors do more than generate electricity. Darlington NGS reactors are utilized to support the radioisotope industry in both the medical and food safety fields. The predictable and reliable nature of our reactors enables dependable supply chains for isotope markets and provides opportunity to expand offerings to new isotope markets. OPG's request for a 30-year licence term is based on the following:

- **Experience:** OPG has more than five decades of experience operating nuclear generating stations safely and reliably. OPG's team of nuclear professionals have been operating Darlington NGS safely and reliably since 1990.
- **Proven Technology:** The Canada Deuterium Uranium (CANDU) reactor is a robust technology with multiple safety features, including redundant systems and passive safety mechanisms. CANDU reactors have a strong track record of reliability, with many units operating safely and consistently for decades.
- **Operational and Project Excellence:** Darlington NGS undergoes an international World Association of Nuclear Operators (WANO) peer review every two years and is recognized as a top-performing nuclear power plants in the world. Darlington NGS continues to be seen as operating to the highest levels of operational safety and reliability. In 2016, after years of detailed planning and preparation, OPG's team of project partners, industry experts, energy professionals, and skilled tradespeople successfully commenced refurbishment of the first of four Darlington NGS reactors. The Darlington NGS refurbishment of the units, through major component replacements, inspection, and modifications to improve the plant, will enable OPG to continue safe and reliable operation through a 30-year licence term. The refurbishment of Units 2 and 3 is

complete, and Units 1 and 4 are currently in progress with completion expected by the end of 2026.

- **Accepted Industry Practice:** The concept of a 30+ year licence is common in the international community. Several nuclear power generating stations around the world have 30+ years to indefinite licence terms.
- **Periodic Safety Review:** A Periodic Safety Review (PSR) is a systematic and comprehensive review performed by licensees at approximately 10-year intervals of the design, condition and operation of the facility against modern codes and standards. PSRs are conducted in accordance with REGDOC-2.3.3, *Periodic Safety Reviews* and typically require 2 to 3 years to complete. The PSR results are used to determine reasonable and practical improvements and enhancements to ensure continued safe operation until the next PSR. The identified safety improvements and schedule for their completion are documented in an Integrated Implementation Plan (IIP) and submitted to the CNSC for acceptance.
- **Regulatory Oversight:** The CNSC's continuous oversight of compliance and safety performance at Darlington NGS is independent of licence length and includes provisions such as:
    - **Reporting:** REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants* requires licensees to submit quarterly and annual reports on various subjects and provides requirements related to the submission of other important reports (such as updates to the safety analysis report and proposed decommissioning plan), that are reviewed by the CNSC. Under REGDOC-3.1.1, licensees are also required to report any unplanned situations and events to the CNSC.
    - **Compliance Verification:** The CNSC conducts regular inspections and evaluations to verify licensees are complying with the licensing basis and other conditions as specified within the station's operating licence. Inspections are carried out by permanent onsite CNSC Inspectors with assistance from CNSC Head Office staff. Compliance verification activities enable the CNSC to provide assurances of the continuing compliance and safety performance of licensees.
    - **Enforcement:** The CNSC uses a graduated approach to enforcement to encourage compliance. When a non-compliance is identified, the CNSC determines the appropriate enforcement action based on the safety significance and other factors, such as whether the non-compliance is systemic or repeated. Enforcement tools range from informal discussions to orders under the NSCA, administrative monetary penalties and legal prosecution. In addition, the CNSC Commission under Section 25 of the NSCA, irrespective of the duration of a licence, can amend, suspend in whole or in part, or revoke a licence at any time, on its own initiative.
    - **Regular Assessment of Compliance and Performance:** the CNSC provides summary assessments to the public and CNSC Commission on the overall state of Canadian nuclear power plant compliance and safety performance in reports such as the annual Regulatory Oversight Report (ROR). The ROR also includes discussions on emerging regulatory issues pertaining to the industry at large and to each licensed station. The ROR is presented in an annual public CNSC Commission meeting where Indigenous Nations and communities and members of the public may observe the meeting and formally participate as intervenors.

- **Environmental Protection Reviews:** the CNSC conducts periodic Environmental Protection Reviews (EPR) to evaluate how effectively a licensee is protecting human health and the environment in its community. The EPR considers the results of CNSC compliance and technical assessment activities as well as results from the CNSC Independent Environmental Monitoring Program and other independent verification activities. EPR reports are made available through the CNSC's website and on the open government portal.

OPG is committed to building and growing long-term, mutually beneficial working relationships with Indigenous Nations and communities regarding nuclear operations and future projects. Our relationships are developed on a foundation of respect for the rights of Indigenous Nations and our goal is to build and preserve openness, transparency, and trust. OPG is committed to building engagement plans with Indigenous Nations and communities for both the licence renewal application process as well as ongoing engagement after a licensing decision is made. OPG is steadfast in its commitment to supporting meaningful engagement during and after the licencing application process and will work in collaboration with Indigenous Nations and communities to build the engagement plans.

OPG believes in open and transparent communication in a timely manner to maintain positive and supportive relationships, and confidence of key stakeholders and the local community who have an interest in the operation and management of the station. OPG's community relations and public information program has been recognized as a strength by national and international utility peers and OPG strives to make a difference to help improve the well-being of its host communities through quality programming and environmental partnerships and programs.

OPG recognizes that Indigenous Nations and communities and members of the public appreciate the opportunity to engage directly with the Commission on matters of interest related to Darlington NGS. OPG values intervenor perspectives and welcomes opportunities to address both in-person (oral) and written interventions at any future Commission proceeding concerning Darlington NGS, e.g., ROR reviews and licence amendment requests.

This application for licence renewal provides the licensing basis for renewal of the Darlington NGS PROL, including any changes and updates to the information previously provided in References 1.0-1 and 1.0-2. In support of this application for renewal of the Darlington NGS PROL, OPG has submitted information in Reference 1.0-3 on implementation plans for Canadian Standards Association standards and CNSC regulatory documents identified by the CNSC for potential inclusion in Darlington NGS's Licence Conditions Handbook.

1.1 Site Description and Ownership

Located in the traditional territory of the Michi Saagiig and in the Municipality of Clarington in Durham Region (70 km east of Toronto), Ontario, OPG's Darlington NGS is a facility comprised of four CANDU pressurized heavy water reactors. Darlington NGS has a net generating capacity of 3,524 MW.

Darlington NGS's location and the location of the exclusion zone and structures within the zone are found in the following drawings:

i. Ontario Hydro layout drawing NK38-D0H-10220-1001, Rev 10, February 2015;

ii. Ontario Hydro layout drawing NK38-D0H-10220-1002, Rev 4, March 1982; and,

iii. Darlington NGS-A Plant Survey LO4254-DZS-10162-0531, June 7, 1999.

The Darlington NGS safety report provides detailed and extensive information on the facility and the systems, structures, and component design. This information can be found in Parts 1 and 2 of the safety report.

The Darlington NGS site is owned by OPG, which is owned by the Province of Ontario; the title/deed is available upon request.

1.2 Our People

At OPG, we are growing stronger every day because of the mix of talents and skills our increasingly diverse team of employees bring to the organization. OPG values the importance of a diverse, engaged workforce and we are proud to be an equal opportunity employer that actively seeks applicants from a variety of diverse backgrounds.

In 2021, OPG launched its first ever Equity, Diversity and Inclusion (ED&I) strategy; a 10-year strategy to become a global leader in ED&I best practices. This ambitious strategy identifies nearly 100 initiatives and 15 strategic priorities to be carried out across the enterprise by 2030, including:

- Establishing anti-racism training for all OPG employees (achieved in 2023).
- Providing five million dollars in funding over 10-years to post-secondary programs to graduate and recruit students from historically under-represented communities.
- Partnering with the BlackNorth Initiative to launch a nationwide science, technology, engineering and mathematics recruitment platform to connect BlackNorth candidates with internship, mentorship and career opportunities across the sector.

- OPG's Indigenous Opportunities Network (ION) program, which is a collaboration between OPG, the Electrical Power Systems Construction Association, Kagita Mikam Aboriginal Employment and Training, and unions/vendors engaged on the Darlington Refurbishment Project. Since launching the program in 2018, 125 ION participants have been placed.
- OPG's 2021 Reconciliation Action Plan (RAP), which includes three commitments, such as providing resources to all OPG employees to increase knowledge, understanding, and learning of Indigenous culture under its "People" pillar. The People pillar was established to create an engaged and inclusive workforce that reflects the broad diversity of Indigenous communities and peoples across the company.

Notably, in 2022 OPG made history with an all-women led crew of CNSC-licenced Control Room Shift Supervisors and Shift Managers at the Pickering NGS. OPG's employees are helping us drive our ED&I strategy forward and fostering a more inclusive workplace by getting involved and increasing awareness through numerous employee resource groups including the Abilities Alliance, Indigenous Circle, PRIDE Group, Racial Equality, and Women's Employee Resource Group. Employees have access to additional learning opportunities through various groups and partnerships including Women in Nuclear, the Canadian Centre for Diversity and Inclusion, and Pride at Work Canada.

These initiatives and more have led to OPG being named one of Canada's Best Diversity Employers in 2023, an award that recognizes employers across Canada for exceptional workplace ED&I programs.

1.3 Station Performance

Throughout the licence term, Darlington NGS has continued to maintain a strong performance record that demonstrates OPG's on-going commitment to produce reliable, clean energy while protecting the public, the environment and our staff.

Darlington NGS has had no lost time or work restricted injuries since 2019, and continues to be in the top quartile for Canadian Electricity Association Group I members for Total Recordable Injury Frequency/All Injury Rate. In the last 10-years, OPG has been awarded the Electricity Canada President's Award for Excellence in Employee Safety 9 times for its corporate-wide performance.

On February 4, 2021, Unit 1 achieved a world record of 1,106 days of continuous operation. This accomplishment highlights the effectiveness of the preventive maintenance programs and strong human performance that contribute to overall station reliability.

Throughout the licence term, collective and individual doses were managed well below administrative and regulatory dose limits. This was due to a number of factors including strong equipment reliability, reduced radiological source term following unit refurbishment, low unit forced loss rate and implementation of dose reduction initiatives.

Additionally, the 2020 Darlington NGS Environmental Risk Assessment concluded that the Darlington NGS site is operated in a manner that is protective of human and ecological receptors residing in the surrounding area. Environmental emissions to air and water were typically well below 1% of the Derived Release Limits. Similarly, dose to the public from operation of the Darlington NGS site continued to be a very small fraction of both the annual regulatory dose limit and the annual natural background radiation in the area. Tritium concentrations in groundwater were also consistently low, indicating that the potential for adverse impacts to off-site groundwater quality from the Darlington NGS site is low to negligible.

The Darlington Periodic Safety Review (D-PSR) identified 12 strengths in a wide range of areas where Darlington NGS exceeds modern requirements. The identification of these strengths is consistent with results from recent trends of key plant performance indicators which demonstrate that Darlington NGS has been operated in a safe and reliable manner. The D-PSR also concluded the current plant design, operation, processes and management system will ensure continued safe operation of the station. The implementation of enhancements identified through the CNSC accepted IIP will support and enhance the high standard of safe operation until the next PSR.

Darlington NGS hosted several WANO peer reviews over the licence term that focused on the safe and reliable operation of the station. The results of the evaluations show that Darlington continues to be seen as operating to the highest levels of operational safety and reliability.

OPG continues to invest in Darlington NGS to ensure the station's ongoing safe and reliable operations and to position it for industry-leading operating and cost performance in the longer term. In addition to the ongoing refurbishment of the station's generating units, investments in life cycle and aging management projects, facility upgrades, and work in support of regulatory commitments are included.

Achievements and Initiatives During Current Licence Term

Strong performance of the Darlington NGS is the result of a robust design, solid engineering, operations and maintenance programs and processes that incorporate continuous improvement, and an organization that is committed to safety as a core value and overriding priority. Continuous evaluation of Darlington NGS's performance is what helps the station validate its strengths and areas for improvement; as well as ensuring the station consistently demonstrates the *"Staying on Top – Advancing a Culture of Continuous Improvement"* Institute of Nuclear Power Operations values. *"Staying on Top"* provides a set of values and behaviors for establishing a culture that achieves sustainable results and enables continuous performance improvement. Annual *"Staying on Top"* assessments are conducted to ensure we are driving excellence in all areas. Our commitment to excellence will serve as our strongest asset in maintaining our position as a leader in the industry.

A few of Darlington NGS's achievements and initiatives during the current licence term are discussed below, with further details provided in Sections 2 and 3 of this application.

Integrated Implementation Plan

The Darlington NGS Integrated Safety Review (D-ISR) IIP NK38-REP-03680-10185, *Darlington NGS Integrated Implementation Plan (IIP)*, outlines improvements that support Darlington NGS's continued safe operation and focus on enhancing the station's safety and reliability. The D-ISR was performed in support of refurbishment and life extension. The IIP presents the scope and schedule for the implementation of actions resulting from environmental assessments, integrated safety reviews, addressing code gaps, component condition assessments, and integrated aging management programs. Overall, 541 of 622 of the IIP refurbishment and continuing operation commitments have been completed up to Q1 2024.
In support of continued long-term operation into the next licence period, a Periodic Safety Review (D-PSR) was completed to confirm that the design, condition and operation of the

Darlington NGS supports continuing commercial operation from 2025 to 2035. The D-PSR IIP NK38-REP-03680-11940, *Darlington NGS Periodic Safety Review (D-PSR): Integrated Implementation Plan,* was accepted by CNSC staff in Q1 2024.

Darlington Refurbishment Project

The Darlington NGS Refurbishment Project is a multi-year, multi-phase project that is enabling the Darlington NGS to continue safe and reliable operation. The project includes the replacement of life-limiting critical components, the completion of upgrades to meet applicable regulatory requirements, and the rehabilitation of components at Darlington NGS's four units. To date, Units 2 and 3 have been successfully returned to service and Units 1 and 4 refurbishment activities are progressing on schedule with planned completion of the refurbishment project in 2026.

While the primary focus of refurbishment is the proactive replacement of the reactor core components, there has also been a considerable number of initiatives and improvements completed ensuring Darlington NGS's continued safe operation through the next 30-years.

Equipment Reliability

OPG has made a considerable investment in Darlington NGS over the current licence term in equipment reliability. This includes $800M+ on projects to improve equipment reliability and address aging and obsolescence. These initiatives will improve system and equipment reliability in support of safe and reliable operation for years to come.

Fuel Handling Equipment Reliability

Significant improvements have been made in fuel handling equipment reliability where we experienced a best in CANDU fleet performance score of 98% in December 2023, in contrast to 82% in December 2016.

Over the past few years, the Darlington NGS Fuel Handling team has been integral to the success of the station, supporting major outages and refurbishment campaigns. This includes the successful defuel of all four reactor units, and the refuel and return to service of Unit 2 and Unit 3. To support the station's continued operation post-refurbishment, Fuel Handling developed and implemented a reliability improvement program in 2019. The program consists of approximately 1000 scopes of work, including major equipment replacements, upgrades and refurbishments. To date over 50% of the program has been completed, with the remainder of the program expected to be completed by the end of 2026 to support the long-term reliability of the fuel handling equipment and the return to four-unit fueling.

Emergency Mitigating Equipment

In response to the 2011 Fukushima Daiichi event, OPG has implemented Emergency Mitigating Equipment (EME) at Darlington NGS to enhance reactor cooling and monitoring capabilities. The EME is deployed in two phases.

Phase 1: Rapid deployment of on-site mobile equipment for immediate restoration of reactor cooling, monitoring and containment protection.

Phase 2: Deployment of three portable diesel generators stored at Pickering NGS that can be deployed to Darlington NGS within 12 hours to provide additional cooling and containment protection.

EME is securely stored, staged, maintained and tested by OPG's Emergency Response Team on a recurring schedule.

Additionally, a containment filtered venting system has been installed to filter radioactive materials from the vacuum building, preventing their release.

In February 2022, OPG conducted Exercise Unified Command, a full-scale exercise simulating a beyond-design-basis accident at Darlington NGS. The exercise involved multiple agencies and tested OPG's ability to respond to a large-scale emergency using the EME, demonstrating the effectiveness of both on-site and off-site emergency preparedness measures.

OPG continues to benchmark industry best practices for EME processes, procedures and equipment.

Emergency Power Generators

Darlington NGS has increased nuclear safety redundancy with the installation of a third Emergency Power Generator (EPG). This was followed by the replacement of EPG2 in 2020 and the replacement of EPG1 in 2023. Each EPG is a standalone mini power plant capable of supplying eight megawatts of reliable backup electricity to the Emergency Power System at Darlington NGS in the unlikely event of an emergency.

Tritium Removal Facility

Since 2015, the TRF has removed approximately 157.5 million Curies (5.81e+18 Bq) of reactor heavy water tritium from Ontario CANDU reactors. Initiatives to improve and ensure continued detritiation capability include:

- Commissioned a new building, the West Annex, which has an additional 1900 Mg of storage capacity for heavy water, as well as drum handling facilities;
- Installed a wet scrubber on the recombiner outlet and ventilation systems of the TRF to further enhance tritium reduction.

1.4 Innovation at OPG

OPG has made advancements in innovation during the current licence term, including the Monitoring & Diagnostics (M&D) Centre, X-LAB and innovations in training.

Monitoring & Diagnostics Centre

The M&D Centre was established in 2017, leveraging data analytics and remote continuous online monitoring to closely track critical components, utilizing more than 2,400 Advanced Pattern Recognition models and about 20,000 data points across the OPG fleet.

The M&D Centre provides early detection to support the condition-based maintenance strategy to execute the right work at the right time. The Centre also provides Darlington NGS with thermal performance monitoring service to minimize generation losses from the turbine cycle.

The M&D Centre received the 2022 Canadian Nuclear Society Innovative Achievement Award in recognition of significant innovative achievements and the implementation of new concepts displaying clear qualities of creativity, ingenuity and elegance in the nuclear field in Canada.

The M&D Centre has also benchmarked against various utilities through organizations such as Electric Power Research Institute (EPRI) and has been recognized as one of the industry leaders, leveraging data analytics to enhance plant reliability and to minimize generation loss.

OPG's Innovation Department (X-Lab)

OPG is recognized as a world class leader regarding the implementation of innovative strategies, often benchmarked for innovation practices and processes. OPG's innovation department, coined the "X-Lab", was established in 2017 and is dedicated to transforming mindsets, fostering creativity, and implementing cutting-edge technologies and processes. The X-lab has brought value and efficiency to OPG's daily operations, while advancing the company towards its net-zero climate goals. The X-Lab Innovation Team spearheads innovation in the utility sector with a mission to redefine standards. The team's vision is to drive enhancements in equipment reliability, safety, and employee efficiency while nurturing an innovation culture.

- OPG is positioning itself as an industry leader in robotic utilization through the adoption of the SPOT Robotics Platform by Boston Dynamics. This platform drives efficiency while maintaining OPGs high level of executional excellence and safety. The SPOT robot has enabled OPG to perform tasks online, and in harsh environments that would otherwise require a unit outage to perform safely by a human.
- In 2023, the EPRI Global Innovation Effectiveness (GIE) Cohort reviewed OPG's innovation practices and processes and recognized the X-Lab Innovation Team for industry-leading practices. The GIE aims to provide insights into the effectiveness of innovation by examining how utilities strategize, structure, and cultivate an innovative culture.
- OPG has leveraged an internal cloud-based idea management system, Launchpad, to capture innovative ideas from employees across OPG. Ideas are visible to all employees who can then vote, comment, and/or collaborate to develop ideas into actionable projects. The X-Lab team ensures every voice is heard, fostering an environment where ingenuity thrives.
- Micro-drone Operation enables lightweight drones to be utilized by staff. This allows for visual inspections to be performed more efficiently.

By empowering employees and facilitating seamless collaboration, the X-Lab Innovation Team remains committed to shaping the future of energy delivery, setting new benchmarks for innovation in the process.

Innovative Strategies for Training

Training has embedded innovation in its program.

- Fuel Handling Simulators: the updated simulator allows Operators to become more proficient in fuel handling activities while working in a low-risk environment. The Fuel Handling team has utilized the simulator to not only expose the Operators to enhanced procedures, but to fine tune first-of-a-kind procedures.
- TRF Simulator: the simulator allows Operators to become more proficient in TRF evolutions such as startup and shutdown as well as time to practice team effectiveness, human behaviours utilizing human performance tools and first-of-a-kind procedures while working in a zero-risk environment. Simulator improvements are being implemented in 2024 to better model transients, start-up and shutdown evolutions.

- Virtual Reality Crane Simulators: maintenance training instructors improved crane operator performance by incorporating a virtual reality simulator into crane operator training.
- Flight Simulator: incorporation of a flight simulator for human performance training. This places individuals in an unfamiliar environment where they are able to observe the full benefits of human performance tools/techniques while being challenged with distractions and competing priorities.
- Simulated Radiological Source Generator: Radiation Protection (RP) training has improved RP technician performance by incorporating a simulated radiological source generator into their continuing training. A radio frequency simulated source eliminates actual live radiological sources. Technicians are demonstrating greater radiological risk mitigation proficiency while eliminating any exposure to radiological sources. The simulation equipment includes portable wireless dosimeters, survey meters, gamma sources and scenarios that mimic conditions that were unachievable in previous training conditions.

1.5 Improvement Plans and Significant Future Activities

An overview of OPG's planned improvement plans and significant future activities concerning Darlington NGS during the requested 30-year licence term is discussed below, with further details provided in Sections 2, 3, and 4 of the application.

Completion of the Darlington Refurbishment Project

Completion of the refurbishment project is on track for 2026 and through the major component replacements, inspection, and modifications to improve the plant, will enable OPG to continue safe and reliable operation of Darlington NGS through a 30-year licence term.

Completion of Integrated Implementation Plan Activities and Future Periodic Safety Reviews

Completion of the improvements outlined in the D-ISR IIP and the D-PSR IIP support Darlington NGS's continued safe operation, with focus on enhancing the station's safety and reliability. The D-PSR IIP covers the period of operation of Darlington NGS units from November 2025 to November 2035.

PSR's will continue to be conducted at approximately 10-year intervals through the requested licence term. PSRs are conducted in accordance with CNSC regulatory document REGDOC-2.3.3 and improvements identified, and documented in an IIP, will support continued safe operation of Darlington NGS.

Asset Management

Darlington NGS will continue to invest in station equipment through developed aging/asset strategies and Life Cycle Management Plans that provide asset investments using a risk-based value framework through 2055.

Tritium Removal Facility Major Component Replacement Project

The TRF will undergo a major component replacement in six outages commencing in 2026. This will extend the life of the facility for decades to come. Major scope in these outages includes re-design and replacement of the Cryogenic Refrigeration System (CRS) oil turbine, and the installation of additional CRS hydrogen compressor capabilities. This work will improve safety and plant reliability by addressing obsolescence and improving redundancy.

Isotopes Production

Darlington NGS's support for safe production of isotopes includes the planned production of Cobalt-60 (Co-60), Molybdenum-99 (Mo-99), and Yttrium-90 (Y-90) and there is potential for additional growth in this fast-changing and life-saving field. The reactor cores are analyzed to be safe in this configuration and processes and procedures are in place to ensure safe handling and hand-off of the resultant isotopes to OPG's strategic partners.

Darlington for the Future

The Darlington for the Future (D4F) initiative includes focus areas that will allow OPG to achieve and sustain industry leading top quartile performance over the station's 30-year post-refurbishment operations window. The D4F initiative started in 2019 and is planned to continue to 2030, with key focus areas including (but not limited to):

- Plant Reliability: develop asset life cycle plans to end of Darlington NGS extended life;
- Pressure Tube Life: implement fuel channel improvements to support pressure tube operational targets to 250,000 equivalent full power hours.
    - During refurbishment, Darlington NGS completed major life extension activities, including replacement of pressure tubes as well as other major reactor core assembly components. Improvements were made to these replaced components through the manufacturing process to mitigate known aging mechanisms based on pre-refurbishment industry operating experience.
    - Baseline Inspections: The condition of the fuel channel components is regularly monitored via inspection programs, consistent with the life cycle management approach used for all major components, demonstrating that component condition remain within the licensing basis and fitness-for-service criteria. Largescale inspection campaigns completed pre-refurbishment across the OPG nuclear fleet, particularly during late-life operation, have enabled the development of improved modelling capabilities that increase confidence in long term projections of known degradation mechanisms. The breadth of operating experience that OPG has accumulated will be applied along with industry lessons learned to improve upon existing life cycle management.

OPG's Reconciliation Action Plan

In the fall of 2021, OPG launched the RAP, which outlined the commitment to advancing reconciliation with Indigenous peoples under the pillars of leadership, relationships, people, economic empowerment, and environmental stewardship:

- Leadership: Commit to reconciliation as a journey and track progress with metrics and targets around commitments.

- Relationships: Build positive and mutually beneficial relationships with Indigenous communities and peoples based on respect and understanding.
- People: Create an engaged and inclusive workforce that reflects the broad diversity of Indigenous communities and people across OPG.
- Economic Empowerment: Advance economic reconciliation with Indigenous communities and businesses through meaningful engagement, collaboration and partnership.
- Environmental Stewardship: Be a trusted partner in environmental stewardship and an ally in addressing climate change.

The RAP is our road map for how we intend to work in partnership with Indigenous communities, businesses and organizations to advance reconciliation. It's also about how we intend to grow and continue learning as an organization. The 2021 edition of the RAP included 38 specific action and commitments with clear deliverables and timelines spanning between 2022 and 2031.

An annual report was published in the fall of 2022, which noted that the first-year goals were achieved through much work, dedication, and collaboration with communities. OPG remains on track and ahead of schedule to meet its commitment of expanding opportunities for Indigenous businesses to participate in nuclear procurement under its "Economic Empowerment" pillar. The RAP is being updated and published in Q2 2024 with over 20 new commitments that were developed through internal discussions and input from Indigenous Nations, communities, and businesses. Included in the RAP update will be a report on our 2023 results.

The RAP is aligned with the Truth and Reconciliation Commission's Call to Action #92, which urges corporate Canada to create a better future by applying a reconciliation framework to business activities. For OPG's supporting activities refer to Section 4.2.

OPG's Climate Change Plan

In 2020, OPG released its first-ever climate change plan to create a cleaner environment to help tackle climate change, with the goal of becoming a net-zero carbon company by 2040 and helping the markets that OPG operates in achieve net-zero economies by 2050. The guiding principle of this climate change plan is to be the catalyst that enables the transformation to clean economies, in the most efficient and responsible way possible.

Tackling climate change will take a combination of electricity generating technologies and innovative solutions. To reach these goals, OPG has implemented a Climate Change Action Plan organized around four pillars:

- Mitigate Carbon Emissions: OPG is working towards the electrification of the economy, addition of clean power (hydro, nuclear, and renewable) and is exploring the reduction of emissions in natural gas generating stations through means such as carbon capture.
- Adapt to the Impacts of a Changing Climate: OPG will continue to invest towards all generating asset-based climate vulnerabilities to ensure continued production of clean and reliable power.
- Innovate and Deploy New Technologies: OPG will continue to innovate through investments such as Small Modular Reactors (SMRs), deploy nature-based climate

solutions, and increase OPG's aggregate resource pool of distributed energy resources to meet changing electricity demands.

- Lead the Decarbonization of Ontario's Economy: OPG will continue to lead in and share the expertise to help decarbonization through SMRs and hydro development, electrification infrastructure, and sustainably focused operational excellence.

2.0 Safety and Control Areas (SCAs)

This section documents CNSC's regulatory requirements for the safety performance of programs. The sections are sub-grouped as 14 Safety and Control Areas (SCAs) that are further divided into specific areas that define the key components of each SCA. The SCAs cover the functional areas of:

Management:	**(SCAs 1, 2 and 3)**
Facility and Equipment:	**(SCAs 4, 5 and 6)**
Core Control Processes:	**(SCAs 7, 8, 9, 10, 11, 12, 13 and 14)**

Section 2.1

Management System

2.1 Management System

OPG maintains a nuclear management system in accordance with the current operating licence and associated Licence Conditions Handbook. OPG's nuclear management system is applicable to all OPG nuclear facilities and is compliant with CSA N286-12, *Management System Requirements for Nuclear Facilities*.

The fundamental objective of OPG's nuclear management system is to ensure OPG nuclear facilities are operated and maintained using sound nuclear safety and defence-in-depth practices to ensure radiological risks to workers, the public, and the environment are As Low As Reasonably Achievable (ALARA), and in keeping with the OPG *Nuclear Safety and Security Policy* and the best practices of the international nuclear community.

OPG's nuclear management system sets out the principles, required supporting actions and documentation to support safe and reliable nuclear facilities, and brings together in a planned and integrated manner, the processes necessary to satisfy requirements and to carry out licenced activities safely.

Management system requirements provide direction to develop and implement management practices and controls. Programs and processes are created such that all applicable regulatory requirements and codes and standards are embedded and integrated within the nuclear management system, including aspects of health, safety, environment, security, economics and quality.

OPG's nuclear management system satisfies the requirements set out in the Nuclear Safety and Control Act (NSCA), regulations made pursuant to the NCSA, the PROL, and the measures necessary to ensure that safety is of paramount consideration in operation of OPG's nuclear facilities.

The OPG documents in the table below require written notification of change per Darlington NGS Licence Conditions Handbook, LCH-PR-13.03/2025-R005:

Table 1: SCA 1 – Management System

Document	Title
N-CHAR-AS-0002	Nuclear Management System
N-PROG-AS-0001	Nuclear Management System Administration
OPG-PROG-0001	Information Management
OPG-PROG-0039	Project Management Program
OPG-STD-0140	Managing Change
N-STD-AS-0020	Nuclear Management System Organizations
OPG-PROC-0166	Organization Design Change
N-POL-0001	Nuclear Safety & Security Policy
N-STD-AS-0023	Nuclear Safety Oversight
OPG-PROG-0005	Environment Health and Safety Managed Systems
N-PROC-AS-0077	Nuclear Safety & Security Culture Assessment
N-PROG-RA-0010	Independent Assessment
N-GUID-09100-10000	Contingency Guideline for Maintaining Staff in Key Positions When Normal Station Access is Impeded
OPG-PROG-0033	Business Continuity Program
OPG-PROG-0009	Items and Service Management

2.1.1 Management System

OPG's nuclear management system is documented in charter N-CHAR-AS-0002, *Nuclear Management System* (the Charter), and provides the framework for programs and processes which collectively ensure that Darlington NGS operates safely and reliably.

The Charter takes authority from N-POL-0001, *Nuclear Safety & Security Policy*, established by OPG's Board of Directors. In accordance with N-POL-0001, the Chief Nuclear Officer (CNO) is accountable to the Chief Executive Officer (CEO) and Board of Directors to establish a management system that fosters nuclear safety and security as the overriding priority.

The Charter, consistent with N-POL-0001, communicates the expectations of the CNO. Collectively, the Charter and its reference processes establish a quality program, the nuclear management system, and fulfill the requirements of CSA N286-12.

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

The nuclear management system has evolved over the licence term, to support the OPG centre-led business model. Several programs have transitioned from being Nuclear-only, to being owned by corporate business units (e.g., Items and Services Management, Information Management, and Environment and Health and Safety). For these programs, ownership and accountability for the program resides with the Corporate program owner but the CNO remains accountable for the effectiveness of the implementation of these programs in Nuclear, and in meeting the requirements of CSA N286-12. Oversight and review of the health and effectiveness of these corporate programs continue to be part of the nuclear management system.

2.1.2 Organization

N-STD-AS-0020, *Nuclear Management Systems Organizations*, describes the organization and responsibilities of OPG in support of the Charter and CSA N286-12. The objectives are to:

a) Maintain a sufficient number of qualified staff to safely operate, maintain, and support the nuclear generating stations, and;

b) Maximize the efficiency and effectiveness of its workforce.

Under the current governance requirements outlined in N-STD-AS-0020, applicable documents must be updated when role accountabilities change to ensure currency and accuracy.

Organizational change includes changes to all components of the organization, including but not limited to safe and effective operations, work, people, processes and practices technology systems, governance/policies, programs, organization design, financial performance, culture, information systems, and internal and external stakeholder relationships and agreements.

Organization design change specifically refers to changes to the organization structure (i.e. structure, hierarchy, spans and layers, reporting lines, positions, accountabilities, role documents, jobs, classifications, locations, etc.). OPG-PROC-0166, *Organization Design Change*, describes the process for managing changes to the organization structure as outlined above which, depending on the nature of the change, may result in changes to role documents identified in N-STD-AS-0020. OPG-PROC-0166 assigns accountabilities and related requirements for preparing, reviewing, approving and implementing organizational changes. The documented change process includes the following:

a) Gated criteria to evaluate the complexity of the change; minor or material;

b) Direction to assess various aspects of the change (e.g. requirement for pressure boundary and/or regulatory interface, governance changes, cumulative impact of several minor changes);

c) Approval levels that correspond with the level of change;

d) Communications according to the level and complexity of change.

N-STD-AS-0020 and OPG-PROC-0166 support N-PROG-AS-0001, *Nuclear Management System Administration* in the Nuclear Management System (N-CHAR-AS-0002).

Figure 1 provides the current Darlington NGS organizational structure. The Darlington NGS organizational chart information is updated each year and submitted to the CNSC. Figure 2 provides the Darlington NGS Refurbishment organizational structure.

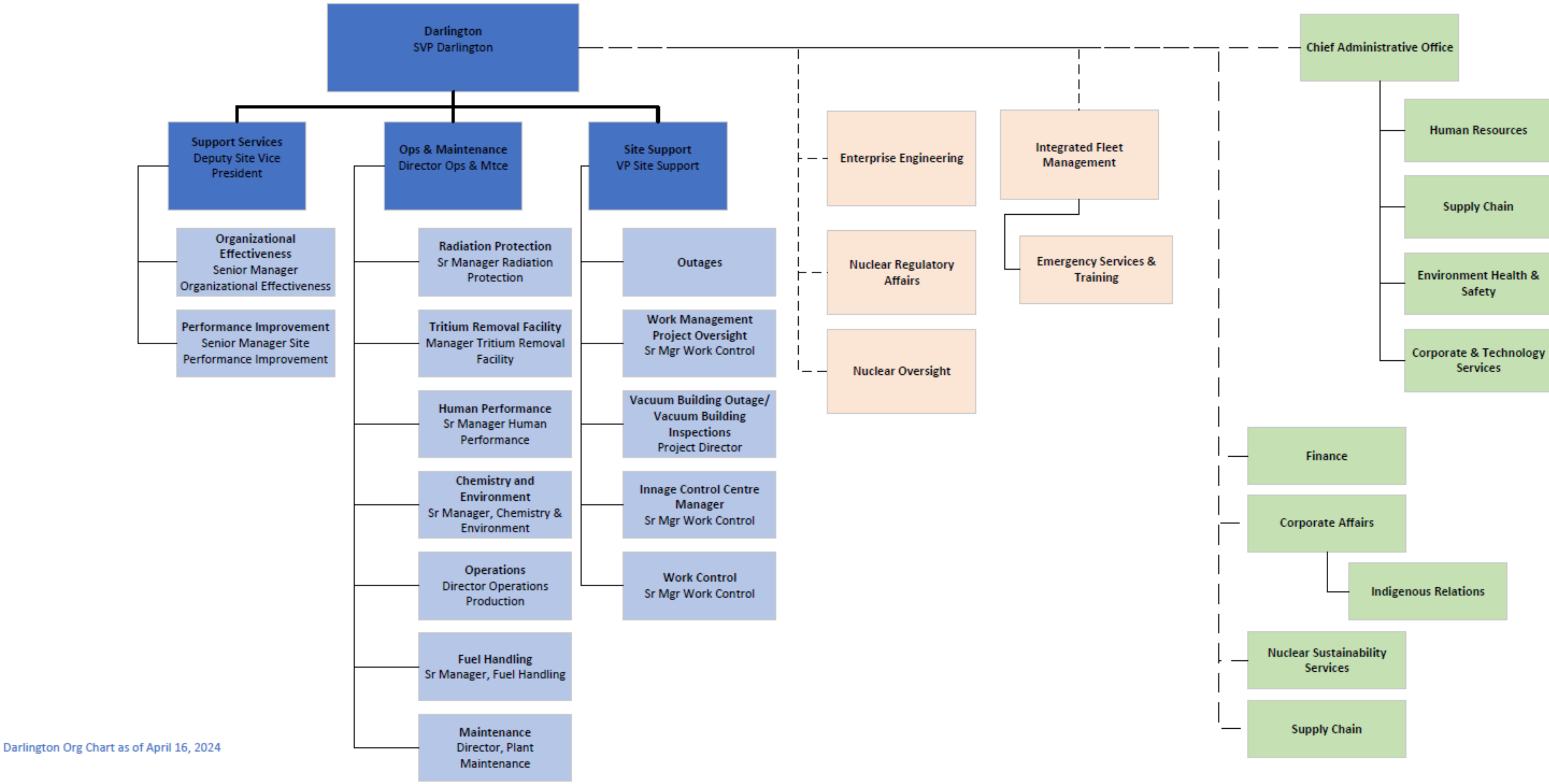


Figure 1: Darlington NGS Organizational Chart

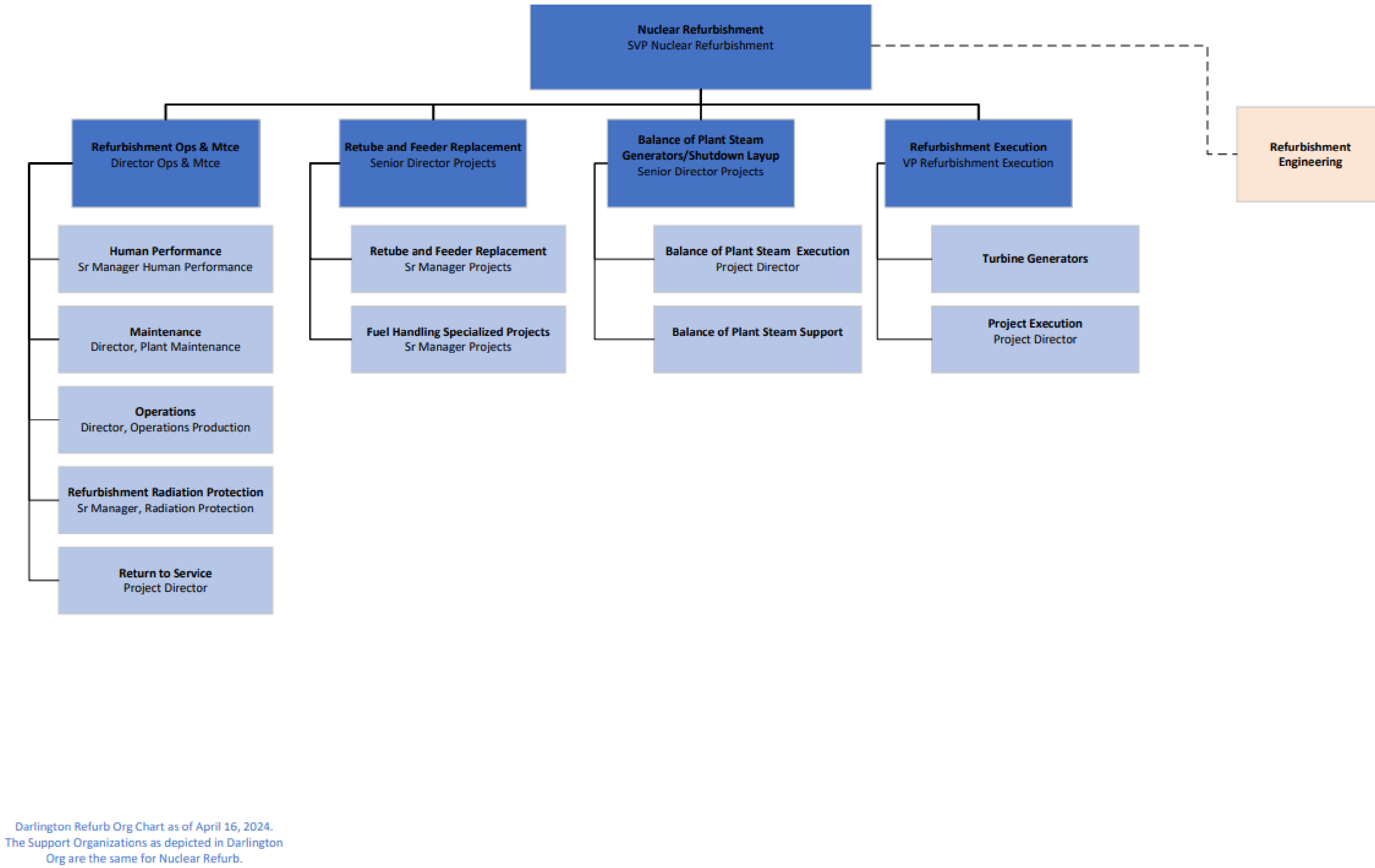


Figure 2: Darlington Refurbishment Organizational Chart

2.1.2.1 Staffing Management

Workforce planning is an integrated and continuous process that identifies and addresses critical gaps between the current workforce and future needs in the context of Darlington NGS's operating strategy.

Staffing plans at OPG use workforce planning data (i.e. approved business plan demand, supply and attrition assumptions) to proactively identify potential resourcing gaps and risk areas requiring mitigation. The plans are prepared annually and are periodically reviewed throughout the year to ensure any changes to workforce profiles are regularly assessed for risks, mitigation plans are incorporated, and adequate qualified staffing levels are maintained for safe reliable operation of Darlington NGS.

Recruitment and Onboarding

OPG has a number of internal and external recruiting programs that are administered through the Recruitment and Onboarding team within the Human Resources organization. The Recruitment and Onboarding organization works with hiring managers to source and attract a diverse and high performing workforce.

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

Further, OPG proactively seeks Indigenous post-secondary student participation in co-ops, internships and summer employment opportunities in an effort to build an Indigenous talent pipeline. OPG has partnerships with ED&I and Indigenous programs at Ontario Tech University, Durham College, Humber College, Queen's University, Lakehead University, and Trent University and continues to expand post-secondary partnerships.

To advance hiring of qualified equity-deserving candidates in the four designated groups (Women, Indigenous Peoples, Racialized People, Persons with Disabilities) in the labour market and increase representation at OPG, Recruitment in partnership with Ethics & Equity has designed a special recruitment program that will extend substantive equity, address historic and ongoing hardship, and reduce the risk of discrimination against Indigenous Peoples and those in the four designated groups in various stages of the hiring process. When jobs are posted as part of this program, opportunities expressly state the position is to increase designated group members at OPG. Applicants will be advised that self-identification as a member of a designated group is an eligibility criteria.

OPG's Indigenous Opportunities Network (ION) is dedicated to the recruitment of Indigenous Peoples through a network of employers in the energy industry and in partnership with Kagita Mikam, an Indigenous recruitment agency, develops approaches to Indigenous recruitment to build career pathways to OPG and across the industry.

OPG's onboarding program integrates high-quality employees and contractors into the organization. It promotes exceptional performance aligned with company goals and values. The Onboarding Centre, a centralized hub, provides new hires with essential information and tools for productivity. Collaborating with internal stakeholders, it ensures access, training, and safety protocols. OPG prioritizes an inclusive and supportive experience, enabling effective contributions to organizational success.

Knowledge Management

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

OPG has invested in knowledge management for ongoing operations as well as the delivery of projects and initiatives to ensure that the critical knowledge and expertise of employees is sustained.

Talent and Succession Planning

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

The OPG succession planning process follows an annual Enterprise talent review cycle. In Nuclear, monthly succession planning meetings are held to address current and future planning talent requirements. Nuclear Leadership Team members are an integral part of the process.

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

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

2.1.3 Performance Assessment, Improvement and Management Review

OPG program N-PROG-RA-0010, *Independent Assessment* provides independent assessment (internal and external) processes to perform a comprehensive and critical evaluation of all activities affecting OPG nuclear facilities. This program ensures the management system under N-CHAR-AS-0002 is reviewed with sufficient frequency to confirm its continuing effectiveness. The program is comprised of the following processes:

- Internal independent assessments performed by Nuclear Oversight.
- External independent assessments performed by the Nuclear Safety and Review Board (NSRB).

An annual audit plan identifies the specific audits to be conducted by Nuclear Oversight in the upcoming year. The annual audit plan is based on key risk areas, legal and regulatory requirements.

The NSRB reports to the CNO who reports to the President and CEO on nuclear related matters. The NSRB also reports annually to the Generation Oversight Committee of the Board of Directors. The Generation Oversight Committee is responsible for performing the duties set out in their Charter to assist the Board in fulfilling its oversight responsibilities, including the safe, secure and efficient operations of OPG's generating facilities and compliance with nuclear, health and safety, and environmental laws and regulations.

The NSRB performs the following:

a) Provides the CNO with an independent assessment of OPG activities that may impact on Nuclear Safety and performance.

b) Communicates directly with OPG personnel on matters of NSRB interest.

c) Observes and reviews any aspect of OPG performance related to safety, productivity, human performance, material condition and reliability.

d) For site reviews, the NSRB gets perspective from, and assesses the relationship between, the CNSC and the site being assessed.

e) Reports on the effectiveness of Nuclear Oversight in the execution of the Independent Assessment program.

f) For site reviews, reports on Corporate Functional Area Manager (CFAM) for performance around oversight and support.

g) Provides, as applicable, advice on lessons learned and good practices coming out of the nuclear industry, and recommendations on improving Nuclear Safety and performance.

h) Provides results of assessments, including recommendations on actions to improve performance, to the CNO and senior management team.

As a learning organization, Darlington NGS strives for continuous improvement. OPG program N-PROG-RA-0003, *Performance Improvement*, establishes the processes that support the conduct of performance improvement and, by extension, employ the principles of problem prevention, detection and correction at OPG. This program covers the key areas of performance improvement, namely; corrective action, self-assessment, benchmarking, operating experience, and nuclear safety culture.

Self-assessment and benchmarking activities for functional and line organizations of OPG are performed in accordance with N-PROC-RA-0097, *Self-Assessment and Benchmarking*. Self-assessments and benchmarking are utilized to evaluate actual performance against management expectations, industry standards of excellence and regulatory requirements. OPG's Self-assessment and benchmarking program is aligned with the World Association of Nuclear Operators (WANO) performance objectives and criteria. The WANO performance objectives and criteria is a comprehensive guideline of industry practices and standards and lessons learned from operating experience, and as a result reflects a global standard for nuclear excellence. N-PROC-RA-0097 provides methods for identifying shortfalls in performance of processes, programs, practices, behaviours, roles, responsibilities and organisational expectations. It also defines those elements required to plan, execute, report, and monitor self-assessments.

Any adverse conditions are identified during the performance of audits or self-assessments are documented as per procedure N-PROC-RA-0022, *Processing Station Condition Records*, with corrective actions assigned as required.

In addition to the above, OPG performs regular program health and performance reviews for all applicable programs within the nuclear management system in accordance with N-PROC-RA-0023, *Fleetview Program Health and Performance Reporting*. Fleetview Program Health and

Performance is a fleet-wide functional review and reporting process to monitor and routinely report on overall program effectiveness. The reporting process involves three key areas:

- Program oversight and leadership.
- Program execution performance indicators.
- Program action plans.

A Fleetview Program Health and Performance Report for every program is completed at minimum annually (programs that directly impact or support nuclear plant safety, reliability and generation complete a report tri-annually) for CNO and Nuclear Executive Committee review. The inputs into the report support OPG to drive continuous improvement efforts and sustainable performance. The oversight provided by Nuclear Executive Committee ensures that gaps are self-identified and self-corrected through sustainable actions in order to achieve industry top quartile performance. For programs that may require additional oversight, the Nuclear Executive Committee will conduct focused meetings to further drive improvement of program performance.

The effectiveness of the Performance Improvement program is routinely assessed through a set of Key Performance Indicators (KPI) in the monthly Performance Improvement Health Report. The monthly Performance Improvement Health Report is distributed to the Performance Improvement departments fleetwide and is shared and discussed at the Performance Improvement peer team meetings.

The KPIs are also included in the Fleetview reports for Nuclear Executive Committee review where any decline in performance or failure to meet targets will be challenged. It is expected that an action plan is provided for any KPI failing to meet the target.

The Corporate function provides next-level oversight to 14 key nuclear programs. CFAMs and Site Functional Area Managers (SFAMs) collaboratively use the Governance, Oversight, Support and Perform (GOSP) model to critically measure performance using methods described in corporate oversight governance. Routine peer team meetings are effectively used to share site and industry best practices, discuss tactical and strategic actions to correct performance shortfalls and gaps to excellence. To assist CFAMs with strategically and consistently managing the GOSP model, each CFAM has developed an oversight plan for their functional area, routinely updating them based on awareness of current industry and site performance. CFAM performance and reflection meetings are routinely held to share best practices and sustain proficiency.

2.1.4 Operating Experience (OPEX), Problem Identification and Resolution

OPG's Performance Improvement program (N-PROG-RA-0003), also establishes the process to ensure deficiencies, non-conformances, weaknesses with a process, document, service, or conditions that adversely impact, or may adversely impact plant operations, personnel, nuclear safety, the environment or equipment and component reliability, are promptly identified and corrected.

For those issues considered significant or repetitive in nature, these processes ensure that the appropriate levels of management are notified, causes are identified, and actions are taken to preclude recurrence, and actions taken to address the identified issues are verified to be complete and effective. Refer to Section 2.3.3 for further details.

Under N-PROG-RA-0003, N-PROC-RA-0035, *Operating Experience Process* (OPEX) establishes processes to prevent reoccurrence of significance internal and external events by ensuring internal and external OPEX is evaluated, distributed to appropriate personnel, and applied to implement actions that improve plant safety and reliability.

The OPEX process is comprised of three elements:

1) External OPEX: Information received from nuclear industry sources, coordinated weekly through the CANDU Owners Group (COG), are reviewed to identify any vulnerabilities and weaknesses that could result in similar events or problems at OPG. Sources of external OPEX include, but are not limited to, WANO, Institute of Nuclear Power Operations (INPO), International Atomic Energy Agency, US Nuclear Regulatory Commission and other CANDU stations. Relevant non-nuclear OPEX is also considered in areas such as Industrial safety and balance of plant operations. As per N-PROC-RA-0022, actions are identified when required to address these vulnerabilities or weaknesses and implement lessons. External OPEX is also used to keep OPG staff informed of relevant industry information.
2) Internal OPEX: Internal events and lessons learned are reviewed in accordance with N-GUID-01533-10001, *OPEX Guideline*, and are communicated as appropriate to WANO, INPO, COG, and other OPG sites.
3) Use of OPEX: OPEX repositories are made available for convenient access by OPG staff, in support of their daily activities.

Combined, these elements meet the objectives by ensuring consistency for evaluating, integrating, accessing and sharing external and internal OPEX and ensuring repositories are accessible by OPG and external staff in support of daily activities.

In 2021, OPG developed and released a new OPEX database to facilitate the distribution of external OPEX from COG to departmental OPEX Single Points of Contact, management of OPEX reviews, and documentation of initial assessments or dispositions from site departments. The OPEX database also provides a readily available repository of all previous external OPEX and site reviews/responses to new OPEX with searching capabilities.

As part of ongoing improvements for the OPEX process and use of OPEX at Darlington NGS, there are number of initiatives in progress:

- Development of a web based OPEX search engine. The new search engine will be able to extract information from various sources such as the Station Condition Record (SCR) database, OPEX Database, Work Reports from Asset Suite, *Iconnect* database, etc., and be user friendly, easy to navigate and able to provide quick access to key OPEX events relevant to line organization tasks.
- A revision of the current OPEX Health Metrics indicators to challenge status quo for indicators with consistent green scores over a long period and raising the target score for green, yellow, white and red ranges to further improve performance and challenge the fleet for maintaining excellence. A second part of this initiative is OPEX Health Metrics automation of KPIs to provide efficiency in completing monthly metrics and provide visibility to line organizations of where the data is specifically feeding from. This feature will help identify trends (declines or improvements) in specific KPIs and which line organizations are contributing to it. The benefit will provide line organizations the opportunity to check and adjust their behaviours towards implementing OPEX internally and from external sources.

- Adding OPEX items from the weekly screening package from COG into each day of the Integrated Station Brief meeting package as a point of discussion and understanding lessons learned from new key OPEX items that are applicable to the station.

Establishing a Plant Information Center Impact Identifier program to support line organizations in understanding how internal events that are Industry Reporting and Information System (IRIS) reports are impacting station performance. OPG's governance, oversight and internal reporting structure have been aligned with Plant Information Center and IRIS to drive sustainable performance improvements in all business areas through comparison against top performances in the North American nuclear industry.

2.1.5 Configuration Management and Change Management

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

The standard controls the changes which may affect configuration by:

- Requiring regulatory and licensing reviews, approvals and safety evaluations to ensure physical configuration or configuration information changes conform to the design and licensing basis.
- Reviewing impacts so that related configuration information is maintained consistent with the change.
- Ensuring changes to the design and licensing basis receive appropriate verification and approvals before the change is made.
- Ensuring change processes work in accordance and consistently with each other for design, procurement, construction, installation, commissioning, operation and maintenance, including surveillance, training, and testing.

Figure 3 shows the relationship between nuclear management system activities, programs and configuration management.

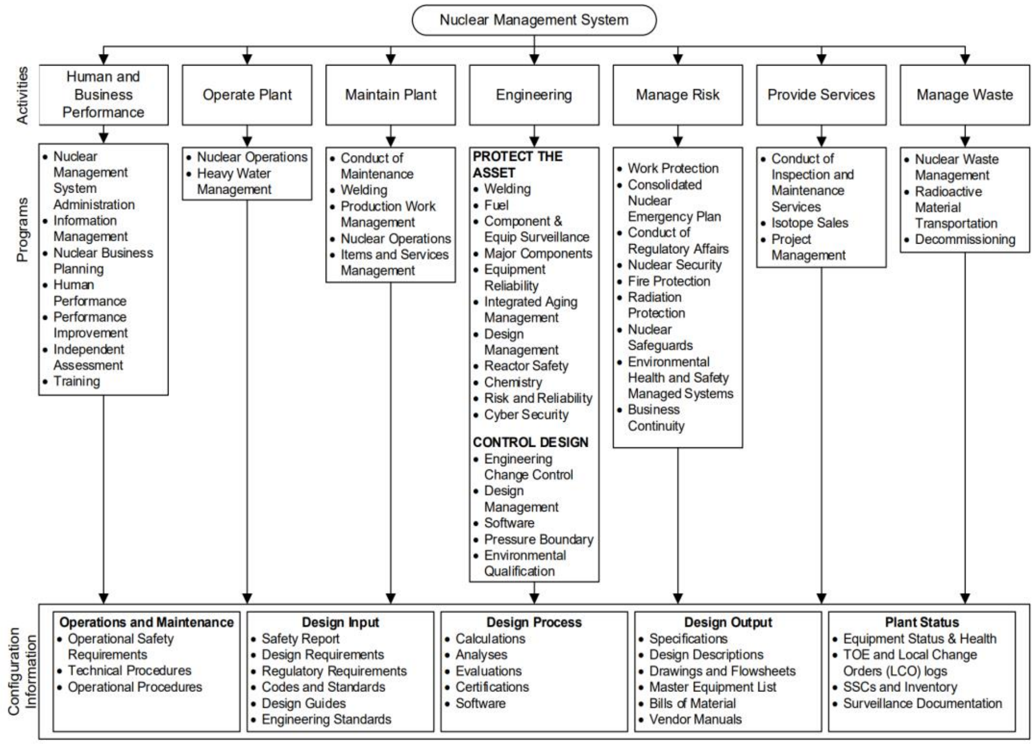


Figure 3: Configuration Management Relationships

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

Design changes are performed in accordance with OPG's program N-PROG-MP-0001, *Engineering Change Control*. The program and its implementing procedures have been written to be consistent with N-POL-0001, CSA N286-12, all relevant legal, statutory and regulatory requirements, including those of the CNSC, as wells as Industry guidelines. The ECC program ensures design changes to each OPG facility (including SSC, software and engineered tooling) are controlled such that the facility configuration is managed in accordance with the design and licensing bases and remains within the Safe Operating Envelope (SOE).

For pressure boundary SSC, OPG's program N-PROG-MP-0004, *Pressure Boundary* complies with the general configuration management requirements and additional requirements in N-STD-MP-0027. The ECC process detailed in N-PROC-MP-0090, *Engineering Change Control Process*, ensures that OPG's pressure boundary processes are described in the Pressure Boundary program.

Configuration management is an important aspect of maintaining and keeping Darlington NGS in an assessed state within the SOE and is reviewed both by internal and external organizations regularly. Actions are taken as appropriate to correct any identified adverse conditions.

OPG's Nuclear Oversight audits of the ECC program in 2017, 2020 and 2023 found that the managed system controls are effective and that overall, the program achieves its goal of execution and control of engineering changes to support the safe and reliable operation of OPG facilities.

The ECC program documents undergo cyclic review and revision. Such revisions include improvements based on industry OPEX and as suggested by users. Ongoing process improvements are also generated through two monthly meetings intended to identify any problem areas and share OPEX. The Design Managers' Working Group consists of the OPG facility Design Authorities and other managers of various OPG and vendor design organizations, while the Engineering Change Control Working Group consists of working-level staff from those organizations. Thus, the process is regularly examined from varying points-of-view to ensure that it meets requirements and is efficient.

OPG continues to make use of vendor companies to Engineer, Procure, Construct (EPC) modifications that will improve the reliability of Darlington NGS and OPG facilities. To ensure use of EPC is successful, OPG is continually working to better define the requirements and level of oversight required for contracted work. EPC is managed through a quality assurance program to ensure that OPG's expectations for vendor design and installation quality are met. Refer to Section 2.1.8 for additional details regarding supply and contractor management.

2.1.6 Safety Culture

N-POL-0001 is issued by the Board of Directors and establishes the fundamental principles for OPG employees. It emphasizes the vital importance of nuclear safety and security as the top priority in all activities performed in support of OPG facilities and underscores the value that OPG places on ensuring the highest level of protection for individuals, the environment, and surrounding communities. The policy highlights the organization's firm commitment to prioritizing nuclear safety over any other consideration, including cost, schedule, or production. By adhering to this policy, OPG employees can be confident that they are contributing to a culture of safety and responsibility that is paramount to the success of the organization.

The requirements of N-POL-0001 are outlined as follows:

As Nuclear Professionals, everyone shall demonstrate respect for nuclear safety and security by:

- Knowing how your work impacts on Control the power, Cool the fuel and Contain radioactivity (3C's).
- Knowing how you can Deter access, Detect a threat and Delay the assailant (3D's).
- Applying Event-Free tools and defences to prevent events.
- Reporting adverse conditions and unusual behaviours.
- Being vigilant around the control of sensitive information and equipment.
- Acknowledging that a credible threat to security exists and that Nuclear Security is important.

Everyone shall conduct themselves in a manner consistent with the following Traits of a Healthy Nuclear Safety and Security Culture:

1. Personal Accountability;
2. Questioning Attitude;
3. Effective Safety Communication;

4. Leadership Safety Values and Actions;
5. Decision-Making;
6. Respectful Work Environment;
7. Continuous Learning;
8. Problem Identification and Resolution;
9. Environment for Raising Concerns;
10. Work Processes;
11. Vigilance.

In accordance with the policy, the Nuclear President and CNO are accountable to the CEO and the Board of Directors to establish a management system that fosters nuclear safety as the overriding priority.

The above safety and security culture traits are incorporated into OPG's organization and administrative procedures starting at the policy level and cascading throughout the charter, programs and procedures as demonstrated in Figure 4:

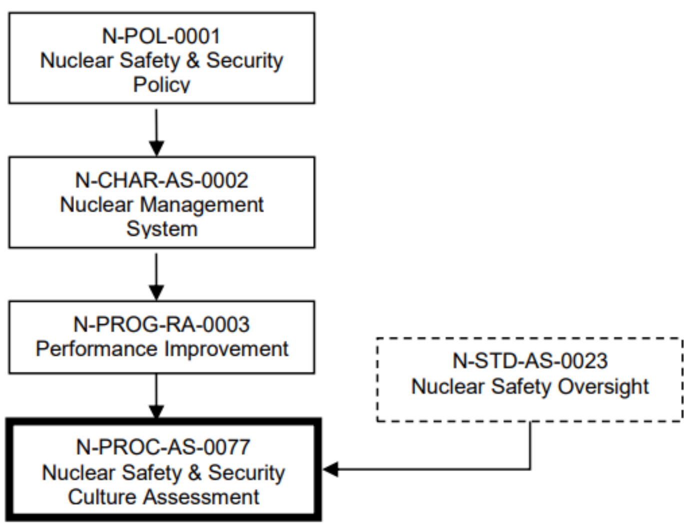


Figure 4: Safety and Security Programs and Procedures

N-STD-AS-0023, *Nuclear Safety Oversight,* summarizes the framework and accountabilities for nuclear safety oversight as well as the external and internal processes used for oversight and assessment of nuclear safety. This standard applies to all aspects of nuclear operations and to all work and other activities undertaken at or in support of the stations. Nuclear safety oversight is conducted in a manner consistent with the Traits of a Healthy Nuclear Safety and Security Culture as detailed below in Figure 5:

Nuclear Safety & Security Culture

Rev. 03 Jan, 2021

Nuclear Safety

TRAIT 1 — Personal Accountability

All individuals take personal responsibility for safety. Responsibility and authority for nuclear safety are well defined and clearly understood. Reporting relationships, positional authority, and team responsibilities emphasize the overriding importance of nuclear safety.

- **Standards**: Individuals understand the importance of adherence to nuclear standards. All levels of the organization exercise accountability for shortfalls in meeting standards.
- **Job Ownership**: Individuals understand and demonstrate personal responsibility for the behaviors and work practices that support nuclear safety.
- **Teamwork**: Individuals and work groups communicate and coordinate their activities within and across organizational boundaries to ensure nuclear safety is maintained.

TRAIT 2 — Questioning Attitude

Individuals avoid complacency and continuously challenge existing conditions and activities in order to identify discrepancies that might result in error or inappropriate action. All employees are watchful for assumptions, anomalies, values, conditions, or activities that can have an undesirable effect on plant safety.

- **Nuclear is Recognized as Special and Unique**: Individuals understand that complex technologies can fail in unpredictable ways.
- **Challenge the Unknown**: Individuals stop when faced with uncertain conditions. Risks are evaluated and managed before work proceeds.
- **Challenge Assumptions**: Individuals challenge assumptions and offer opposing views when they believe something is not correct.
- **Avoid Complacency**: Individuals recognize and plan for the possibility of mistakes, latent issues, and inherent risk, even while expecting successful outcomes.

TRAIT 3 — Effective Safety Communication

Communications maintain a focus on safety. Safety communication is broad and includes plant-level communication, job-related communication, worker-level communication, equipment labeling, operating experience, and documentation. Leaders use formal and informal communication to convey the importance of safety. The flow of information up the organization is considered to be as important as the flow of information down the organization.

- **Work Process Communications**: Individuals incorporate safety communications in work activities.
- **Bases for Decisions**: Leaders ensure that the bases for operational and organizational decisions are communicated in a timely manner.
- **Free Flow of Information**: Individuals communicate openly and candidly, both up, down, and across the organization and with oversight, audit, and regulatory organizations.
- **Expectations**: Leaders frequently communicate and reinforce the expectation that nuclear safety is the organization's overriding priority.

TRAIT 4 — Leadership Safety Values and Actions

Leaders demonstrate a commitment to safety in their decisions and behaviours.
Executive and senior managers are the leading advocates of nuclear safety and demonstrate their commitment both in word and action. The nuclear safety message is communicated frequently and consistently, occasionally as a stand-alone theme. Leaders throughout the nuclear organization set an example for safety. Corporate policies emphasize the overriding importance of nuclear safety.

- **Resources**: Leaders ensure that personnel, equipment, procedures, and other resources are available and adequate to support nuclear safety.
- **Field Presence**: Leaders are commonly seen in working areas of the plant observing, coaching, and reinforcing standards and expectations. Deviations from standards and expectations are corrected promptly.
- **Incentives, Sanctions, and Rewards**: Leaders ensure incentives, sanctions, and rewards are aligned with nuclear safety policies and reinforce behaviours and outcomes that reflect safety as the overriding priority.
- **Strategic Commitment to Safety**: Leaders ensure plant priorities are aligned to reflect nuclear safety as the overriding priority.
- **Change Management**: Leaders use a systematic process for evaluating and implementing change so that nuclear safety remains as the overriding priority.
- **Roles, Responsibilities, and Authorities:** Leaders clearly define roles, responsibilities, and authorities to ensure nuclear safety.
- **Constant Examination:** Leaders ensure that nuclear safety is constantly scrutinized through a variety of monitoring techniques, including assessments of nuclear safety culture.
- **Leader Behaviours:** Leaders exhibit behaviors that set the standard for safety.

TRAIT 5 — Decision-Making

Decisions that support or affect nuclear safety are systematic, rigorous, and thorough. Operators are vested with the authority and understand the expectation, when faced with unexpected or uncertain conditions, to place the plant in a safe condition. Senior leaders support and reinforce conservative decisions.

- **Consistent Process**: Individuals use a consistent, systematic approach to make decisions. Risk insights are incorporated as appropriate.
- **Conservative Bias**: Individuals use decision-making practices that emphasize prudent choices over those that are simply allowable. A proposed action is determined to be safe in order to proceed, rather than unsafe in order to stop.
- **Accountability for Decisions**: Single-point accountability is maintained for nuclear safety decisions.

TRAIT 6 — Respectful Work Environment

Trust and respect permeate the organization. A high level of trust is established in the organization, fostered, in part, through timely and accurate communication. Differing professional opinions are encouraged, discussed, and resolved in a timely manner. Employees are informed of steps taken in response to their concerns.

- **Respect is Evident**: Everyone is treated with dignity and respect.
- **Opinions are Valued**: Individuals are encouraged to voice concerns, provide suggestions, and raise questions. Differing opinions are respected.
- **High Level of Trust:** Trust is fostered among individuals and work groups throughout the organization.
- **Conflict Resolution:** Fair and objective methods are used to resolve conflicts.

TRAIT 7 — Continuous Learning

Opportunities to learn about ways to ensure safety are sought out and implemented.
Operating experience is highly valued, and the capacity to learn from experience is well developed. Training, self-assessments, and benchmarking are used to stimulate learning and improve performance. Nuclear safety is kept under constant scrutiny through a variety of monitoring techniques, some of which provide an independent "fresh look."

- **Operating Experience**: The organization systematically and effectively collects, evaluates, and implements relevant internal and external operating experience in a timely manner.
- **Self-Assessment**: The organization routinely conducts self-critical and objective assessments of its programs and practices.
- **Benchmarking**: The organization learns from other organizations to continuously improve knowledge, skills, and safety performance.
- **Training**: The organization provides training and ensures knowledge transfer to maintain a knowledgeable, technically competent workforce and instill nuclear safety values.

TRAIT 8 — Problem Identification and Resolution

Issues potentially impacting safety are promptly identified, fully evaluated, and promptly addressed and corrected commensurate with their significance. Identification and resolution of a broad spectrum of problems, including organizational issues, are used to strengthen safety and improve performance.

- **Identification**: The organization implements a corrective action program with a low threshold for identifying issues. Individuals identify issues completely, accurately, and in a timely manner in accordance with the program.
- **Evaluation**: The organization thoroughly evaluates issues to ensure that problem resolutions and solutions address causes and extents of conditions commensurate with their safety significance
- **Resolution**: The organization takes effective corrective actions to address issues in a timely manner commensurate with their safety significance.
- **Trending:** The organization periodically analyzes information from the corrective action program and other assessments in the aggregate to identify programmatic and common cause issues

TRAIT 9 — Environment for Raising Concerns

A safety-conscious work environment (SCWE) is maintained where personnel feel free to raise safety concerns without fear of retaliation, intimidation, harassment, or discrimination. The station creates, maintains, and evaluates policies and processes that allow personnel to freely raise concerns.

- **SCWE Policy**: The organization effectively implements a policy that supports individual's rights and responsibilities to raise safety concerns and does not tolerate harassment, intimidation, retaliation, or discrimination for doing so.
- **Alternate Process for Raising Concerns**: The organization effectively implements a process for raising and resolving concerns that is independent of line management influence. Safety issues may be raised in confidence and are resolved in a timely and effective manner.

TRAIT 10 — Work Processes

The process of planning and controlling work activities is implemented so that safety is maintained. Work management is a deliberate process in which work is identified, selected, planned, scheduled, executed, closed, and critiqued. The entire organization is involved in and fully supports the process.

- **Work Management**: The organization implements a process of planning, controlling, and executing work activities such that nuclear safety is the overriding priority. The work process includes the identification and management of risk commensurate to the work.
- **Design Margins**: The organization operates and maintains equipment within design margins. Margins are carefully guarded and changed only through a systematic and rigorous process. Special attention is placed on maintaining fission product barriers, defense-in-depth, and safety-related equipment
- **Documentation:** The organization creates and maintains complete, accurate, and up-to-date documentation.
- **Procedure Adherence**: Individuals follow processes, procedures, and work instructions.

Nuclear Security

TRAIT 1 — Vigilance

Being attentive for unusual observations, specifically in the cyber world and in people's behaviours. Security depends on the vigilance, procedural adherence, and observational skills of staff. Prompt identification of potential vulnerabilities permits proactive intervention and corrective action.

Attributes:

- **Recognize Threats**: Staff members identify and question unusual indications and occurrences, and report them to management, as soon as possible, using established processes. When unsure of the security significance of these events or observations staff seek guidance.
- **Protection of Information**: Classification and control measures are understood and used by staff to protect sensitive information.
- **Protocols**: Staff follow security and cyber security protocols to minimize risk.
- **Screening**: Screening processes match the risks and threats associated with specific roles and responsibilities.

AS NUCLEAR PROFESSIONALS, EVERYONE HAS A PERSONAL RESPONSIBILITY TO:

CONTROL power | COOL fuel | CONTAIN radioactivity | DETER access | DETECT threats | DELAY assailants

ONTARIO POWER GENERATION

Figure 5: Nuclear Safety and Security Culture

OPG conducts comprehensive, systematic and rigorous safety culture assessments at least every 5-years in compliance with CNSC regulatory document REGDOC-2.1.2, *Safety Culture*.

In June 2021, Darlington NGS successfully conducted a station-wide Nuclear Safety and Security Culture Assessment in order to identify areas for improvement or areas of strength. The assessment included a staff survey of all Darlington NGS employees and Contract Partners on the site, as well as an on-site evaluation; including document reviews, staff interviews and observations. The 22-person assessment team included a mix of both internal and external members. 2378 people responded to the survey (equivalent to a 99.2% participation rate) with over 2300 comments provided. The on-site interviews yielded approximately 2698 data points and over 2200 comments.

The assessment focused on perceptions, attitudes and behaviours of the organization, and concluded that Darlington NGS has a healthy nuclear safety culture, strong respect for nuclear safety, and nuclear safety is not compromised by production priorities. In particular, station personnel feel they can challenge any decision if needed, without fear of reprisal. The assessment team also noted a few areas where additional focus is required, such as: expanding the qualifications of the work force, developing the proficiency of new staff, and improving the efficiency of the work management process.

This marked Darlington NGS's first evaluation since the implementation of REGDOC-2.1.2, of the Vigilance trait in Nuclear Security. The evaluation determined that Darlington NGS has a healthy nuclear security culture. However, from this first-time review, there is room for improvement in raising awareness and comprehension of potential risks and threats linked to nuclear security, including cyber security.

All results were documented in a self-assessment report in accordance with N-PROC-RA-0097 and N-PROC-AS-0077, *Nuclear Safety & Security Culture Assessments*. As per N-PROC-AS-0077, the results were communicated to staff by the Vice President via a communication within a month following the assessment, and action plans were developed with input from the Site Vice President’s direct reports and the Host Peer of the assessment. Areas for improvement were documented and actions taken to address the findings were tracked.

Since the 2021 assessment, COG, in collaboration with Canadian Nuclear Utilities, has developed a tool to assist in the assessment of the Nuclear Safety and Security Culture. This tool can efficiently process and compare all the survey and interview data, significantly accelerate the report generation process, and provide a more precise depiction of the culture within OPG facilities.

OPG will continue to conduct station-wide assessments at least every 5-years as per REGDOC 2.1.2. Current internal best practices recommend assessments at a 3-year frequency, therefore OPG has scheduled the next assessment for Darlington NGS staff and contract partners on site for 2024.

In addition to the comprehensive station-wide assessment, OPG has instituted a Darlington Nuclear Safety and Security Culture Monitoring Panel (NSSCMP) tasked with overseeing the key process indicators that reflect the state of the organization's nuclear safety and security culture. This panel, comprised of the senior plant leadership team, convenes three times annually to deliberate on the 11 nuclear safety and security culture traits. In doing so, strengths and potential concerns that merit additional attention by the organization are identified and acted upon. The use of the NSSCMP is considered to be a Periodic Safety Review strength as it exceeds the requirements of CNSC REGDOC 2.1.2 and further promotes meaningful conversations and the sharing of lessons learned amongst station leaders to ensure any emergent issues that could impact Nuclear Safety and Security Culture are addressed.

One component contributing to these discussions is facilitated by the NSSCMP Power App. This online tool, developed in 2020, enables frontline station personnel to evaluate the 44 attributes constituting a robust Nuclear Safety and Security Culture and provide input directly to the NSSCMP. This approach allows OPG to capture insights from staff regularly working in and around the plant, helping to discern faint signals within the organization.

During the current licence term, OPG also implemented the Nuclear Safety and Security Culture Trait of the Week and accompanying App to remind staff about each of the attributes under the Traits on a rotating basis. Figure 6 depicts Trait 4 *Leadership Safety Values and Actions*.

Figure 6: Leadership Safety Values and Actions

OPG continues to have an extensive Management and Leadership development program that includes Shift Manager licensing, the First Level Manager program for managerial positions, Nuclear Professional Development Seminar training, and Senior Nuclear Plant Manager training. These courses include training on the tools that supervisors use to reinforce the expected behaviours in the workforce that reflect a strong Nuclear Safety Culture and enhance supervisors' ability to identify, analyze and solve leadership issues encountered in nuclear plants and sustain and strengthen job performance. The Safety Culture for Managers training is in the process of being updated and refreshed for new managers coming into role using updated OPEX from industry events.

OPG has a strong commitment to use external review mechanisms, such as WANO and the NSRB, to ensure that the company maintains high standards of operational performance. An extensive framework of internal oversight, including the Generation Oversight Committee, Nuclear Executive Committee, Nuclear Safety Oversight Committee, and independent assessments conducted by Nuclear Oversight, provides a comprehensive and critical evaluation of all activities affecting OPG on an on-going basis. These internal and external assessment mechanisms are used to identify opportunities for improvement and reinforce the culture of a learning organization.

The processes described above also ensure that a strong Nuclear Safety Culture is pervasive throughout the organization.

2.1.6.1 Safety Culture and Organizational Effectiveness

Organizational effectiveness is monitored using the INPO Staying on Top (SOT) values. INPO's SOT values is a tool used by Industry for assessing organizational effectiveness and is based on the analysis of specific, common characteristics that exist in organizations that have achieved uninterrupted high performance for decades. SOT values include: Setting Long-Term Direction, Leadership and Talent Development, Excellence Standards, Continuous Learning, and Self-Awareness and Self-Correction. OPG performs an assessment of SOT at Darlington NGS every year to constantly monitor and course correct as required.

Another tool used to monitor organizational effectiveness is the Employee Engagement survey. This pulses the organization on several key areas including commitment to the organization, the perspective of the leadership team, communication effectiveness, and alignment. This was recently done in 2022 and again at the end of 2023 OPG-wide.

Information gathered from SOT meetings and the annual assessment as well as the Employee Engagement survey are included among the inputs managers use in the NSSCMP for each Nuclear Safety and Security Culture Trait assessment.

The interactive Organizational Roadmap metrics are reviewed by the NSSCMP as part of the package put together for the NSSCMP meetings. This roadmap, developed by INPO, shows the relationship between Leadership and Team Effectiveness, SOT, Nuclear Safety Culture and Organizational Effectiveness as well as key INPO documents such as Integrated Risk Management, Technical Conscience and Operations and Maintenance Fundamentals. OPG has tied its performance objective and criteria codes that are applied to SCRs to this roadmap so that we can see if there are any trends arising that align with Nuclear Safety and Security Culture and ultimately, Organizational Effectiveness. The outcomes from the Organizational Effectiveness Reflection sessions and the SOT annual assessments are also used as indicators to the overall health of Nuclear Safety and Security culture.

2.1.7 Records Management

OPG-PROG-0001, *Information Management,* establishes a set of standards and procedures for the management of OPG's information throughout its life-cycle, regardless of media, including electronic systems such as e-mail, SharePoint, and the Intranet to ensure consistent and appropriate use. The program describes requirements for a management system of activities related to information. It also establishes uniform and efficient processes for management, maintenance, and final disposition of records and documents throughout OPG as well as the overall OPG process for governance including electronic filing, approval, distribution, and maintenance of the OPG governance framework.

Procedures under this program establish a consistent process across OPG including the establishment of a hierarchy of authority for documents, only one owner for the document, controlled release of the document for revision, controlled review of the document by stakeholders and individuals affected by the change, and the controlled approval and authorization of the document before it is issued as a governing document. The Information Management program is applicable to all OPG employees and agents (i.e., temporary staff and contractors).

One objective of the Information Management program is the advancement of electronic, digital, and mobility solutions that provide tools that effectively and efficiently capture, change, issue, and make content available electronically to end users with the highest quality. During the current licence term, a number of enhancements were made to Information Management tools used by OPG staff. For example:

- OPG's enterprise software, Asset Suite, was recently upgraded to incorporate new features, to improve the user experience, and to maintain full vendor support. Cyber security has also evolved rapidly and is covered in Section 2.12.5.
- A new application allows workers to electronically submit and file their records and documents in Asset Suite/Curator rather than waiting on Records Centre to manually index and upload images. The tool significantly reduces turnaround time on availability and cuts manual entry of key information (metadata) about the record/document by 50% or more. The average turnaround time is less than 5 days. The application has the ability to pre-set documentation specific metadata elements (e.g., System Classification List, retention, Pressure Boundary flags, etc) to reduce keying and indexing errors. Further screens have been added to the application's automated tools to improve human performance in the governance submission process.
- The Vendor Document Management (VenDM) tool continues to be used by Nuclear Refurbishment and the Projects Organization as an electronic system for the management of vendor documentation deliverables. Vendors and OPG recipients use VenDM to process requests for information, to perform review and commenting, and for the approval of documentation including application of electronic stamps.
- Electronic Work Packages are used by Darlington NGS Maintenance to allow the use of tablets for downloading work order tasks and associated documentation for use in the field. Workers can mark up/place keep using the electronic procedures and proceed to record their test results and final work completion reports. This solution eliminates a paper-based process from Work Order binders to final records.

A new application is planned to be used to further automate OPG's client service processes. Initial consultations are complete to embed key information management processes in the tool, to improve control for the many OPG workers who handle confidential security information, and to automate external information exchange and Legal Hold processes.

In conjunction with the Cyber Security program data protection project, the security document access process is planned to be upgraded/modernized to take best advantage of evolving encryption protections and to automate the approvals and Asset Suite access.

Records projects are underway to decrease the amount of legacy paper records in physical vaults and to scan quality assurance records for ease of access and secure fast retrievals.

2.1.8 Supply and Contractor Management

Supply and Contractor management are performed in accordance with OPG-PROG-0009, *Items and Service Management*, which interfaces with OPG-PROG-0038, *Contract Management* for managing contracts for services.

OPG-PROG-0009 establishes a governing document framework that meets regulatory requirements and ensures effective and efficient planning for, and procurement of items and service. OPG-PROG-0038 establishes a governing document framework for managing contracts related to contractor services.

The supply chain organization is responsible for providing the necessary services and materials in a timely manner and of the appropriate quality to the Darlington NGS site. Supply Chain confirms all the quality aspects for receipted materials based on designated quality requirements. The contract owner confirms quality aspects for services. Vendor quality is maintained through audits, receiving inspections, and vendor oversight and surveillance.

OPG's Counterfeit, Fraudulent and Suspect Items (CFSI) program is implemented through N-PROC-MM-0021, *Supply Inspection*, N-GUID-08173-10010, *Receiving Inspection Guideline,* Supply Chain Quality Services Supplier Audit Checklist(s) N-TMP-10294 and N-GUID-01900-10005, *Guideline to Identify Counterfeit, Fraudulent and Suspect Items*, and is aligned to industry best practices. All suppliers to OPG are required to have an implemented CFSI program and this is verified by supplier audits carried out by OPG.

Enhanced purchasing clauses and receiving inspections have been in place for several years to prevent CFSI material from being supplied to or received by OPG. Standardized training on CFSI was developed and implemented to support this program. External reviews and benchmarking indicates that OPG's CFSI program is an industry-leading, well established and an effectively implemented program.

OPG has also improved the supply chain quality engineering and supplier performance management process (N-PROC-MM-0041, *Quality Engineering and Supplier Performance Management*), which involves identifying and managing supplier quality issues from SCRs, audits, receiving inspections, and vendor oversight and surveillance activities.

2.1.9 Business Continuity

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

The Business Continuity program is aligned with OPG's business goals and objectives. It ensures that if a disruption occurs or if there is a threat of disruption, critical business and operational processes continue to be available, or resume to at least the defined minimum operability within required time limits. Business Continuity is structured as an 'all hazards' program adaptable to a range of hazards, or a combination of multiple hazards, including Human Health Emergency (e.g., COVID-19 pandemic).

OPG has continuity plans in place for Darlington NGS which were revised in 2022 to reflect an approach which considers many different natural and technological hazards, as well as the pandemic scenario and staffing strategies during pandemics (principles which also apply to other considerations such as labour disruptions). These plans will continue to be reviewed and updated at a minimum every 3-years or when major changes occur.

OPG has an enterprise-wide Infectious Disease Response Guideline which replaces previous pandemic plans. This response guideline outlines OPG's strategic approach to respond to any infectious disease introduced into the workplace from a singular incident up to a full pandemic response. This guideline and the associated Infectious Disease Incident Response Team were utilized effectively as a part of OPGs Emergency Response Organization in response to the

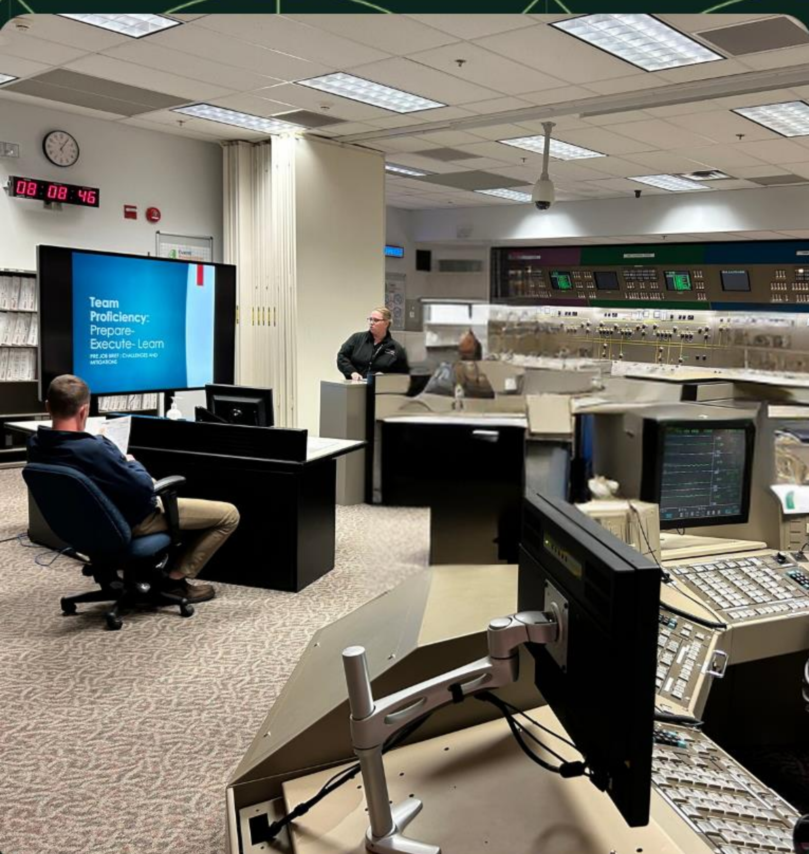
COVID-19 pandemic to support safe operations during this period. Following the COVID-19 pandemic, OPG conducted a review of the response to capture lessons learned, best practices and identify areas for improvement within the Business Continuity program to maximize OPGs preparedness against future pandemics.

In 2022, Nuclear Oversight conducted an audit of the Business Continuity program at Darlington NGS, to determine whether the program requirements defined in governance are met and are effectively implemented to support safe and reliable operation with deficiencies corrected as required. This performance-based audit of the Business Continuity program identified that the managed system controls are effective.

OPG continues assessing and further developing effective response strategies to address enterprise ransomware events. As previously mentioned, cyber security has also evolved rapidly and is covered in Section 2.12.5.

Section 2.2

Human Performance Management



2.2 Human Performance Management

Darlington NGS has an effective Human Performance Management Program that meets or exceeds all applicable regulatory requirements and related objectives to enable effective Human Performance through implementation of processes that ensure a sufficient number of licensee personnel are in relevant job areas, have the necessary knowledge, skills, procedures and tools in place to safely carry out their duties.

The OPG documents in the table below require written notification of change per Darlington NGS Licence Conditions Handbook, LCH-PR-13.03/2025-R005:

Table 2: SCA 2 – Human Performance Management

Document	Title
N-PROC-OP-0047	Limits of Hours of Work
N-LIST-09110-10005	Listing of Broad Population and Safety Sensitive Job Codes
N-PROG-AS-0002	Human Performance
N-STD-AS-0002	Procedure Use and Adherence
N-STD-OP-0002	Communications
N-STD-OP-0004	Self-Check
N-STD-OP-0012	Conservative Decision-Making
N-STD-RA-0014	Second Party Verification
N-PROC-OP-0005	Pre-Job Brief / Safe Work Plan and Post-Job Debriefing
N-CMT-62808-00001	Continuous Behaviour Observation Program (CBOP) – Participants Materials – Workbook Components
D-PROC-OP-0009	Station Shift Complement
D-INS-09260-10001	Duty Crew Minimum Complement Assurance
N-PROG-TR-0005	Training
N-PROC-TR-0008	Systematic Approach to Training
N-INS-08920-10004	Written and Oral Initial Certification Examination for Shift Personnel
N-INS-08920-10002	Simulator-Based Initial Certification Examinations for Shift Personnel
N-INS-08920-10001	Requalification Testing of Certified Shift Personnel
N-MAN-08131-10000-CNSC-031	Responsible Health Physicist
N-MAN-08131-10000-CNSC-006	Shift Manager, Darlington Nuclear
N-MAN-08131-10000-CNSC-010	Authorized Nuclear Operators
N-MAN-08131-10000-CNSC-008	Control Room Shift Supervisor
N-MAN-08131-10000-CNSC-025	Unit 0 Control Room Operator

2.2.1 Human Performance Program

The objective of the Human Performance Program is defined by program document N-PROG-AS-0002, *Human Performance*. Darlington implements the program vision from Section 1.1:

> *"Nuclear is recognized as an event-free operator, applying error reduction techniques and controls to achieve safe, reliable, and cost-effective generation of electricity. The goal of the Human Performance program is to continually reduce the frequency and severity of events through the systematic reduction of human error and the management of defences in pursuit of zero events of consequence."*

Through the following supporting standards, N-PROG-AS-0002 drives continuous improvement of Human Performance and establishes processes to monitor and correct any organizational deficiencies to minimize human error:

- N-STD-AS-0002, *Procedure Use and Adherence:* provides requirements for usage of, and adherence to approved procedures.
- N-STD-OP-0002, *Communications:* specifies requirements for both verbal and written communication practices when performing maintenance and operating activities including expectations for three-way communication and use of phonetic alphabet.
- N-STD-OP-0004, *Self-Check:* describes the features of the Nuclear Self-Check program.
- N-STD-OP-0012, *Conservative Decision-Making:* provides management expectations for a conservative decision-making culture and establishes responsibilities and accountabilities for affected managers to ensure conservative decisions are made.
- N-STD-RA-0014, *Second Party Verification:* establishes the scope and extent of verification and degree of independence required and, to prevent errors going undetected, specifies requirements for verification when a second person confirms a specific task or activity satisfies established requirements.

Darlington NGS Refurbishment implements NK38-NR-PLAN-09701-10001, *Nuclear Refurbishment Human Performance Plan*, for Darlington NGS units which are operating within the construction island. NK38-NR-PLAN-09701-10001 is aligned with and referenced in N-PROG-AS-0002.

Darlington NGS leaders recognize that an understanding of the role of Human Performance in safety, supported by leadership and employee behaviours, helps prevent human error-related events. Human Performance standards and expected behaviours are defined, established, and incorporated in processes, procedures and training.

The primary intention of the Human Performance Program is to create continuous improvement within the organization and to reduce the potential for human error through the use of appropriate analysis methods or techniques. The advantages of this are in improved safety, quality, and efficiency. Initiatives to provide staff with an understanding of the factors that influence Human Performance and provide them with a set of tools and references to predict, manage, and prevent error-likely situations include:

- Enhanced communications (e.g., station spotlight, weekly focus area), increased awareness during periods of time when there are higher vulnerabilities for errors, outage and on-line unit/station specific messaging delivered to key audiences at appropriate times using past Operating Experience (OPEX), and current trending data.

- Station Condition Records and Corrective Actions Plans are leveraged to improve performance trends in accordance with N-PROC-RA-0022, *Processing Station Condition Records*;
- In 2022, OPG implemented OPG-STD-0173, *Fail Safe Strategy*, which focuses on adding barriers, capacity, and defences rather than relying on humans to be error free;
- A new digital/electronic platform was created in 2023 to embed fail safe into safe work planning, Pre-Job Briefs and Post Job De-briefs;
- An emphasis has been placed on implementing and enhancing N-INS-09030-10004, *Observation and Coaching*. Observation and Coaching (O&C) have three main groups:
    1. Peer-to-peer coaching: Staff are encouraged to coach each other to ensure safety and promote learning.
    2. Supervisor Oversight/Field Presence: Planned O&Cs. Usually from the direct supervisor on a specific activity to improve performance of the workers.
    3. Paired O&C: A leader observing another supervisor perform an O&C and provide feedback to improve performance of our supervisors.

  Since 2020, O&Cs have been recorded in a data repository software called *iConnect.* The data is trended and reviewed in various forums.
- There is focus on individual and team proficiency through oversight of crew composition and individual development. Darlington NGS understands that qualifications are an important piece of proficiency, but not the only part of ensuring that a job is completed safely.
- Tracking, trending and actions taken on organizational learnings identified from Department Event Free Day Resets and lower-level events identified as Crew Learnings in accordance with N-INS-09030-10002, *Site and Department Level Event Free Day Resets*.

The effectiveness of the Human Performance Program has resulted in Darlington NGS achieving top industry performance in Site Event Free Day Resets (SEFDRs). N-INS-09030-10002, establishes the criteria which is used to measure the Human Performance events. Monitoring this performance as depicted in Figure 7 below demonstrates a reduction in consequential events attributed to Human Performance errors. Figure 7 also shows the trend of SEFDRs rates, yearly counts and their associated targets from 2015 to date.

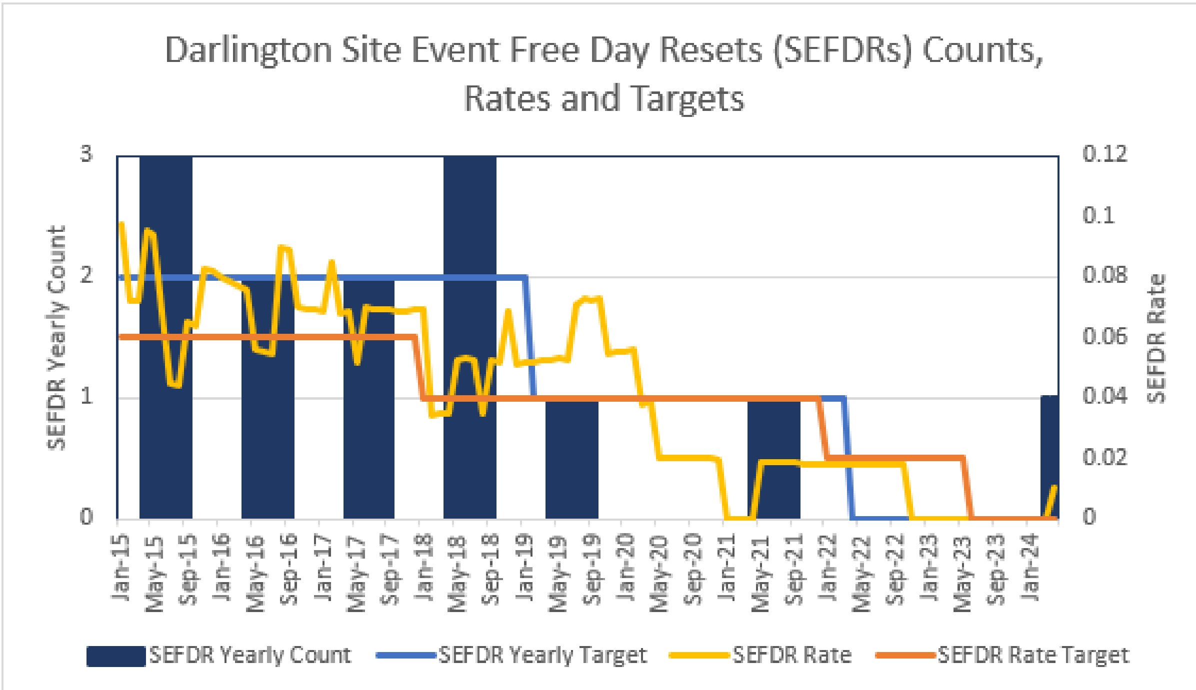


Figure 7: Darlington Site Event Free Day Resets

The number of SEFDRs had decreased since 2015 and the target was improved from 2 to 1 in 2019. To further challenge ourselves for continual improvement, the target was improved to 0 in 2022. The last SEFDR occurred April 23, 2024; a record 1074 days between events during the licencing period.

Planned Improvements

OPG is aligning with current industry best practices by enhancing Human Performance tools. These tools, specifically *Event Prevention Tools* help the individual worker maintain positive control of a work situation by increasing self-awareness, understanding and focus to identify hazards and risks which require mitigation. This is further enhanced by the application of the *Core 4+* initiative which is applied during work activities, regardless of the risk perception associated with the task. *Core 4+* comprises of the following event prevention tools:

- Pre-Job Briefing/Post Job Debriefing;
- Procedural Use and Adherence;
- 2-minute Job Site Drill;
- Verification Practices.

At the center of these tools is *Stop When Unsure* that is to be used at anytime during the job process as illustrated in Figure 8.

Figure 8*:* Core 4+

The addition of *Stop When Unsure* to *Core 4+* is also aligned with creating and supporting a healthy nuclear safety and security culture with the support of the *Positive Stop Work Program* where an environment for raising concerns is cultivated, encouraged, and positively recognized by Leaders in the organization. As part of this initiative, training associated with *Stop When Unsure* will enhance the use of questioning attitude by teaching supervisors and workers how to recognize cues when they are unsure and the steps for how to resolve any aspects that are required to reduce potential for error and to safely execute the work event-free.

Darlington NGS continues to leverage internal and external training courses to enhance staff and leaders' knowledge in Human and Organizational Performance Principles. Dynamic Learning Activities such as the flight simulator, implemented in 2019, will continue to be used to train and reinforce the importance of event prevention tools.

As part of continuous improvement practices, Darlington NGS continues to perform routine self-assessments and benchmarking to continually identify and address areas for improvement in the implementation of the Human Performance Program.

2.2.2 Personnel Training

The training program for regular staff, contractors, temporary personnel and other staff assigned work at OPG is defined by N-PROG-TR-0005, *Training*. This document, in combination with internal training procedures, defines the key activities involved in our training process and is compliant with REGDOC-2.2.2*, Personnel Training.*

The training program provides the structure, processes, and tools for defining, developing, implementing, documenting, assessing, and improving the training required to ensure staff have the appropriate knowledge, skill, and attitudes for safe and efficient plant operation. For tracking, OPG utilizes the Training Information Management System (TIMS) which is a database application that stores and tracks training and qualification information for all staff, including contractors. The system also provides automatic updates via email for upcoming scheduled training and identifying expiring qualifications to employees and their supervisors. In 2023 alone, TIMS tracked a total of 36,644 hrs of training for Darlington NGS, comprising of computer-based training, classroom and on-the-job training.

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

The Health of Training reports continue to drive improvements to OPG's major training performance areas. The quarterly reports are used to assess against World Association of Nuclear Operators (WANO) performance objectives and criteria. The reports are prepared by the training organization in co-operation with the applicable line organization and the training for each major job family is evaluated using the following objectives:

- Teamwork between Training and Line Organizations.
- Rigorous Use of SAT.
- Quality Trainers and Quality Learning Experiences.
- Organizational Capacity Sustained through Succession Planning.

Actions from the Health of Training reports successfully maintain a solid SAT foundation for OPG's Nuclear Training Programs upon which it continues to build and improve. Improvements to the training programs are driven by feedback from internal and external OPEX, Station Condition Records, Curriculum Review Committees, self-assessments, audit reports, CNSC inspections and in response to the training committee's needs.

Planned Improvements (Innovation in Training)

The objective of innovation in training is to incorporate innovative solutions and technology into our training. Line and Training Managers effectively collaborate to create learning solutions and technologies that support exemplary worker and station performance.

Some examples of where innovative training techniques were developed include:

Fuel Handling Simulator:

Operations Training instructors improved Fuel Handling Panel Qualified Operator and Field Operator defueling performance by delivering Just-in-Time (JIT) training utilizing the newly updated Fuel Handling simulator. The updated simulator allows Operators to become more proficient in fuel handling activities all while working in a zero-risk environment. Simulator improvements include high fidelity screens and realistic cockpit and keyboards that incorporate simulated defueling scenarios. As well, the Fuel Handling team has utilized the simulator to not only expose the Operators to enhanced procedures but to fine tune the flow of what are now first-of-a-kind procedures.

Virtual Reality Crane Simulator:

Maintenance Training instructors improved crane operator performance by incorporating a virtual reality (VR) simulator into crane operator training. Training material improvements include the incorporation of simulated scenarios such as precision lifts, crane failures, and risk management decision points. The VR crane simulator offers a learning opportunity that is personalized, on-demand and realistic.

Tritium Removal Facility (TRF) Simulator:

Operations Training instructors improved TRF Panel Qualified Operator and Field Operator performance by delivering JIT training utilizing the TRF simulator. The simulator allows Operators to become more proficient in TRF evolutions such as startup and shutdown as well as time to practice team effectiveness, human behaviours utilizing Human Performance tools and first-of-a-kind procedures while working in a zero-risk environment. Simulator improvements are being implemented in 2024 to better model transients, start-up and shutdown evolutions.

Current Learning Culture and Use of Technology

Darlington NGS has established a learning culture where development is encouraged and learning resources are available at the time of need to promote proficiency and encourage employee development. At OPG we started a journey a few years ago to establish the enablers for enhancing our learning culture and the actions we will be taking as a result of our external benchmark self-assessment will help us enhance our learning culture in support of continued operational excellence. Our future growth strategy will include:

- Proficiency Heat Maps and Individual Development Plans have been created.
- Extensive use of Dynamic Learning Activities, JIT Training, Job Familiarization Guides.
- Micro-learning through Video Learning-On-Demand library with 550 videos is available to refresh skills.
- Adaptive Learning was piloted in 2021 in our Nuclear General Employee Training program and is now used in more than 10 high demand courses. It provides the right training to the right people based on previous experience, training and education.
- All Leaders are trained on Facilitative Leadership Techniques to enable learning and development.

Operations Training

Operations Training supports Darlington NGS through the development of knowledgeable, skilled, and highly competent Operations staff. This is accomplished through comprehensive initial and continuing training programs for non-licensed Operators and for persons in Certified positions, including Authorized Nuclear Operators, Unit 0 Control Room Operators, Control Room Shift Supervisors and Shift Managers. The training programs are based on the principles of Systematic Approach to Training and incorporate elements of continuous learning and performance improvement.

The Operations Training program supports safe and reliable plant operation through training and reinforcement of Operator Fundamentals and Human Performance error prevention tools. Operator Fundamentals are embedded in all aspects of the training program and are utilized as a basis for evaluating operator performance. Inclusion of OPEX in training is a key element of continuous learning and performance improvement.

JIT training is delivered to ensure critical evolutions are conducted safely and efficiently. It reinforces Nuclear Safety culture, expectations and behaviour. Some examples of when JIT training is conducted for Operations include unit shutdown, heat transport system warm-up and cooldown, approach to critical and turbine run-up and shutdown. The effective implementation of JIT training has been instrumental in the successful return to service of the refurbished Darlington NGS units which contain a fresh fuel core and where systems have been modified such as the turbine-governor control system.

More recently, the use of Prepare-Execute-Learn as a methodology was introduced to minimize the probability and consequences of Human Performance events. This is accomplished by identifying Human Performance precursors up front, by implementing well established Human Performance tools to prevent and mitigate errors and by strengthening feedback processes to promote continuous learning. Operations Trainers assist line management by promoting self-awareness among staff and reinforcing the use of Human Performance error reduction tools and techniques during training activities in the classroom, the simulator and in the field.

Other initiatives include:

- Incorporation of a flight simulator in Human Performance training. The course introduces the trainees to the psychology behind the Human Performance tools. Following completion of the theoretical classroom portion, the trainees are provided an opportunity to practice the Human Performance tools/techniques using various interactive simulations in a flight simulator. This places the trainee in an unfamiliar environment, different from the station, where they are able to observe the full benefits of the Human Performance tools/techniques while being challenged with distractions and competing priorities.
- Development and upgrades to control panel simulators for the Fuel Handling, Tritium Removal Facility and Target Delivery Systems.
- Use of Video Learning-On-Demand as a valuable tool that is available 24/7 to enhance work preparation and pre-job briefs.
- Development of Dynamic Learning Activities to promote effective use of Operator Fundamentals and Human Performance error prevention tools.
- Main Control Room simulator upgrades to improve versatility and maintainability.

Maintenance Training

Maintenance Training and Station Maintenance organizations continue to collaborate on Workshops and Dynamic Learning Activities to build proficiency and verify performance to standards and expectations. The scope is defined through Curriculum Review Committee, Staying on Top, and Continuous Improvement meetings based on direct observations of performance. Technical areas that have been delivered through continuing training cycles including: ground fault detection and correction using a systematic based approach, foreign material exclusion, compressors, troubleshooting plan development, bolted joint workshops on performance standards, governance and best practices, electrical safety, bearing alignment which included use of laser alignment tools, tube bending, and precision measuring tools. Human Performance elements include: verification practices, peer coaching, interactive pre-job briefings, and the 2-Minute Job Site Drill are also included.

Maintenance Training have implemented innovative solutions using virtual interfaces, including a Crane Virtual Reality Simulator. This training approach also improves accessibility to training resources when station equipment is in use. In addition, portable demonstration units have been implemented for gasket and leak mitigation training. These units focus on bolted joint proficiency building and are available for use in both the training environment and onsite to support work preparation and ongoing rehearsal.

Engineering Training

Engineering training focuses on core elements of nuclear professionalism and culture by concentrating on key elements of conduct and behaviours within the learning material. Training material has been organized to expand and make engineers aware of the library of proficiency enhancing learning material. A strong collaborative effort has been directed to collect and share learning to improve knowledge transfer and OPEX. Engineering training has built an extensive library of videos and other presentation material of individuals sharing lessons learned.

Engineering training has a robust continuing training program. An important component of this training program is the Conduct of Engineering Workshops. Every year senior engineering leaders select a new topic and the material is developed and delivered to approximately 1200 OPG engineers. The chosen topic is a backdrop to the application expected behaviours within the engineering community and an opportunity to reinforce culture.

Many others outside of Enterprise Engineering take some components of this training to enhance knowledge of nuclear operations.

Leadership Training

Leadership Training at OPG designs and delivers enterprise-wide leadership development programing to all leaders. Applying a blended training approach, initial and continuing training programs are co-delivered with line leaders and subject matter experts from across the company to bring diverse thoughts, ideas and perspectives, to enhance the learning and sharing of OPEX. The program focuses on supervisor fundamentals and accountabilities (safety and compliance) and leadership behaviours (culture, coaching, communication and facilitative leadership).

Throughout 2022 and 2023, continuing leadership training focused on Facilitative Leadership, promoting the power of collaborative action through the seven practices of a Facilitative Leader. Additionally, OPG offers leadership development opportunities through industry partners and experts including Institute of Nuclear Power Operations, World Nuclear University, CANDU Owners Group (COG) and WANO (including *Leading Nuclear,* an international partnership with EDF Energy UK). Examples include:

- Nuclear Professional Development Seminar to benchmark and learn best practices of leadership, working relationships, human performance, human behaviours, safety culture, teamworking and change management. The course, designed for senior plant staff, allows participants to review management issues and problem solving through case studies and industry experience.
- Leading Nuclear Program which focuses on strengthening knowledge transfer between nuclear sites and developing staff through mentoring.

  Participants form lifelong support networks with counterparts from different plants and countries. It's a valuable opportunity for senior managers looking to enhance their leadership skills and prepare for higher-level responsibilities in nuclear power plants.

Emergency Response Organization Training

Alignment between Emergency Preparedness Training and Enterprise Emergency Management teams is maintained through formal reviews of potential training needs identified in field performance observations during training sessions, both through classroom and on-the-job training. OPG extensively uses drills and real events as means of continuous learning through post training critiques and feedback. In 2022, a broad improvement initiative was implemented to improve the documentation and analysis of training program elements and benchmarking and best practices with OPG Training.

2.2.3 Personnel Certification

As per the Power Reactor Operating Licence (PROL), the initial and continuing training programs for the certified persons at Darlington NGS are designed in accordance with CNSC regulatory document, REGDOC-2.2.3, *Personal Certification, Volume III, Certification of Persons Working at Nuclear Power Plants*. This regulatory document specifies the requirements to be met by persons working, or seeking to work, in positions for which a certification by the CNSC is required. It also specifies the requirements regarding the programs and processes supporting certification of their workers that licensees must implement to train and examine persons seeking or holding a certification issued by the CNSC.

Darlington NGS's PROL requires individuals who are appointed to the following positions have valid CNSC certification:

(i) Responsible Health Physicist (RHP);

(ii) Shift Manager (SM);

(iii) Control Room Shift Supervisor (CRSS);

(iv) Authorized Nuclear Operator (ANO);

(v) Unit 0 Control Room Operator (U0 CRO).

Consequently, Darlington NGS is responsible for training and testing workers to ensure that they are fully qualified to perform the duties of their position, in accordance with the regulatory requirements.

The processes used to train and qualify persons for initial certification as SMs, CRSSs, ANOs and U0 CROs are outlined in the following training qualification documents:

- N-TQD-101-00001, *Authorized Nuclear Operator Initial Training and Qualification Description;*
- N-TQD-102-00001, *Nuclear Shift Manager/Control Room Shift Supervisor Initial Training and Qualification Description;*
- N-TQD-105-00001, *Darlington Unit 0 Control Room Operator (CRO) Initial Training and Qualification Description.*

The process used to train and qualify persons for initial certification as RHPs is outlined in:

- N-TQD-443-00001, *Radiation Protection Training and Qualification.*

The processes used to ensure certified persons maintain their qualification are outlined in:

- N-TQD-103-00001, *Nuclear Certified Personnel Continuing Training and Qualification Description;*
- N-TQD-443-00001, *Radiation Protection Training and Qualification.*

Both initial and continuing training programs are based on N-PROC-TR-0008, *Systematic Approach to Training* as required by REGDOC-2.2.3 Vol III and REGDOC-2.2.2.

Table 3 contains the number of certified staff at Darlington NGS as of May 6, 2024.

Table 3: Certified Staff at Darlington Nuclear

Certified Position	Number of Certified Staff	Number of Trainees
Shift Manager and Control Room Shift Supervisor	29	26
Authorized Nuclear Operator	64	6
Unit 0 Control Room Operator	18	1
Responsible Health Physicist	5	0

The continuing training program for Certified Operating staff is at a mature stage. This training includes refresher training and update training for design or engineering changes, infrequently performed test and evolution exercises, JIT training and formal evaluations (knowledge and performance) of certified staff. Certified Operating staff complete greater than 200 hours per year of continuing training.

In line with our industry peers, Certified Operating staff have internalized the need to maintain a Line of Sight to the Reactor Core in all aspects of unit operations. This includes initiatives to improve leadership and team effectiveness; creating a culture of continuous learning, promotion of conservative decision-making; recognition and mitigation of proficiency shortfalls, improving operator training, promoting understanding of procedures important to the protecting the core and utilizing independent oversight. Integral to this is a Training to Improve Performance initiative whereby line-identified performance issues are addressed in a timely fashion through training. This initiative has been very effective at preparing crews to respond proficiently to unit upsets.

All Certified Operating staff have been trained and qualified on the restart and operation of the refurbished units according to the process outlined in the following document:

- N-TQD-901-00001, *Nuclear Refurbishment Training and Qualification Description.*

Knowledge and performance-based training has been and will continue to be provided to Certified Operating staff prior to the restart of each refurbished unit.

Planned Improvements

In October 2023, the Commission superseded regulatory document REGDOC-2.2.3 *Personnel Certification, Volume III: Certification of Persons Working at Nuclear Power Plants* with REGDOC-2.2.3 *Personnel Certification, Volume III: Certification of Reactor Facility Workers, Version 2*. OPG has since requested a licence amendment via Reference 2.2-1 to amend the PROL replacing the current reference to the regulatory document with REGDOC-2.2.3, *Personnel Certification, Volume III: Certification of Reactor Facility Workers, Version 2.*

Version 2 incorporates changes that provides more flexibility for those persons acquiring initial certification. The update streamlines the requirements for maintaining and reinstating certification.

To ensure long-range Certified Operating staffing requirements are met, a team has been established at the OPG fleet level to model staffing numbers to 2030. The projection considers internal and external attrition as well as Certified Operating staff returning to Darlington NGS Operations as the Darlington NGS Refurbishment Project draws to a close in 2026.

The Certified Operating staffing requirements feed a long-range training plan. The long-range training plan is updated annually based on Certified Operating staffing demand and identifies Authorization Trainer resources required to meet the demand. Authorization Trainer resources are drawn from Certified Operating staff and are qualified as Trainers.

In cooperation with our industry partners through COG, Darlington NGS will be investigating opportunities to optimize and strengthen the initial training programs for Certified Operating staff. This includes improvements to selection process, optimization of program length and reviewing the scheduling of the on-the-job training to improve the development of Control Room Shift Supervisor in Training. The desired outcomes will be to improve the trainee learning experience, reduce program duration and improve candidate throughput.

2.2.3.1 Initial Certification Examinations and Requalification Tests

The following CNSC documents contain the requirements for administering the certification examinations and requalification tests required by REGDOC-2.2.3 for persons in Certified Operating positions, e.g., SM, CRSS, ANO and U0 CRO:

- CNSC-EG1, Rev.0: *Requirements and Guidelines for Written and Oral Certification Examinations for Shift Personnel at Nuclear Power Plants;*
- CNSC-EG2, Rev.0: *Requirements and Guidelines for Simulator-based Certification Examinations for Shift Personnel at Nuclear Power Plants;*
- CNSC document: *Requirements for the Requalification Testing of Certified Shift Personnel at Nuclear Power Plants, Revision 2.*

Initial certification examinations for persons who are seeking certification in one of the Certified Operating positions are conducted in accordance with the following instructions:

- N-INS-08920-10002, *Simulator-Based Initial Certification Examinations for Shift Personnel;*
- N-INS-08920-10004, *Written and Oral Initial Certification Examinations for Shift Personnel.*

Adherence to these OPG instructions ensures that initial certification examinations are administered in a consistent manner and in accordance with the requirements of CNSC-EG1 and CNSC-EG2.

OPG's Simulator Training program maintains two Darlington NGS Full Scope Training Simulators. The Simulators are used for the training and examination of persons seeking or holding certification as SM, CRSS, ANO and U0 CROs. The simulators replicate the main control room - Unit 2 and Unit 0. The simulators are modelled to operate and respond as plant systems will do under normal and transient conditions. The design, modification, and upkeep of the simulators are governed by N-PROC-TR-0023, *Simulator Quality Assurance*, and N-PROC-TR-0024, *Simulator Change Control.*

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

Requalification Testing for persons in Certified Operating positions is conducted in accordance with the following instruction:

- N-INS-08920-10001, *Requalification Testing of Certified Shift Personnel.*

This includes Written Tests and simulator-based Comprehensive Simulator Tests and Diagnostic Simulator Tests for all Certified Operating staff.

Adherence to this instruction ensures requalification tests are administered in a consistent manner and in accordance with the requirements endorsed by CNSC in e-Doc# 3385987, *Implementation of Requirements for the Requalification Testing of Certified Shift Personnel at Nuclear Power Plants, Revision 2, May 1, 2009.*

As per REGDOC-2.2.3, the initial certification examinations and requalification tests for the Responsible Health Physicist continue to be administered by the CNSC.

As required under REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants*, Section 3.3, Item 6 (b), OPG submits a report detailing certification exam results and pass/fail rates. Results are also supplied to the CNSC in accordance with CNSC-EG1 and CNSC-EG2 *Examination Follow-up* sections during the Certification process.

The CNSC obtains assurance that each person it certifies is qualified to carry out the duties of the applicable position by means of a regulatory oversight regime of the licensees' training programs and certification examinations based on a combination of appropriate regulatory guidance and compliance activities.

Authorization Training staff are qualified as examiners according to the requirements outlined in the following documents:

- N-TQD-602-00001, *Nuclear Trainer Training and Qualification Description;*
- N-QG-602-00001, *Operator Training Instructor Qualification Guide.*

Planned Improvements

The LCH currently permits, as a pilot project, the use of Multiple Choice Question (MCQ) format examinations for General Written Initial Certification Examinations. As part of the Authorization Program Optimization Project, OPG will be seeking to formalize the use of the MCQ format not only for General Written Initial Certification Examinations but also to extend use of this examination format to other Initial Certification knowledge-based examinations. MCQ format examinations are widely used across the industry and are used for requalification testing at OPG currently. With the MCQ format, the design and development of questions and the grading of candidate answers is more objective than modified essay style examinations. MCQ format examinations allow for the sampling of a greater number of knowledge areas over a given examination time period.

OPG will continue to demonstrate to the CNSC its capability to self-administer the Certified Operator staff training and examinations and to ensure sufficient qualified staff are available to ensure safe and reliable operation of the Darlington NGS station. This includes the requirement that sufficient trained and qualified staff will be available to deliver these training programs throughout the continued operation and refurbishment timeframe.

2.2.4 Work Organization and Job Design

Minimum Shift Complement

The processes that ensure an adequate number of qualified workers with the correct skills and competencies within the facility at all times are captured within D-PROC-OP-0009, *Station Shift Complement*, D-INS-09260-10001, *Duty Crew Minimum Complement Assurance*, and D-INS-03490-10003, *Minimum Shift Complement Resources, Qualifications and Procedures required for Responding to Resource-Limiting Events.*

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

Procedure D-PROC-OP-0009 documents and describes the qualifications and minimum number of workers required under all operating states (including Refurbishment, where applicable) and their roles and responsibilities. It also states policies in place to prevent minimum shift complement violations as well as the mitigating measures to be taken in the event a violation occurs.

Instruction D-INS-09260-10001 defines the responsibilities and describes processes to ensure that the shift minimum complement is always met. This includes usage of the Minimum Complement Coordinator Program (MCCP), Main Control Room turnovers, person-to-person relief, Duty Crew accounting, absence reporting for the Emergency Response Organization (ERO) and shift personnel and emergency role qualifications.

Instruction N-INS-03490-10003, provides instructions to ensure that procedures and qualifications linked to Minimum Shift Complement are maintained.

Management of Minimum Shift Complement

MCCP is the approved information management system dynamic software program to manage the minimum shift complement system. There are many capabilities of the system, including:

- Assignment of ERO roles for each shift.
- Tracking ERO / shift complement staff as they arrive (badge in) and leave (badge out) the protected area.
- Forecasting of staff requirements.
- Various reporting including expiring qualifications, time exception and several accounting lists.

To ensure MCCP uses the most up to date information, it is live linked to the following software programs:

1. Training Information Management System – ensures the qualification of staff assuming minimum shift complement roles.

2. Time reporting software (MyTime) – tracks the schedules of staff, including shift assignment and time off (vacation etc.).

The MCCP software reflects D-PROC-OP-0009 updates on staffing numbers and positions (after CNSC review).

Every year, changes are made to the software to update it, adding improvements, increasing efficiency, and making it more robust. Some of the most notable changes since the last licence term, starting in 2015 were:

- Daily automatic emails sent to supervisors and managers with notification of any shifts within the next two weeks that are forecasted to be below minimum complement.
- Automatic notification (email) to SMs and appropriate staff at beginning of day shift if minimum complement is not met to enable corrective actions can be taken.
- Addition of crew schedules beyond shift crews A-E (XYZ, STU, NOPQ).
- Real-time link to all ERO and workgroup positions in the Training Information Management System.
- Addition of complement history reporting capabilities.
- Added the capability to search other facilities (Pickering NGS) for qualified Emergency Response Maintainers that could be loaned to Darlington NGS if required.
- The addition of various menus, sub-menus, and new commands to improve functionality and user experience.
- Provide the ability to automatically limit the number of times an employee can be stepped up within a certain period of time.
- Implement changes that if an employee's minimum shift complement role (workgroup role) will expire within a certain time frame, it will be highlighted on the main display screen.

Changes to Minimum Complement

Since 2015, Darlington NGS has gone through organizational changes that have led to changes to the Minimum Shift Complement such as:

- Moving to a days-based maintenance program.
- Removal of the Shift Advisor Technical (SAT) position.
- Changes to Radiation Protection qualification requirements for ANOs and CROs.

To ensure the changes required to the Minimum Shift Complement would not impact the stations' ability to maintain safe operation and to respond to resource-limiting emergencies, tabletop, and field walkdown review exercises were conducted, and gaps were addressed through a Corrective Action Plan.

Darlington NGS has also implemented a mass texting system for notifying employees of the need for minimum complement coverage. The text is sent out to those with the relevant qualification, detailing the shift required and who to communicate with to volunteer for the coverage.

2.2.5 Fitness for Duty

Darlington NGS maintains robust procedures and policies to ensure that all staff members are fit for duty. OPG prioritizes the safety and well-being of the employees and recognizes the importance of their physical and mental readiness to perform their roles effectively. To achieve this, comprehensive measures to assess and monitor the fitness of the workflow are in place in order to comply with:

- REGDOC-2.2.4, *Fitness for Duty: Managing Worker Fatigue;*
- REGDOC-2.2.4, *Fitness for Duty, Volume II: Managing Alcohol and Drug Use, Version 3;*
- REGDOC-2.2.4, *Fitness for Duty, Volume III: Nuclear Security Officer Medical, Physical and Psychological Fitness.*

Regarding the implementation of REGDOC-2.2.4, *Fitness for Duty, Vol. II: Managing Alcohol and Drug Use, Version 3,* OPG has implemented programmatic elements to comply with certain requirements as mandated by REGDOC-2.2.4. 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 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, which was heard in January 2024.

Procedure OPG-PROC-0208, *Fitness for Duty: Policy of Managing Alcohol and Drug Use* identifies the processes for addressing fitness for duty as it applies to alcohol and drug use including:

- Testing procedures.
- Responsibilities and expectations.
- Prevention, assistance, and rehabilitation.
- Investigations and consequences.

Initial and continuing training elements address fitness for duty. These focus on explaining company policies, expectations, and the various employee support programs available, such as:

- The Continuous Behaviour Observation Program (CBOP). CBOP is designed to develop a supervisors and managers ability to recognize and respond to behaviours that could impact worker performance and safety.
- Additional training is provided for SMs and CRSSs on monitoring fitness for duty for safety sensitive and safety critical personnel.
- Training is conducted for the Fitness for Duty: Policy of Managing Alcohol and Drug Use program through 3 computer-based training courses:
    - A module in the yearly Nuclear General Employee Training (for all site staff).
    - Fitness For Duty – Managing Alcohol and Drug use for workers.
    - Fitness For Duty – Managing Alcohol and Drug use for supervisors.

If an OPG Security Officer suspects a worker is unfit, they deny access to the facility, and notify appropriate supervisory personnel. OPG also periodically uses canine drug monitoring at the security monitors as an additional barrier to alert Security Officers to review the fitness for duty of suspected staff entering the protected area.

Employee's Hours of Work (HoW) is also monitored. Procedure N-PROC-OP-0047, *Hours of Work Limits and Managing Worker Fatigue* prescribes the process for monitoring and controlling the HoW for Nuclear Broad Population and Safety Sensitive employees to meet the requirement set out by CNSC REGDOC-2.2.4, Ontario Employment Standards Act and Collective Agreement provisions. It includes guidance and instruction on the following:

- Hours of work (Including Regulatory limits, shift schedules and special exceptions).
- Monitoring requirements for workers.
- Reporting requirements.
- Management of worker fatigue.

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

Additional HoW monitoring is completed by workgroup Single Point of Contacts. OPG has implemented a new time keeping and reporting system (MyTime) that allows for custom reports to be generated which has improved the discernment of HoW. Each workgroup SPOC monitors and reports on HoW for their departments. There has been a concerted effort by the SPOCs to educate those that approve time sheets on how to identify situations that can lead to HoW violations and how to disposition when they are identified. OPG's guide, N-GUID-08945.1-10000, *Limits of Hours of Work – Nuclear Monitoring and Reporting Process* ensures that reporting requirements are understood and complied.

Employee Programs

OPG strives to create a work environment that fosters optimal physical and mental fitness of the staff by providing a variety of employee support and educational programs.

Telus Health (Employee Family Assistance Program) - supports employees and their families in dealing with a range of personal and work-related challenges by providing confidential and accessible resources including counselling and emotional support, manager/supervisor resources, educational resources etc.

Maple Telemedicine - provides employees and their families access to a licensed physician for a variety of health concern by text, phone, or video.

Addictions Treatment Services - provides virtual and confidential assistance to employees and their families who are experiencing problems with alcohol, drugs, or process addictions (ex. gambling).

Section 2.3

Operating Performance

2.3 Operating Performance

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

The OPG documents in the table below require written notification of change per Darlington NGS Licence Conditions Handbook, LCH-PR-13.03/2025-R005:

Table 4: SCA 3 – Operating Performance

Document	Title
NK38-OPP-03600	Darlington Nuclear Operating Policies and Principles
N-STD-MP-0016	Safe Operating Envelope
N-STD-OP-0025	Heat Sink Management
N-STD-OP-0024	Nuclear Safety Configuration Management
N-PROG-OP-0001	Conduct of Operations/Nuclear Operations
N-PROG-OP-0004	Chemistry
N-STD-OP-0012	Conservative Decision-Making
N-STD-OP-0036	Operational Decision Making
N-STD-MP-0019	Beyond Design Basis Accident Management
N-STD-OP-0011	Operations Performance Monitoring
N-PROC-RA-0035	Operating Experience Process
N-PROC-RA-0022	Processing Station Conditions Records
N-PROG-RA-0003	Performance Improvement
N-STD-OP-0017	Response to Transients
N-PROG-MP-0014	Reactor Safety Program
N-STD-OP-0009	Reactivity Management
N-STD-OP-0021	Control of Fuelling Operations
NK38-OSR-08131.02-10001	Operational Safety Requirements: Emergency Coolant Injection System
NK38-OSR-08131.02-10002	Operational Safety Requirements: Emergency Water System
NK38-OSR-08131.02-10003	Operational Safety Requirements: Fuel and Reactor Physics
NK38-OSR-08131.02-10004	Operational Safety Requirements: Shutdown Systems
NK38-OSR-08131.02-10005	Operational Safety Requirements: Main Steam Supply System
NK38-OSR-08131.02-10006	Operational Safety Requirements: Containment
NK38-OSR-08131.02-10007	Operational Safety Requirements: Steam Generator Emergency Cooling System
NK38-OSR-08131.02-10008	Operational Safety Requirements: Moderator System
NK38-OSR-08131.02-10009	Operational Safety Requirements: Powerhouse Steam Venting System
NK38-OSR-08131.02-10010	Operational Safety Requirements: Reactor Regulating System
NK38-OSR-08131.02-10011	Operational Safety Requirements: Group 1 Service Water Systems
NK38-OSR-08131.02-10012	Operational Safety Requirements: Emergency Power Supply System
NK38-OSR-08131.02-10013	Operational Safety Requirements: Feedwater System
NK38-OSR-08131.02-10014	Operational Safety Requirements: Shutdown Cooling System

Document	Title
NK38-OSR-08131.02-10015	Operational Safety Requirements: Heat Transport System
NK38-OSR-08131.02-10016	Operational Safety Requirements: Group 1 Electrical Power Systems
NK38-OSR-08131.02-10017	Operational Safety Requirements: Darlington NGS Toxic Gas Monitoring and MCR Breathing Air
NK38-OSR-08131.02-10018	Operational Safety Requirements: Fuel Handling System and Irradiated Fuel Bays
NK38-OSR-08131.02-10019	Operational Safety Requirements: Powerhouse Steam and Flooding Protective Provisions
NK38-OSR-08131.02-10020	Operational Safety Requirements: Annulus Gas System
NK38-OSR-08131.02-10021	Operational Safety Requirements: Critical Safety Parameter Monitoring Instrumentation
NK38-OSR-08131.02-10022	Operational Safety Requirements: Shield Cooling System
NK38-CALC-63432-10001	Darlington NGS ECIS Instrument Uncertainties and Allowable values
NK38-CALC-68200-10001	Darlington NGS SDS1 Instrument Uncertainties and Allowable values
NK38-CALC-68300-10001	Darlington NGS SDS2 Instrument Uncertainties and Allowable values
NK38-CALC-63420-10001	Darlington NPCS Instrument Uncertainties and Allowable values
NK38-CALC-63671-10001	Darlington NGS Steam Generator Emergency Cooling System Instrument Uncertainties and Allowable Values
NK38-CALC-63210-10001	Darlington NGS Moderator System Instrument Uncertainties and Allowable Values
NK38-CALC-67322-10001	Darlington NGS PSVS Instrument Uncertainties and Allowable Values
NK38-CALC-63700-10001	Darlington NGS Reactor Regulating System Instrument Uncertainties and Allowable Values
NK38-CALC-64320-10001	Darlington NGS Feedwater System Instrument Uncertainties and Allowable Values
NK38-CALC-63341-10001	Darlington NGS Shutdown Cooling System Instrument Uncertainties and Allowable Values
NK38-CALC-63330-10001	Darlington HTS Instrument Uncertainties and Allowable Values
NK38-CALC-67320-10001	Darlington NGS Powerhouse Steam and Flooding Protective Provisions Instrument Uncertainties and Allowable Values
NK38-CALC-63488-10001	Darlington NGS Annulus Gas System Instrument Uncertainties and Allowable Values
NK38-CALC-60350-10001	Darlington NGS Critical Safety Parameter Monitoring Instrumentation Uncertainties and Allowable Values
NK38-CALC-63411-10001	Darlington NGS Shield Cooling System Instrument Uncertainties and Allowable Values
N-PROC-RA-0005	Written Reporting to Regulatory Agencies
N-PROC-RA-0020	Preliminary Event Notifications

2.3.1 Conduct of Licensed Activity

N-PROG-OP-0001, *Nuclear Operations*, implements a series of standards and procedures to ensure that the plant is operated safely, reliably and per regulatory requirements. The program establishes safe, uniform, and efficient operating practices and processes within nuclear facilities that provide nuclear professionals at Darlington NGS the ability to ensure the facility is operated in such a manner that the PROL, NK38-OPP-03600, *Darlington Nuclear Operating Policies and Principles*, and other applicable regulations and standards are followed. It also supports the alignment and prioritization of equipment maintenance in a manner that protects the health and safety of workers, the public and the environment.

The following standards under the Nuclear Operations program provide instructions and requirements for consistent and safe operation of Darlington NGS.

- N-STD-OP-0036, *Operational Decision Making,* provides instructions on the systematic approach to decision making. It describes the principles and attributes, roles and responsibilities, and various levels of authority when making operational decisions.
- N-STD-OP-0011, *Operations Performance Monitoring*, provides a consistent manner of identifying and reporting common and site-specific performance. It is a tool used by station management to ensure standards for performance are being maintained or improved, and opportunities for continuous improvement are identified.
- N-STD-OP-0021, *Control of Fuelling Operations*, establishes the standard requirements such that fuelling operations and conduct of activities do not adversely affect reactivity control, containment of the fuel, and cooling of the fuel.

Furthermore, N-STD-OP-0012, *Conservative Decision-Making* (under N-PROG-AS-0002, *Human Performance*) describes management's expectations on conservative decision making with regards to the safe operation of the plant, such that decisions are made with full regard to the potential safety consequences and conservative actions are taken in the face of uncertainty.

The following subsections describe critical aspects of the Nuclear Operations program.

Heat Sink Management

N-STD-OP-0025, *Heat Sink Management*, specifies the requirements for management of reactor heat removal in all planned reactor states and planned configurations when the reactor is operating in low power conditions. A variety of analyzed heat sink configurations are described in detail in operating manuals and are by design, diverse from one another such that the heat sinks are physically and electrically independent. For planned outages, heat sinks are determined and planned to account for the various stages of maintenance. For forced outages or accident conditions, the heat sink will be determined by the responsible personnel, and reactor systems are aligned by following the applicable abnormal operating procedures or Emergency Operating Procedures (EOPs).

During the refurbishment of Darlington NGS units, a project was undertaken to install two additional, conceptually different Auxiliary Shutdown Cooling (ASDC) pumps in each unit to provide an additional back up heat sink for use during outages (i.e. low pressure and low temperature conditions). The ASDC pumps and their support services are to be independent, diverse, and physically separated from the main shutdown cooling pumps to the extent practicable. The ASDC pumps provide sufficient flow to maintain primary heat transport system temperature below 90°C (194°F) from 24 hours after shutdown.

Response to Transients

N-STD-OP-0017, *Response to Transients*, defines the roles and responsibilities of operating crews when responding to transients, to ensure the unit is placed in the appropriate safe state. Operating crews regularly practice these roles through continuing training and self-assessed crew drills. Following any transient event and once the unit is in a safe operating state, a post-transient response meeting is held to confirm the cause of the event, verify that all systems and components of the unit operated as expected, ensure responses were per procedures, and initiate the appropriate corrective actions where required. Furthermore, a control room performance critique of the event will be conducted after the unit is in a stable steady state to evaluate the team's behaviours and use of operator fundamentals. Utilizing lessons learned allows for the operations team at Darlington NGS to continually improve their performance and ensure continued safe operation of the station. Detailed descriptions of transient events are well documented.

Reactivity Management

N-STD-OP-0009, *Reactivity Management*, applies systematic processes for monitoring and controlling reactivity in the core and stored nuclear fuel to ensure that reactivity is consistent with fuel design and operating limits.

Reactivity management performance of the station is measured using the Reactivity Management Index (RMI) (refer to Figure 9). It is a standard calculation used in the industry to gauge performance and facilitate benchmarking comparisons between individual plants and utilities. Prior to 2020, Darlington NGS had a RMI target of 95%. Due to demonstrated consistent improvement and high performance in reactivity management in recent years, Darlington NGS has raised its RMI target, including a target of 99.1% in 2023.

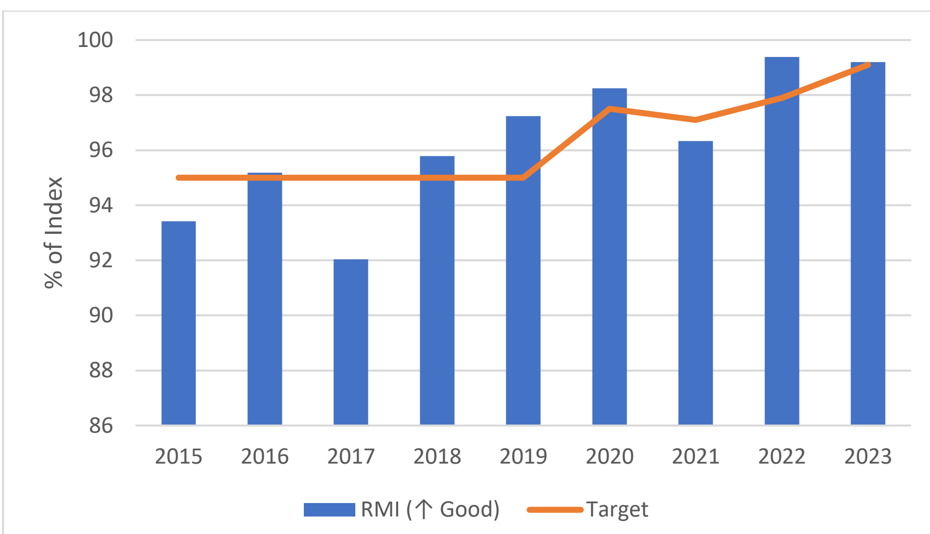


Figure 9: Darlington Average RMI vs Target (by Year), 2015-2023

Plant Status Control

The Plant Status Control program consists of different elements such as N-STD-OP-0024, *Nuclear Safety Configuration Management*, and N-STD-OP-0003, *Operations Narrative Logging*, to ensure that configuration of the station systems and components are monitored and controlled. It involves tracking the various operating conditions, parameters, and activities of the plant in real-time to ensure safe and efficient operation. Plant status control serves several important purposes including ensuring safety, improving operational efficiency, and fault detection.

Darlington NGS tracks significant mispositioning events using Mispositioning Index Value (MIV) (refer to Figure 10). Prior to 2020, Darlington NGS had a target of 97% which has been increased in recent years to drive continual improvement, along with the implementation of several initiatives and corrective actions for improved performance.

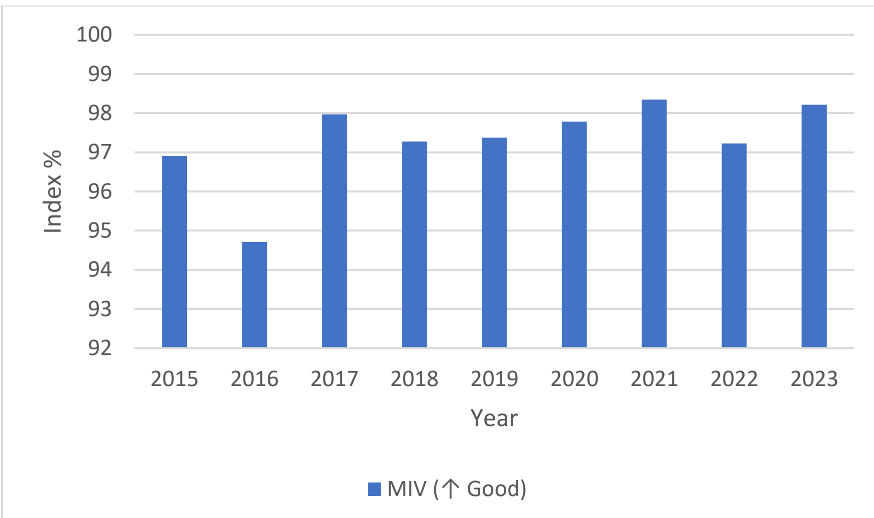


Figure 10: Average Mispositioning Index Value (by Year), 2015-2023

The Plant Status Control program at Darlington NGS strives for continuous improvement through new initiatives, innovation, and automation. The following software applications are utilized by Darlington NGS to support plant status control, and improvements have been made to the applications as discussed below.

- Equipment Status Monitoring (ESM) is used for tracking the position of system devices and components, work protection administration, temporary change requests for documenting system modifications and reactor outage alignments, flowsheet management, and creating equipment tags and status control tags. The current version of the program, ESM3R, is fully electronic and upgraded from the previous versions, which has improved efficiency in the work protection process. The improved electronic work protection process eliminates potential for human errors of older processes that were a combination of electronic and paper-based.
- Operator Shift Log (OSL) is a computer program for administrating Operational narrative logging requirements. It documents the chronological summary of shift activities and is used as part of shift turnovers to acquaint operators with unit conditions. It allows for quality operations logs to be maintained and include pertinent information such as

enhanced monitoring requirements, equipment condition summaries, and abnormal station conditions. A new HTML-based version of the OSL program has been implemented, which has benefits such as remote accessibility and being linked in real-time to other key applications such as ESM3R and Equipment Status Log (ESL).

- ESL is used at Darlington NGS by Fuel Handling and Chemistry for control and monitoring of ion exchange columns, in addition to monitoring, controlling, and tracking of changes to plant systems, structures, and components. The ESL program was updated during the current licence term to improve speed and user experience.

Improvements have been made to signage at the station including signage updating and simplification to ensure proper access and operation of overhead doors, and signage installation for emergency mitigating equipment to ensure clearance is maintained for emergency access.

Current ongoing initiatives for the Plant Status Control program include:

- New harsh environment tags being created for over 4000 tags to ensure compliance with N-PROC-OP-0034, *Equipment Labelling*.
- Signage updates for chemical storage areas.
- Main Control Room (MCR) key storage equipment and labelling has been updated. Key lists and tracking logs are in the process of being updated.

Work Protection

The Work Protection program is governed by N-PROG-MA-0015, *Work Protection,* which describes requirements that are in place within OPG Nuclear to isolate and de-energize equipment to ensure worker safety. These isolation and de-energization requirements are known as "Work Protection”. The program includes a description of management processes, existing corporate governance that further operationalizes this program, and roles and responsibilities that are in place to ensure worker safety where work on equipment requires isolation and de-energization.

Worker safety is achieved through the effective application of a work protection standard and procedures to ensure physical and administrative barriers are established between the energy source and the worker. Work Protection establishes safe conditions for work by creating a Safe Work Area to ensure complete isolation and de-energization of isolated equipment.

The objective of the physical and administrative barriers is to prevent breakthrough events that can expose staff to hazardous energy. As such, the key measure is the number of Level 1 events (events where there were no barriers for potential exposure to hazardous energy). The results of this measure will determine the corrective action requirements to improve performance. Operations Managers own the Work Protection program at the site and provide oversight through the:

- Nuclear Work Protection Review Board: review and provide oversight of the work protection performance in Nuclear. This includes significant trends or events and their associated corrective action plans.
- Local Work Protection Review Board (LWPRB): provide oversight of the Work Protection performance at the Site. The LWPRB reviews and provides oversight and analysis of recent events at all sites, corrective actions of events, Operating Experience (OPEX) and work protection training issues.

- Site Work Protection Working Committee: monthly meetings held to allow workers the opportunity to raise any work protection issues at site. Issues and actions to be reported to LWPRB as required.

The Work Protection Performance Index (WPPI) is a measure of work protection performance. The number and significance of work protection events that occur on site each year affects the index. The annual trend in the WPPI metric is shown in Figure 11. An improvement in WPPI has been realized in the current licence term.

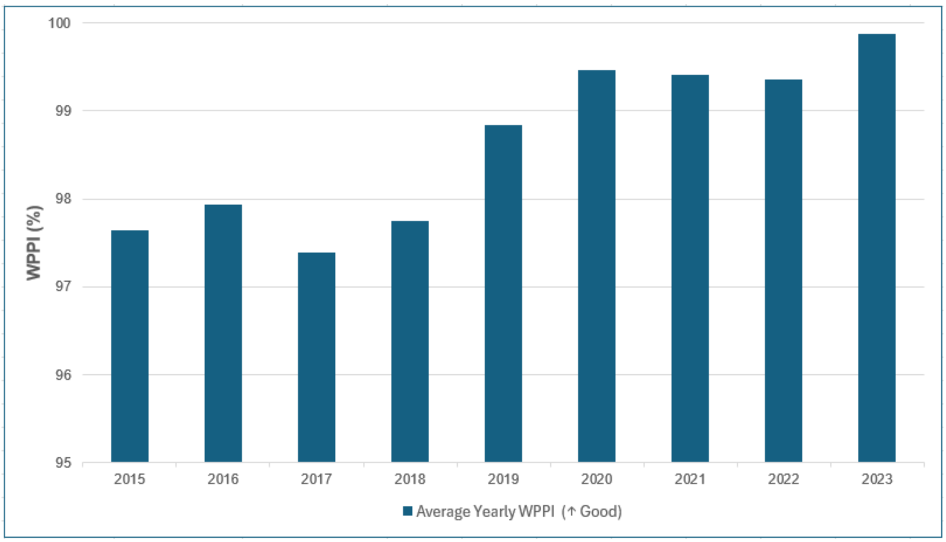


Figure 11: Darlington NGS Yearly Average WPPI

2.3.2 Procedures

As part of the Nuclear Operations program, clear, concise, and accurate procedures are essential for the safe operation of the plant and for efficient and adequate response to transient situations. N-STD-AS-0002, *Procedure Use and Adherence* is in place and provides the requirements on how to use and adhere to administrative and technical procedures. Darlington NGS's operating procedures are developed and revised using defined processes to ensure compliance with operational limits and regulatory requirements, incorporating human performance and error-prevention tools such as second-party verification and place-keeping. N-PROC-AS-0028, *Development, Review and Approval of Technical Procedures* is in place for the development, review, and approval of technical procedures; it outlines the levels of authority required for verification and review, the categorization of Technical Procedure Action Requests (TPARs), and validation and distribution requirements. Additional instructions and standards are in place to provide detailed requirements on content, structure, and usage and adherence of technical procedures (e.g. operating manuals, EOPs, tests, etc.) and work instructions.

Validation is completed on both new procedures and procedures with extensive revisions. For procedures normally executed by MCR staff, the validation is completed before issuance by certified staff using the full-scope simulator, with additional input sought from trainers. Field validations are normally completed after issuance. Procedures requiring field validation are issued with a validation watermark and contain instructions on how to complete the validation.

Darlington NGS has multiple departmental procedures groups (e.g. Maintenance, Operations, Refurbishment, Fuel Handling, Tritium Removal Facility (TRF) Operations Support, Nuclear Sustainability Services) that are dedicated to updating the technical procedures that their department has ownership of. Due to interfaces between different systems, the different procedures groups collaborate as required to revise various procedures.

Numerous procedure updates have either been completed during the current licence term or are ongoing due to the large amount of station projects and modifications in addition to Darlington NGS Refurbishment. Several measures have been initiated to reduce TPAR backlog and improve the prioritization of implementing procedure updates. This includes development of training materials for new procedure authors, increasing staffing in procedures groups, increasing collaboration with Refurbishment procedures group, streamlining the processes for reviews, verifications and approvals, and consolidation of databases into a single software application.

The software application simplifies the process of submitting a TPAR and increases accessibility and engagement with users. This allows for more detailed information to be requested for specific situations, such a project TPARs or TPARs submitted as part of Corrective Action Programs.

Darlington Refurbishment Procedures

The large scope of the Darlington NGS refurbishment project across all four reactor units has resulted in the necessity for thousands of operational procedure revisions. Revisions to procedures must adhere to the strict safety standards of Darlington NGS operations to ensure refurbishment work is executed safely and with high quality. A specific procedures group was created to manage and author these procedure updates. While the other procedures departments are separate from the Refurbishment group, the Refurbishment procedures group revises the same documentation and significant coordination has been required throughout the project. Strong teamwork and communication between all the procedures groups has been essential. A total of 2,117 TPARs were issued from 2016 to 2023 for Darlington NGS Refurbishment. Procedural updates continue to be tracked and completed as required to meet each milestone within the Refurbishment project.

Electronic Based Procedures

OPG is currently working on implementing its Electronic Based Procedures (EBP) project. This digital procedure software will allow the organization to digitize procedural documentation, moving away from manual, paper-based procedures. Overall, EBPs improve the efficiency, accuracy, and accessibility of procedural documentation. It streamlines processes, enhances collaboration, and facilitates compliance with industry regulations and standards. Some key features of this software are:

- Document Creation: This software will improve the ability to standardize procedure organization and formatting across multiple business units.
- Search and Navigation: Improved search functionality to locate specific procedures or specific sections within procedures. Intuitive navigation tools will help users move through the content seamlessly.

- Integration with other applications: EBP can interface real-time with several other applications. For instance, it will interface with Asset Suite to ensure that users are using the most up to date procedure revision. Upon completion of the procedure, it can be uploaded directly to Records without requiring printing or scanning. EBP can also access plant information data which will increase efficiency for filling out procedure steps that require data that is not used for operational decisions, such as daily panel checks in the MCR.
- Error-prevention and human performance functionality: Many features of the EBPs will reduce human performance errors, such as preventing a user from moving to the next step before the current step is checked off as complete or prompting for additional authorization.
- Analytics and Reporting: Increases insights into procedure usage, completion rates and user performance. This can help identify areas for improvement and optimize procedural workflows.

The Darlington NGS Operations Procedures group is in the process of developing its procedures within EBP. It will be a staggered integration, beginning with the MCR panel checks. A trial electronic version of the panel checks using an Excel spreadsheet was able to withdraw data from plant information data successfully. It was decided to move forward with EBP instead of the spreadsheet to improve quality assurance, ease of updating, and to broaden the applicability beyond panel checks.

2.3.3 Reporting and Trending

As described in Section 2.1, N-PROG-RA-0003, *Performance Improvement*, establishes the processes that support the conduct of Performance Improvement (PI) and, by extension, employs the principles of problem prevention, detection, and correction at OPG Nuclear.

The implementing processes under this program allow for the prompt identification of adverse conditions, proactive identification and resolution of potential issues, or opportunities for improvement. Non-conformances, deficiencies, and adverse conditions must be promptly identified to prevent impact on plant operations, personnel, nuclear safety, the environment, or equipment and component reliability. These processes ensure that problems are corrected or dispositioned with a level of rigour commensurate with their risk significance. For those problems deemed to be of higher significance or systemic in nature, these processes ensure appropriate levels of management are notified, causes identified, actions taken to minimize or prevent recurrence, action completion and effectiveness verified, and lessons learned communicated.

N-PROC-RA-0022, *Processing Station Condition Records*, provides instruction on how adverse conditions are reported and outlines the process for effective evaluation, resolution, and trending of the adverse conditions. Each Station Condition Record (SCR) is reviewed and dispositioned by an SCR co-ordinator before going through two levels of review, a screening committee, and a management review committee to ensure the disposition was accurate and complete. Most of the SCRs generated are determined to be not significant on their own and are dispositioned for trending (Category D), closed out to another SCR (Category CO) or determined to be non-events (entered in error, a duplicate or does not represent an adverse condition at Darlington NGS). The remainder of the SCRs require an evaluation of known facts or an investigation to determine the cause and related corrective action(s) that will reduce the frequency of recurrence of the adverse condition(s). Refer to Figure 12 for distribution of SCR categories. This distribution of the SCR population is closely aligned with industry best practices based on benchmarking with nuclear utilities.

Additionally, N-PROC-RA-0035, *Operating Experience Process*, is in place for conducting OPEX evaluations for applicable SCRs. The procedure establishes OPG Nuclear processes for evaluating, integrating, accessing, and sharing OPEX information. External OPEX received from nuclear industry sources is used to prevent similar events at OPG Nuclear and initiate the required actions, incorporate OPEX lessons learned into training, and keep staff informed of relevant industry information. Internal OPEX is used to communicate internal events to non-incident OPG Nuclear sites and to applicable external organizations. Refer to Section 2.1.4 for further details on the OPEX process.

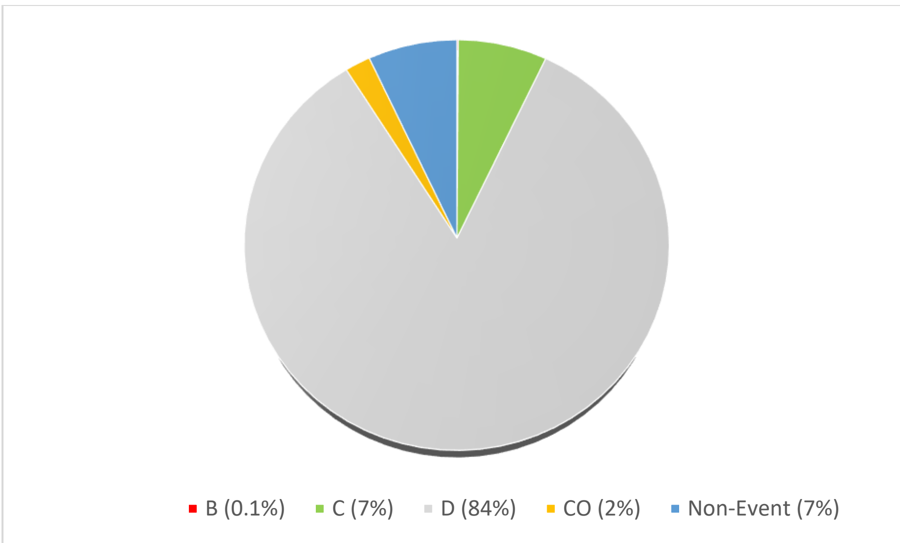


Figure 12: Distribution of SCR Categories (Avg)

Root cause and apparent cause investigations are conducted for higher significance events to improve plant reliability and human performance at Darlington NGS. Reporting and trending analysis is conducted to identify trends in performance at a lower level before they become a more significant issue. The trending includes aspects from cognitive analysis, data analysis and industry experience. Reporting is done quarterly through SCR trending and PI reports. Identified adverse trends are addressed by initiating an SCR and corrected as required through the corrective action program.

The following improvements have been made in the areas of reporting and trending through leveraging technological advancements and collaborative approaches in communication strategy:

- Integration of Smart Performance Objective & Criteria Artificial Intelligence (SPOCAI) auto-coding and advanced trend analysis marks a pivotal shift towards data-driven decision-making processes.

- The inception of the Weekly Proactive Trend Meeting encompasses cross-functional team discussions and underscores the imperative of fostering a communicative environment.
- The Validation of Trend process acts as a safeguard, proactively scrutinizing and challenging the potential impact of identified trends to prevent the development of consequential organizational issues.
- The implementation of a trend watch list and the utilization of trend performance indicators enhance the team's ability to meticulously observe, assess, and predict evolving patterns, ensuring that strategic actions are rooted in robust analytical foundations.
- Evolution in trend management, through centralizing trend reports within process improvement and integrating World Association of Nuclear Operators (WANO) Performance Objectives & Criteria (PO&C) codes through SPOCAI, negates personal biases and delivers a consistent coding database for the entire fleet. This improves the effectiveness of navigating through quantified data, identifying emerging trends, and taking the appropriate actions in alignment with organization strategies and objectives.

Regulatory Reporting

OPG Darlington NGS reports "Operating Performance" to CNSC in accordance with Darlington NGS Licence Conditions Handbook, Licence Condition 3.3 "Reporting Requirements", and REGDOC 3.1.1, *Reporting Requirements for Nuclear Power Plants*, which include both scheduled and unscheduled reports. Darlington NGS meets the requirements of REGDOC 3.1.1 by adhering to the following governance, which are part of the management system per CSA N286-12, *Management System Requirements for Nuclear Facilities*:

- N-PROC-RA-0020, *Preliminary Event Notification*, identifies the process by which preliminary notification requirements to facility and off-site organizations, management, and external officials and agencies are made after an event has occurred.
- N-PROC-RA-0022, *Processing Station Condition Records* provides instruction on how adverse conditions are documented. It further outlines the use of reporting, documentation, evaluation and oversight process for the effective resolution and trending of adverse conditions at OPG. This procedure meets management system requirements that are directed by N-PROG-RA-0003, *Performance Improvement*. Adverse conditions typically have some level of risk-significance associated with them taking into consideration any actual or potential impacts on operability or whether it is reportable.
- N-PROC-RA-0005, *Written Reporting to Regulatory Agencies*, defines roles, accountabilities, and processes for complying with regulatory requirements for Written Event Reports to regulatory agencies and for scheduled reports to CNSC.

Throughout the current licence term, Darlington NGS has submitted all routine scheduled reports in accordance with REGDOC-3.1.1. OPG submits various scheduled reports as defined in REGDOC 3.1.1, which permit both CNSC and OPG to proactively determine if decreases in performance are occurring. Darlington NGS has submitted unscheduled reports in accordance with REGDOC-3.1.1. There have been no significant events that affected the conduct of licensed activities at Darlington NGS.

2.3.4 Outage Management Performance

The objective of the outage management program is to ensure that inspections, testing, maintenance, and modifications activities are correctly identified and safely completed while the reactor is in the shutdown state. The Outage Management processes for preparation and execution of planned and forced nuclear unit outages within OPG Nuclear receive authority from N-PROG-MA-0019, *Production Work Management*. Governance associated with planned outages is in accordance with N-PROC-MA-0013, *Planned Outage Management*. Governance associated with forced outages is in accordance with N-PROC-MA-0049, *Forced Outage Management*. Governance associated with TRF outages is in accordance with D-INS-39000-10003, *Tritium Removal Facility Planned Outage Management*. These procedures include a standard set of milestones that provides the methodical approach for guiding an outage through its life cycle. The milestones provide direction to plan, execute, monitor, and control outage activities to bring about the successful completion of outage goals and objectives while maintaining safety as the overriding priority. During the current licence term, Darlington NGS outages have been managed in a safe and effective manner.

Planned outages are performed at Darlington NGS to perform inspections and undertake preventative and corrective maintenance of station components and equipment that require a unit shutdown state. Outage plans are focused on nuclear, radiological, and conventional safety and follow a detailed schedule. Outage preparation and execution involve organizations across the station and close coordination amongst work groups. Per REGDOC-3.1.1 requirements, Darlington NGS follows a process for submitting outage plans and schedules to the CNSC to ensure details of regulatory undertakings and commitments are clearly defined and communicated. The outage management program includes provisions to ensure that following the restart of the reactor, an outage completion assurance is submitted to the CNSC to confirm that all regulatory undertakings and major work on safety related systems have been completed successfully.

The primary objective of forced outage management is to correct the unit issue which caused the unit to shutdown, and safely return the unit to service. In addition, the forced outage provides a potential opportunity to complete other critical outage related work within the regulated market rules. Darlington NGS maintains ready to execute forced outage plans to be completed in the event a forced outage occurs. Regularly scheduled meetings between the Outage Department and all stakeholders are held to ensure that the correct work is identified on the forced outage plan should a unit be forced to shut down. Work identification for forced outage includes mandatory scope to be completed such as routine items required for readiness for service criteria, routine start-up and shutdown inspections/testing and regulatory commitments.

The Darlington for the Future (D4F) initiative includes actions that would allow OPG to achieve and sustain industry leading top quartile generation performance over the station’s 30-year post-refurbishment operations window. One focus area initiative is planned outage duration with the objective to reduce planned outage durations by optimizing schedule, leveraging innovation, technology, and improved resource strategies. The result will be more efficient outage performance, maximized reliability, fitness for service and operational stability. The D4F initiative will be guided by the current procedures and will use the same rigorous outage planning process to ensure the right work is selected, equipment reliability is maintained, and safety is the overriding priority. This initiative is led by a dedicated team that has started detailed planning to ensure these advanced strategies are developed and ready to implement in outages following refurbishment.

2.3.5 Safe Operating Envelope

The Safe Operating Envelope (SOE) at Darlington NGS is defined, implemented, and maintained per N-STD-MP-0016, *Safe Operating Envelope*, which is compliant with the requirements of CSA Standard N290.15 2010, *Requirements for the Safe Operating Envelope for Nuclear Power Plants*. The standard defines the processes, organizational responsibilities, and key program elements to ensure the SOE is defined and documented in a manner which is consistent with the station operating documentation. Furthermore, the standard for SOE is critical to the implementation of N-PROG-MP-0014, *Reactor Safety Program*. The objective of the SOE is to define the set of limits and conditions within which the plant shall be operated to ensure conformance with the Safety Analysis upon which reactor operation is licensed. This set of limits and conditions are monitored and controlled by operators, as applicable per operating requirements. Limits and conditions that are part of the SOE include safety limits, safe operating limits, conditions of operability, actions and action times, and surveillances.

Station systems included within the SOE have, where applicable, corresponding Operational Safety Requirements (OSRs), Instrument Uncertainty Calculations (IUCs), and Compliance Tables (CTs). The preparation methodologies for OSRs and IUCs are described in the applicable OPG standards, and the limits and conditions contained in OSRs and IUCs, along with any system surveillance requirements, are incorporated into station operating documentation. SOE CTs list all SOE parameters for a specific system, and connect all Safe Operating Limits, Conditions of Operability and Surveillance Requirements to applicable station operating documentation.

As SOE documents are considered living documents, they are revised and updated as required to reflect new safety analyses and modifications. OPG's Engineering Change Control program has controls in place to ensure the need to revise SOE documentation is appropriately flagged as well as ensure these revisions are conducted and implemented correctly.

The SOE program at Darlington NGS has undergone continuous improvements driven by internal and external inspections and audits. As a continuous improvement opportunity, the Darlington NGS SOE Improvement Project was initiated to iteratively improve SOE documentation over time. As part of this initiative, OPG self-identified an opportunity to provide further clarity to the technical basis of some existing safety limits and availability requirements in the OSRs.

A Nuclear Oversight audit of the Reactor Safety program across OPG's nuclear facilities was conducted in May and June 2023, and included an assessment of the implementation and maintenance of the SOE. The Reactor Safety program was found to be effective as a whole. When benchmarked with reference to WANO PO&C, OPG met these requirements along with the requirements of CSA Standard N290.15. Furthermore, the results found that the program goals, standards, and expectations exhibit industry standards of excellence.

2.3.6 Accident and Severe Accident Management and Recovery

OPG maintains an Accident Management program for Darlington NGS, which meets the requirements of CNSC regulatory document REGDOC-2.3.2, *Accident Management: Severe Accident Management Programs for Nuclear Reactors* in conjunction with the elements of safety analysis described in Section 2.4.

For Anticipated Operational Occurrences and Design Basis Accidents for Darlington NGS, OPG maintains Abnormal Incident Manuals (AIMs). AIMs consist of the procedures for responding to events which have an immediate effect on a reactor unit, requiring the response of several major systems, and involving failure or impairment of one or more of the following:

- Reactor power control;
- Fuel cooling;
- Breach of one or more barriers to containment of radioactivity.

These are event-based procedures, based on the design-basis accident set.

An EOP is required for all single failure process upsets which directly and adversely affect reactor power control, and/or fuel cooling functions which are not satisfactorily terminated by automatic action of the process or mitigating systems. The Darlington NGS EOPs are included in the AIMs.

For Beyond Design Basis Accidents (BDBAs) at Darlington NGS, OPG maintains Emergency Mitigating Equipment Guidelines and Severe Accident Management Guidelines (SAMGs). OPG's BDBA management program is implemented through N-STD-MP-0019, *Beyond Design Basis Accident Management*. Severe Accident (SA) management provides an additional layer of defence in depth to mitigate the consequences of accidents that fall beyond the scope of events considered in the plant design basis. Instead of the rule-based approach, SAMG uses a symptom-based/knowledge-based approach that includes steps for plant status diagnosis and equipment evaluation, making it well suited for responding to events involving failures affecting multiple components, systems, or lines of defense. The transition of the different strategies to prevent an event from progressing are shown below in Figure 13.

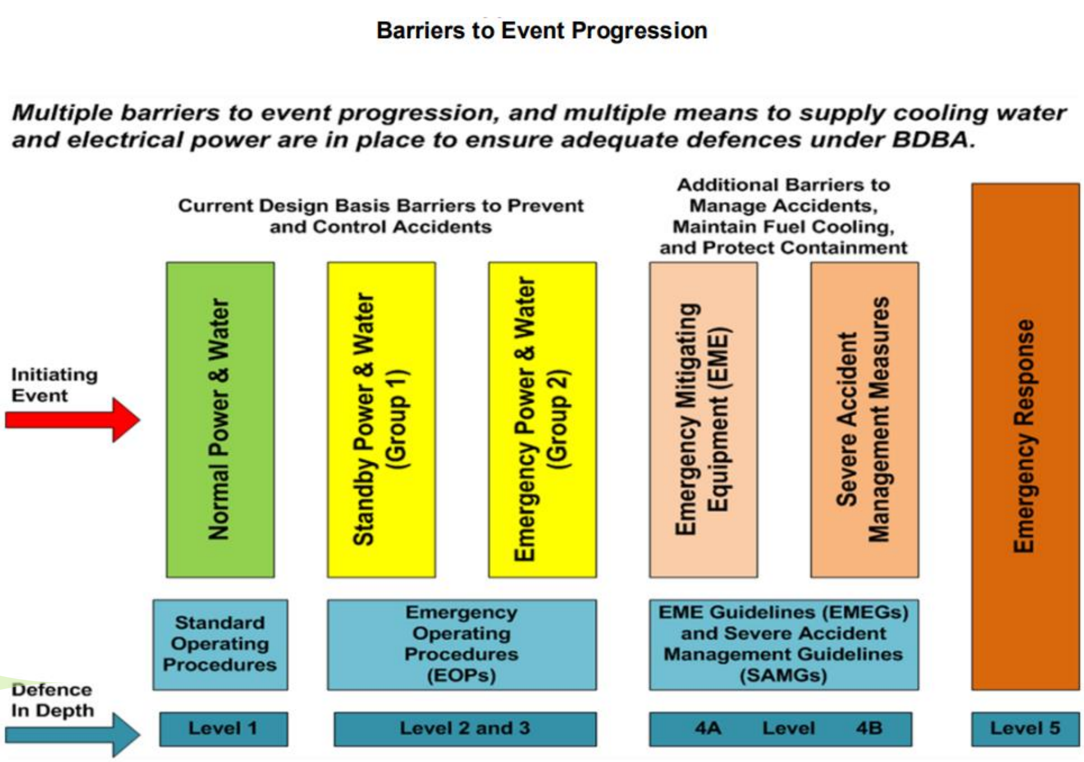


Figure 13: Barriers to Event Progression

In response to a plant transient, control room staff are expected to diagnose the initiating event and to select the appropriate event-specific response procedure. It is critical to achieve acceptable fuel cooling in accident scenarios, through correctly diagnosing the initiating event, correctly implementing the response procedure(s), and ensuring functionality of mitigating equipment. In parallel with this event-based response, independent control room staff employ a symptom-based approach to assess the effectiveness of the procedure and its implementation by monitoring Critical Safety Parameters (CSP). In case any of the above-mentioned criteria for achieving acceptable fuel cooling are not met, one or more of these CSPs may exceed its specified setpoint, in which case control room staff will take specified actions to restore the CSP value(s) within an acceptable range. These CSPs, their setpoints, and the related restoration procedures are specified in the AIMs.

For SA response and recovery, there are several key positions, roles and responsibilities established to support SAMG implementation at Darlington NGS, such as the Site Management Centre decision making authority (i.e. Emergency Response Manager/Authorized Duty Manager), the SAMG Technical Support Group, the Shift Manager, and the operations crew. Critical actions in the SAMG are listed below, and each action has different steps of responsibility (i.e. evaluate, recommend, authorize, implement), with specific personnel assigned to each step.

- Transition from EOPs to SAMG;
- Implement SA mitigation actions;
- SA recovery strategies;
- End SAMG use and initiate long term recovery.

Details on the roles and responsibilities of OPG staff during a nuclear emergency, including communication strategies and interface with the public and with regulatory or other agencies can be found in N-PROG-RA-0001, *Consolidated Nuclear Emergency Plan*.

As per the requirements of the Reactor Safety program, OPG regularly performs self-assessments of the SAMG and BDBA management framework. The scope of these self-assessments is to review relevant engineering changes and confirm their implementation in the BDBA framework documents, address pending corrective actions, and verify completion of the actions initiated as a part of the previous self-assessments and/or audits.

Section 2.4

Safety Analysis

2.4 Safety Analysis

Darlington NGS has an effective Safety Analysis program which meets or exceeds all applicable regulatory requirements and related objectives. The program ensures the maintenance of the safety analysis that supports the overall safety case for the facility. It also ensures there is demonstrated acceptability of the frequency and consequences of design-basis and beyond design basis events, with the ability of protective systems and emergency mitigating equipment to adequately control power, cool the fuel and contain or limit any radioactivity that could be released from the plant.

The safety analysis is governed by N-PROG-MP-0014, *Reactor Safety Program*, which establishes organizational responsibilities and key program elements for the management of issues related to Nuclear Safety Analysis (NSA) and the following major aspects of safe operation:

- Safety Analysis Basis and Safety Report Updates;
- Safe Operating Envelope (SOE);
- Beyond Design Basis Accident (BDBA) Management.

In addition, the Reactor Safety program governs generic Canada Deuterium Uranium (CANDU) Safety Issues (CSIs) management, the Discovery Issue Resolution Process, the Technical Operability Evaluation process, and Operational Safety Requirements (OSRs) and Instrument Uncertainty Calculations (IUCs) preparation and revision processes.

The Safety Analysis Basis includes the NSA and assessments performed to demonstrate regulatory and design requirements are met and to determine safe operating limits. Safety Analysis consists of three primary parts as discussed in the below subsections:

- Deterministic Safety Analyses (refer to Section 2.4.1);
- Hazard Analyses (refer to Section 2.4.2);
- Probabilistic Safety Assessments (PSA) (refer to Section 2.4.3).

The BDBA and Severe Accident (SA) management program is discussed in Section 2.4.4, along with the safety analysis performed for these areas.

The existing safety analysis at the Darlington NGS is a comprehensive and systematic evaluation of the hazards that can potentially result from operation of the plant and considers the effectiveness of preventive and mitigative measures and strategies in reducing the effects of the hazards. The existing safety analysis supports the overall safety case for Darlington NGS. Improvements to the safety case are continuously made including through CANDU Owners Group (COG) programs, and implementation of CNSC regulatory documents REGDOC-2.4.1, *Deterministic Safety Analysis* (refer to Section 2.4.1) and REGDOC-2.4.2, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants*.

The OPG documents in the table below require written notification of change per Darlington NGS Licence Conditions Handbook, LCH-PR-13.03/2025-R005:

Table 5: SCA 4 – Safety Analysis

Document	Title
NK38-SR-03500-10001	Darlington NGS Safety Report: Part 2 – System Descriptions
NK38-SR-03500-10002	DN 1-4 Safety Report: Part 3 – Accident Analysis
NK38-REP-00531.7-10001	Darlington Analysis of Record
N-STD-MP-0019	Beyond Design Basis Accident Management
N-PROG-MP-0014	Reactor Safety Program
N-PROC-MP-0086	Safety Analysis Basis and Safety Report
N-PROG-RA-0016	Risk and Reliability Program
N-STD-RA-0034	Preparation, Maintenance and Application of Probabilistic Safety Assessment
N-PROG-MP-0006	Software
NK38-REP-09701-10344	RWPB Safety Analysis Summary Report
NK38-REP-09701-10326	Darlington Retube Waste Processing Building – Safety Assessment
NK38-CORR-09701-0597849	RWPB Worker Dose During Normal Operation and Under Accident Conditions

2.4.1 Deterministic Safety Analysis

The primary objectives of performing Deterministic Safety Analysis (DSA) are to confirm that the design of the Nuclear Power Plant (NPP) meets design and safety requirements, and to derive or confirm operational limits and conditions that are consistent with the design and safety requirements. Furthermore, DSA must confirm that the structures, systems, and components, in combination with plant procedures and operator actions, are effective in fulfilling their safety functions and keeping the releases of radioactive material from the plant below acceptable limits. DSA is a systematic process of calculating the public dose consequences for specific Postulated Initiating Events (PIEs) (refer to Section 2.4.1.2) and upset conditions at the plant.

DSA is used to determine the limits that define the SOE of the plant, which is the boundaries in which the plant must be operated. SOE is defined in CSA N290.15 2010, *Requirements for the safe operating envelope for nuclear power plants*, as "the set of limits and conditions within which the nuclear generating station must be operated to ensure compliance with the safety analysis upon which reactor operation is licensed and which can be monitored by or on behalf of the operator and can be controlled by the operator." The SOE is defined by the safety analysis and the credited systems and equipment in the analysis. The SOE is implemented through the OSRs, IUCs, and other safety related limits and system credits that ensure operation within the safety analysis basis. Refer to Section 2.3.5 for further details on the SOE.

N-PROG-MP-0014, *Reactor Safety Program*, and its subsidiary governing documents define the organizational responsibilities and key program elements for the planning, execution, and management of DSA. N-PROC-MP-0086, *Safety Analysis Basis and Safety Report Updates*, governs the updating of Safety Reports and describes documentation of safety analysis. NK38-SR-03500-10001, *Darlington Safety Report Part 1 and 2*, provides a general description of the plant and site in sufficient detail for understanding the interaction of plant systems to facilitate DSA. The results of the DSA are documented in NK38-SR-03500-10002, *Darlington Nuclear 1-*

4 Safety Report: Part 3 – Accident Analysis and NK38-REP-00531.7-10001, *Darlington Analysis of Record*. The documented DSA demonstrates compliance with licensing limits and derived acceptance criteria, identifies limits on process parameters and safety system requirements, and thereby establishes the SOE for the station to satisfy OPG's N-POL-0001, *Nuclear Safety and Security Policy*, requirement to control reactor power, cool the fuel, and contain radioactivity (3 C's).

The performing and documenting of DSA is governed by REGDOC-2.4.1, *Deterministic Safety Analysis*, which was issued in 2014. As DSA that had been performed up to that point was not fully compliant with the new REGDOC, OPG developed the REGDOC-2.4.1 Implementation Plan in 2014 (Reference 2.4-1) for the OPG nuclear fleet which outlined the framework for performing new DSA and identified the scope of the new analysis. Execution of the work defined in this plan is progressing and OPG continues to report on the safety analysis upgrades to meet REGDOG-2.4.1 requirements on an annual basis to the CNSC. The latest update on the status of REGDOC-2.4.1 implementation was issued in 2023.

As required by REGDOC-2.4.1, DSA takes into account the appropriate level of conservatism for the class of event analyzed, the acceptance criteria and trip coverage for each event analyzed, and demonstrates applicable dose limits are met for the events. Any significant gaps between the requirements and analysis results will be evaluated and addressed using a graded approach as allowed for by REGDOC-2.4.1.

OPG maintains DSA current with ongoing analyses and assessments. In addition, DSA is also performed as required for operational support. Primary Heat Transport (PHT) system Aging Management (refer to Section 2.4.1.1 below) and REGDOC-2.4.1 implementation/compliance are two of the major programs contributing to maintaining DSA. Since these programs were created, several safety analysis submissions demonstrating sufficient margin for the plant have been made. Updating the current analysis in the Safety Report to be compliant with REGDOC-2.4.1 is progressing according to the REGDOC-2.4.1 implementation plan. The CNSC monitors these programs regularly and reports the findings in annual Regulatory Oversight Reports.

Per the Reactor Safety program, safety analysis undergoes an ongoing process of review and improvement including self-assessments, corrective actions, and independent assessments. Additionally, the scope of REGDOC-2.4.1 implementation will be updated depending on the significance of new technical insights. For example, the current version of the REGDOC-2.4.1 implementation plan includes analysis of a broader scope of small break loss of coolant accident events beyond the initially identified scope, as well as increased scope of Darlington loss of moderator heat sink events to support increased moderator and PHT system tritium concentration limits.

2.4.1.1 Primary Heat Transport System Aging Management Strategy

OPG's PHT system aging management activities were initiated in 2000 to evaluate the impact of component aging on safety margins. OPG developed an overall Heat Transport System Aging Management Strategy (HTS-AMS) in 2010 to manage all issues related to aging. HTS-AMS also interfaces with the broader N-PROG-MP-0008, *Integrated Aging Management*, in program execution.

The objective was to provide an integrated assessment on the cumulative effects of the identified aging mechanisms, and to develop effective safety margin management strategies based on the results of these assessments. The identification of known PHT system aging mechanisms and effects was completed as part of the Technical Basis Document for PHT system safety margin management. This document was submitted to the CNSC in 2009 (Reference 2.4-2). Key parameters and safety phenomena for all important systems and sub-systems with direct interfaces with the PHT system main circuit have been identified and based on these, the critical accident scenarios from the perspective of PHT system aging impacts were determined.

OPG reports to the CNSC on the status of HTS-AMS and that strategy was updated for 2021 to 2025 and submitted to the CNSC in March 2021. OPG also reports to the CNSC on the progress of safety analysis related to PHT system aging, and the latest progress report was submitted in 2023.

The Refurbishment of all four Darlington NGS reactor units is in progress, and completion will significantly improve issues associated with margin erosion due to aging. However, OPG's programs for monitoring the aging processes and implementing strategies to maintain safety margins will continue.

2.4.1.2 Postulated Initiating Events

Formal identification of PIE is a requirement specified in REGDOC-2.4.1 for performing DSA. These events could lead to a situation which can potentially challenge the safety functions of the nuclear facility and pose radiological hazards to plant, personnel, and public. These PIEs are identified through a systematic process which takes into account a number of factors, including but not limited to, failure modes and effects analysis, regulatory requirements, past licensing experience, engineering judgement, operating experience, design of the plant, and previous DSAs and PSAs.

The identified PIEs include common hazards that can cause upset conditions in one or more units, leading to potentially unsafe conditions in more than one unit simultaneously. For example, common cause events or steam line breaks are part of the licensing basis and are documented in the Darlington NGS Safety Report.

In compliance with REGDOC-2.4.1, all new safety analysis will have PIEs identified through a systematic process and classified into accident categories of Anticipated Operational Occurrences (AOOs), Design Basis Accidents (DBAs) and BDBAs. The delineation between various accident categories is based on initiating event frequencies. The requirements and guidance for analysis of different accident categories are per REGDOC-2.4.1 and COG Guideline for DSA.

The current Darlington Safety Report Part 3, Section 2 contains a listing of PIEs for all DBAs in the Safety Report. These are categorized into Event Class 1 through 5, which was the classification method under which Darlington NGS was originally licensed, specifically to CNSC Consultative Document C-6 Rev 0, *Requirements for the Safety Analysis of CANDU Nuclear Power Plants*. All the current and future safety analyses will be performed to satisfy the REGDOC-2.4.1 requirements, and as such, the events will be classified as AOOs, DBAs or BDBAs, while continuing to comply with the radiological dose limits established under C-6 Rev 0 in accordance with the LCH. Refer to Section 2.5.3.1 for further details on how the design of the station ensures that the PIEs from the safety analyses are taken into account to meet all safety design requirements.

2.4.2 Hazard Analysis

Hazard Analysis for Darlington NGS is performed in compliance with REGDOC-2.4.2, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants*. Hazard Analysis has two main components; the initial Hazard Screening Analysis and the subsequent PSAs of the required hazards. The Hazard Screening Analysis first involves the identification of a list of the internal and external hazards which could affect the safety of the reactor or the non-reactor sources of radiation (i.e. Irradiated Fuel Bays (IFBs) and used fuel dry storage containers). The list is subsequently screened using both qualitative and quantitative methods to identify the hazards for which PSA must be conducted.

The Hazard Screening Analysis for Darlington NGS is updated every 5-years in compliance with the requirements of REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants*. The Hazard Screening Analysis is completed using the OPG PSA Guides for External and Internal Hazards. The OPG PSA guides were sent to the CNSC for review, and the CNSC has accepted the methodology documented in the guides.

NK38-REP-03611-10043, *Hazards Screening Analysis – Darlington*, was last updated in 2019 as part of the 5-year update cycle for the Darlington NGS PSAs. The report documents the hazard identification and screening of both internal and external hazards which are applicable to Darlington NGS. The scope of this screening analysis addresses hazards on both the reactors and the non-reactor sources. The hazard screening analysis was conducted as per OPG's PSA Guides and was compliant with REGDOC-2.4.2.

External hazards are hazards which originate outside of the site boundary or are outside of OPG's direct control. The external hazards are divided into two major categories: human induced external hazards (e.g. hazards such as airplane crashes and railway accidents) and natural external hazards (e.g. hazards such as earthquakes and severe weather). Internal hazards are those which originate within the site boundary and consist of hazards such as onsite transportation accidents and turbine missiles. Hazards which affect multiple reactor units such as earthquakes or high winds were also considered within the scope of the 2019 analysis.

Once a list of the hazards has been generated, the next step is to perform a screening assessment on the hazards. The goal of this step is to simplify the PSA by identifying hazards and combinations of external hazards which do not need to be assessed (i.e. screening them out of the PSA). First, hazards and combinations of external hazards are screened using qualitative criteria. That is, a hazard or a combination of external hazards may be screened out if it meets one of the following criteria listed in Table 6. If a hazard or combination of external hazards cannot be screened out using the qualitative screening criteria, they are then screened quantitively. If a hazard or a combination of external hazards satisfies at least one of the quantitative criteria listed in Table 7, then it may be screened out of the PSA.

Table 6: Qualitative Hazard Screening Criteria

Criterion	Description	Applicable to Reactor and/or Non-Reactor Sources
QL-1	The event is of equal or lesser damage potential than similar events for which the plant has been designed.	QL-1 through QL-5 apply to both the reactor and the non-reactor sources
QL-2	The event has a significantly lower likelihood than another event that has been screened out, and yet the event could not result in worse consequences than the other event.	
QL-3	The event cannot occur at the site or close enough to the site to affect the plant.	
QL-4	The event is included in the definition of another event.	
QL-5	The event is slow in developing such that it can be demonstrated that there is sufficient time to eliminate the source of the threat or provide an adequate response.	
QL-6	The event does not cause an initiating event (including the need for a controlled shutdown) as well as safety system function losses needed for the event.	QL-6 and QL-7 apply only to reactor sources and not to the non-reactor sources.
QL-7	The consequences to the plant do not require the actuation of front-line systems.	

Table 7: Quantitative Hazard Screening Criteria

Criterion	Description	Applicable to Reactor and/or Non-Reactor Sources
QN-1	Severe Core Damage Frequency $< 10^{-6}$ / yr	QN-1 through QN-4 apply only to the reactor sources and not to the non-reactor sources
QN-2	Design Basis Hazard Frequency $< 10^{-5}$ / yr and Conditional Core Damage Probability (CCDP) < 0.1	
QN-3	Severe Core Damage Frequency $< 10^{-7}$ / yr	
QN-4	Design Basis Hazard Frequency $< 10^{-6}$ / yr and CCDP < 0.1	
QN-5	Initiating Event or Hazard Frequency may be screened out if it can be shown that their frequency is $< 10^{-7}$ / yr	QN-5 applies to both the reactor and the non-reactor sources

At the conclusion of the 2019 Hazard Screening Analysis, the required downstream assessments were identified, after systematically screening out most of the internal and external hazards based on the established methodology in the associated PSA Guides. Specifically, Hazard PSAs were subsequently performed (e.g., seismic events, internal fires, high winds, and internal floods) in conjunction with activities under Section 2.4.3. Similarly, certain meteorological hazards such as extreme temperatures and ice-storms were not further addressed as their impacts were already considered in the baseline PSA models to cater to events such as loss of switchyard and loss of bulk electricity supply.

As part of the 2019 Darlington NGS Hazard Screening Analysis, combinations of external hazards were also assessed. This analysis included combinations of human induced hazards with other human induced hazards, human induced hazards with natural hazards, and natural hazards with other natural hazards. Applying qualitative and quantitative methods, the majority of these hazard combinations were screened out from further assessments, and those hazard combinations which remain are addressed in the external events PSAs (refer to Section 2.4.3) or in supporting analysis (such as hydrological assessments) separately submitted to the CNSC.

OPG has updated five PSA Guides for External and Internal Hazards. The guides were revised to ensure that the hazard screening analysis performed for OPG nuclear stations is aligned with industry best practices. OPG recently submitted the Hazard Screening guides to the CNSC for review and CNSC have concluded that the revised PSA Guides meet REGDOC- 2.4.2 requirements and are acceptable.

OPG is planning on performing an update to the Darlington NGS Hazard Screening Analysis set to be completed in 2024. This update will be compliant with REGDOC-2.4.2 Version 2 (2022), *Probabilistic Safety Assessment (PSA) for Reactor Facilities*, and will be conducted according to the revised OPG PSA guides.

OPG is aware that natural external hazards, e.g., severe weather, may become more significant during the operating life of Darlington NGS due to climate change. OPG revisits the Hazard Screening Assessment as the initial step for its periodic PSA update as per regulatory requirements. This is sufficient to capture the incremental effects of climate change as an input to the PSA updates.

2.4.3 Probabilistic Safety Analysis

The purpose of a PSA is to establish whether the design and operation of the plant poses an acceptable level of risk to the public and to identify the primary sources of risk. PSA is a systematic process of radiological hazard identification and risk estimation using quantitative methods. The Darlington NGS PSA identifies the various event sequences that may lead to radioactive releases, assigns them to different categories of consequences, and calculates their frequencies of occurrence. The level 1 PSA estimates the frequency of accidents which may cause severe damage to the reactor core, and this is referred to as the Severe Core Damage Frequency (SCDF). The level 2 PSA estimates the frequency of accidents which may result in a release of radionuclides outside of the boundary of the station, and this is referred to as the Large Release Frequency (LRF).

The entire suite of PSAs for Darlington NGS, performed in compliance with REGDOC-2.4.2, includes:

- Level 1 Internal Events At-Power PSA;
- Level 2 Internal Events At-Power PSA;
- Outage Internal Events PSA;
- Internal Fire PSA;
- Internal Flood PSA;
- High Wind PSA;

- Seismic PSA;
- Non-Reactor Sources PSA.

These PSAs are updated every 5-years to ensure that the PSA models accurately reflect the current design and operation of the station. This regular PSA update is performed to comply with the requirements of REGDOC-3.1.1. OPG has established Safety Goals for the LRF and SCDF which the station PSAs are required to meet, and these Safety Goals are governed by N-PROG-RA-0016, *Risk and Reliability Program*. The PSAs are completed by following the OPG PSA Guides and N-STD-RA-0034, *Preparation, Maintenance and Application of Probabilistic Safety Assessment*. As part of the compliance with REGDOC-2.4.2, the OPG PSA guides were sent to the CNSC for review, and the CNSC has accepted the methodology documented in the guides.

In 2020, OPG performed an update of the Darlington PSAs (NK38-REP-03611-10072, *Darlington NGS Probabilistic Safety Assessment Report*). The purpose of this update was to meet the regulatory obligation to ensure the PSA models reflect the current design of the plant for the 5-year cycle required by REGDOC-3.1.1. For each PSA performed, the OPG Safety Goals were achieved for SCDF and LRF. This demonstrates that the current design and operation of Darlington NGS poses an acceptable level of risk to the public. The updated PSA models are now being used to support the day-to-day operation of Darlington NGS through their use in the software, Phoenix Risk Monitor. All software used by OPG for the PSAs are governed by N-PROG-MP-0006, *Software* which is compliant with CSA N286-12, *Management System Requirements for Nuclear Facilities* and CSA N286.7 1999 (R2012), *Quality Assurance of Analytical, Scientific, and Design Computer Programs for Nuclear Power Plants*.

OPG performs importance analysis as a part of the periodic PSA updates to identify the components and equipment of high importance. PSAs are also used to identify any Single Point Vulnerabilities (SPVs) and eliminate these SPVs with appropriate modifications or procedural changes. This process of identifying and eliminating the vulnerabilities feeds back into the PSA models to reduce the risk by lowering the probabilities of event sequences that could lead to SAs. An example of this is the implementation of the Containment Filtered Venting System to mitigate releases to the environment by providing additional capability to cope with multiple reactor units experiencing SAs and challenging the containment systems.

OPG also credits human action as described in the emergency procedures (i.e. Abnormal Incident Manuals, Emergency Mitigating Equipment Guidelines (EMEGs), and Severe Accident Management Guidelines (SAMGs) to verify the adequacy of the emergency procedures during a SA. Also, OPG performs periodic SA drills and exercises as per N-PROC-RA-0045, *OPG Nuclear Emergency Response Organization Drills and Exercises*, to evaluate the adequacy of the emergency procedures.

The PSA process also interfaces with the SA management program (i.e. procedures and modifications). This linkage facilitates the verification of the adequacy of the SA management program, by utilizing the specific PSA models to identify areas for improvement in the SA mitigating measures.

OPG is performing an update to the Darlington NGS PSAs scheduled for completion in December 2025. This update will be compliant with REGDOC-2.4.2 Version 2 and will be conducted according to the revised OPG PSA guides. PSA model refinements that have been identified since 2020 will be incorporated into the 2025 update with the goal of continually improving the PSA results for Darlington NGS.

OPG acknowledges the importance of continuous enhancement in our PSA practices and methodologies. Upon completion of the Darlington NGS PSAs by the end of 2025, OPG expects the SCDF and LRF results for individual hazards to provide additional insights and inform future opportunities for improvement, including the consideration of physical changes, improvement in operating procedures, and analysis refinement.

2.4.4 Severe Accident Analysis

A BDBA is a classification of an accident with a low frequency of occurrence (less than 10 e-5 occurrences per year) and is therefore not part of the design basis of the station. A SA is a subset of a BDBA, which has potential to release a large amount of radioactive material. Severe Accident Analysis (SAA) is the means by which OPG assesses and manages SAs, to ensure that the risk from the operation of nuclear reactors remains low. The ability to control, cool and contain are challenged in a SA, and event progression may occur in an unpredictable manner, unlike in design basis conditions. As such, the approach to decision-making and prioritization must be different from that applied to normal operation and response to AOOs and design basis events. The response to a SA applies a symptom based/knowledge-based approach that includes steps for plant status diagnosis and equipment evaluation, making it well suited for responding to events involving failures affecting multiple components, systems, or lines of defense.

OPG performs SAA as a part of its periodic PSA updates as per the requirements of REGDOC-3.1.1. OPG last performed SAA as a part of the Level 2 Internal Events PSA update for Darlington NGS in 2020 also known as 2020 DARA-L2P, which was submitted to the CNSC. The Darlington NGS 2020 PSA updates (including DARA-L2P and SAA) were performed in conformance with the requirements of REGDOC-2.4.2.

SAA has been conducted to support the Darlington NGS Level 2 PSA, as part of REGDOC-2.4.2 compliance, and in response to the Fukushima Action Items. Extensive analysis has been carried out to identify BDBAs with the potential to transition to SAs. Included in this work are habitability studies to evaluate the impact of such events on the ability of station personnel to carry out actions as part of the emergency response.

SAA is an integral part of the comprehensive Level 2 PSA methodology. SAA follows a systematic approach which starts with defining the Plant Damage States (PDS) using the Level 1 PSA Fuel Damage Category 2 cutsets that could lead to core damage end states. The plant damage states are defined as follows:

- PDS1 – Events sequences that result in core damage originating from failure to shutdown the reactor;
- PDS2 – Single unit event sequences that could lead to severe core damage;
- PDS3 – Multi-unit event sequences that could lead to severe core damage;
- PDS4 – Event sequences with existing containment impairment known as Containment Bypass events;
- PDS5 and 6 – Limited Core Damage events.

Accident sequences, once binned into the representative PDS, are then analyzed using MAAP-CANDU SAA program. MAAP-CANDU is the Canadian Industry Standard Toolset (IST) for PSA SAA. The current version of the MAAP code used by OPG is MAAP5-CANDU 5.00a which is the most recent code release version.

Credits of relevant realistic system and human actions, along with various BDBA and SAMG strategies and modifications, are also modeled using a best-estimate approach in the SAA simulations using MAAP-CANDU. Each accident sequence analyzed in the SAA is categorized into individual Release Category (RC) bins ranging from RC1 to RC6 based on the Cs-137 and I-131 release source terms. The release categories are defined in the OPG Level 2 PSA Guide as follows:

- RC1 - Early large release with potential for acute offsite radiation effects;
- RC2 - Early Large Release;
- RC3 - Late Large Release;
- RC4 - Early Small Release;
- RC5 - Late Small Release;
- RC6 - Mitigated release.

SAA using MAAP-CANDU also produces accident progression results which provide relevant phenomenological information such as timing for core collapse, calandria vessel failure, hydrogen source terms, hydrogen fires/explosions, core-concrete interaction, and containment failure to facilitate understanding of accident progression for various event scenarios.

The SAA performed as a part of the Level 2 PSA provides further insights in terms of effectiveness of the various BDBA modifications, SAMG strategies, and human interventions by performing sensitivity analysis to assess the importance of key actions and equipment. The results of the SAAs are also evaluated and used as input to the OPG BDBA and SA management program. The insights from the SAA are used in accordance with REGDOC-2.3.2, *Accident Management: Severe Accident Management Programs for Nuclear Reactors*, and REGDOC-2.4.1 to identify areas for improvement. This includes plant modifications and/or updates to the guidelines and procedures such as Emergency Operating Procedures, EMEGs, and SAMGs. OPG assesses BDBAs at Darlington NGS as per the requirements of REGDOC-2.4.1 to ensure that the NPP as designed meets the requirements for release limits established, and that the procedures and equipment put in place to handle the accident management needs are effective, taking into account the availability of cooling water, material, and power supplies.

For emergency preparedness planning, SAA is performed to determine timing of event progression and to perform a consequence assessment of potential releases (i.e. to determine timing of release and dose rates to public to determine time to evacuate and the necessary radius of evacuation).

As mentioned in Section 2.4.3 above, OPG is performing an update to the Darlington NGS PSAs scheduled for completion in December 2025. This update will be compliant with REGDOC 2.4.2 Version 2. As part of the update for the Level 2 PSA, OPG will also review and update the suite of SAA for Darlington NGS.

Refer to Section 2.3.6 for further details on event mitigation and implementation of BDBA Management program through N-STD-MP-0019, *Beyond Design Basis Accident Management*.

2.4.5 Criticality Safety

The objective of criticality safety focuses on the prevention of fuel criticality both inside and outside the core, for either fresh or irradiated fuel.

Darlington reactors use only natural uranium (0.7% U-235) or depleted uranium (0.4% U-235) fuel, which cannot achieve criticality without an unpoisoned heavy water (D2O) moderator. Fresh fuel is stored in such a manner that segregates it from D2O and D2O systems. Thus, ex-core fresh fuel cannot be made critical. Ex-core irradiated fuel is stored in the IFBs under light water (H2O) where the fuel's low fissile content cannot be made critical in any configuration; therefore, no criticality risk exists.

In-core criticality safety control is achieved by procedures specified in the Guaranteed Shutdown State (GSS) Manual. The four types of GSS are over-poisoned GSS, drained GSS, rod-based GSS, and alternate shutdown configuration. Application of GSS is prescribed by the Operating Policies and Principles.

All criticality configurations are addressed as discussed above to ensure continued criticality safety.

2.4.6 Management of Safety Issues

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

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

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

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

2.4.6.1 Management of Safety Issues

A safety issue is defined as an issue related to the design or analysis of a NPP that has the potential to challenge safety functions, safety barriers or both.

In 2007, the CNSC assessed the status of CSIs and, while the safety case was not in question, the CNSC identified control measures to address residual concerns on nuclear safety. The initial list of issues was developed using the IAEA TECDOC-1554 *Generic Safety Issues for Nuclear Power Plants with Pressurized Heavy Water Reactors and Measures for their Resolution*, and each issue was classified into one of the following three categories:

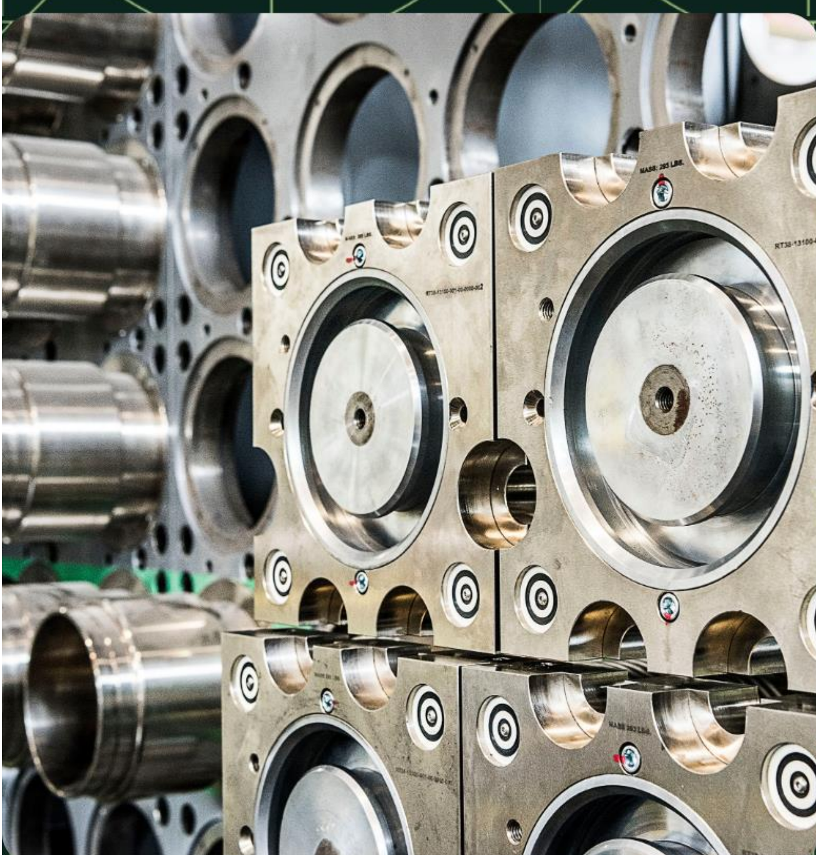
- Category 1: Not an issue in Canada;
- Category 2: The issue is a concern in Canada. However, the licensees have appropriate control measures in place to address the issue and to maintain safety margins;
- Category 3: The issue is a concern in Canada. Measures are in place to maintain safety margins, but further experiments and/or analysis are required to improve knowledge and understanding of the issue, and to confirm the adequacy of the measures.

In 2009, the CNSC identified sixteen Category 3 CSIs of which four were related to Large Break Loss of Coolant Accident (LBLOCA) and twelve were non-LBLOCA (N-REP-03611-0381169, *Application of the CNSC Risk-Informed Decision Making Process to Category 3 CANDU Safety Issues – Development of Risk-Informed Regulatory Positions for CANDU Safety Issues*). For the Darlington NGS station, all 12 non-LBLOCA Category 3 CSIs were previously recategorized to a lower category (Reference 2.4-3). One of the LBLOCA related Category 3 CSI was recategorized to a lower category in 2013 (Reference 2.4-4), and the remaining three were recategorized in 2023 (Reference 2.4-5).

OPG has demonstrated that appropriate control measures have been implemented and currently are in place to address all sixteen CSIs and maintain safety margins.

Section 2.5

Physical Design



2.5 Physical Design

Darlington NGS has an effective program to maintain its design basis which meets or exceeds all applicable regulatory requirements and related objectives. The program ensures that Structures, Systems and Components (SSCs) meet and maintain their design basis given new information arising over time and taking changes in the external environment into account.

The OPG documents in the table below require written notification of change per Darlington NGS Licence Conditions Handbook, LCH-PR-13.03/2025-R005:

Table 8: SCA 5 – Physical Design

Document	Title
N-STD-MP-0028	Conduct of Engineering
N-PROG-MP-0001	Engineering Change Control
N-STD-MP-0027	Configuration Management
N-PROG-MP-0009	Design Management
N-PROG-MA-0016	Fuel
N-INS-08173-10050	Procurement from Licensed Canadian Nuclear Utilities
N-PROC-MP-0090	Engineering Change Control Process
N-PROG-MP-0004	Pressure Boundary Program
N-PROC-MP-0040	System and Item Classification
N-PROC-MP-0082	Design Registration
N-MAN-01913.11-10000	Pressure Boundary Program Manual
N-LIST-00531-10003	Index to OPG Pressure Boundary Program Elements
N-CORR-00531-19076	Authorized Inspection Agency for Pressure Boundary Inspection and Registration Services
N-PROG-RA-0006	Environmental Qualification

2.5.1 Design Governance

OPG's design program satisfies the requirements of CSA N286-12, *Management system requirements for nuclear facilities* as defined in N-CHAR-AS-0002, *Nuclear Management System*. The program ensures that SSCs of facilities operate safely, reliably, and effectively, and are consistent with the design basis, safety analysis and quality control measures. The program also provides assurance that all design activities and their resulting documentation are controlled in a manner consistent with the plant's licensing basis.

N-PROG-MP-0009, *Design Management*, which receives its authority from N-CHAR-AS-0002, sets the overall requirement for execution and control of activities that provide design support and documentation for the nuclear facility. This program complies with CSA N286 and CSA N285.0-08 (and update no. 2), *General Requirements for Pressure-Retaining Systems and Components in CANDU Nuclear Power Plants*. The program defines the minimum set of documentation that identifies and describes the design basis, design outputs, design processes, and the procurement engineering process ensuring implementation and maintenance of the physical nuclear facilities to meet the design basis requirements. The following governance documents receive their authority from N-PROG-MP-0009.

- N-PROC-MP-0040, *System and Item Classification*, defines the requirement and process to be followed for code classification of pressure retaining systems in OPG Nuclear.
- N-PROC-MP-0082, *Design Registration*, defines the requirement and process to be followed for design registration of pressure boundary and legacy pressure boundary systems. Refer to Section 2.5.5.1 for further details on pressure-retaining SSCs.
- N-STD-MP-0028, *Conduct of Engineering*, provides a framework for performing engineering activities in a consistent manner across OPG Nuclear.

N-PROG-MP-0001, *Engineering Change Control (ECC)*, which receives its authority from N-CHAR-AS-0002, sets the overall requirement for modifications to the nuclear facility. The ECC program ensures design changes to each OPG Nuclear facility (including SSCs; software; and engineered tooling) are planned, designed, installed, commissioned, and placed into or removed from service such that the facility configuration is managed and remains within the Safe Operating Envelope (SOE) or safety and design envelope, design basis, and licensing conditions. This program complies with CSA standards N285.0 and N286. This program ensures all steps of a modification are properly assessed, analyzed, and evaluated including identifying the problem statement, determining requirements and risk level, design, review by stakeholders, installation, commissioning and close-out. The following governance documents receive their authority from N-PROG-MP-0001.

- N-PROC-MP-0090, *Engineering Change Control Process*, defines the process to be followed for all changes to the OPG Nuclear design basis, including modifications to, removal of, or abandonment of any SSC, software, or engineered tooling designs;
- N-INS-06700-10000, *Preparation of Human Factors Engineering Worksheet,* provides instruction in the preparation of Human Factors Engineering (HFE) Worksheet. HFE is considered in every modification having a Human System Interface. OPG uses a systematic graded approach to determine the appropriate level of HFE effort and rigor required for a modification. CSA N290.12-14, *Human Factors in Design for Nuclear Power Plants Compliance Assessment Summary*, compliance is generally achieved through the ECC and Design Management programs.

N-STD-MP-0027, *Configuration Management*, which receives its authority from N-PROG-AS-0001, *Nuclear Management System Administration*, ensures that OPG nuclear facilities are operated, maintained, and modified in conformance with their design basis and licensing basis. During all life-cycle phases of the ECC process, it is ensured that constructability, operability, maintainability, and safety issues are identified and incorporated into the design requirements of nuclear design projects and modifications.

N-PROG-MP-0006, *Software,* which receives its authority from N-CHAR-AS-0002, identifies the process and overall requirements for an effective software program. Modifications and design changes involving software complies with CSA N286 and CSA N286.7-99 (R2012), *Quality Assurance of Analytical, Scientific, and Design Computer Programs for Nuclear Power Plants*, and ensures software changes support safe and efficient plant operation. The software program identifies the processes and overall requirements for classification of software and identifies governing standards for each software classification defining requirements for software development, maintenance, procurement, qualification, use and retirement.

Any modification which may affect the International Atomic Energy Agency (IAEA) monitoring systems or equipment, is reviewed to ensure the changes do not impact compliance with the safeguards agreements. This includes, but is not limited to, potential obstruction of fields of view for the IAEA equipment or impact to the power supplies for IAEA equipment. Refer to Section 2.13 for more details.

The health of the design and ECC programs is monitored using the ECC site index. The index incorporates metrics associated with quality of design ECC packages, ECC process compliance, and the timely updating of records and closeout of modifications. Refer to Section 2.1.5 for additional information.

The Plant Design department at Darlington NGS oversees the physical design SCA requirements and maintains the station design basis to ensure that systems remain in compliance with applicable standards, codes and licence conditions. As the Design Authority for Darlington NGS, this department specifies design requirements and authorizes design modifications to SSCs to ensure that all changes are within the SOE, design basis, and licensing conditions as per the station's Power Reactor Operating License (PROL).

2.5.2 Site Characterization

The Darlington NGS site is located in Michi Saagiig Territory, in the township of Darlington within the Municipality of Clarington and Regional Municipality of Durham, in the Province of Ontario. Within the immediate 8 km radius of the station, the area is primarily rural with Bowmanville being the only urban area.

The Darlington NGS site consists of the property described as follows:

- The site lies south of the south limit of the South Service Road of the MacDonald-Cartier freeway (Highway 401) in the township of Darlington. The land area of the site is about 460 ha and has a frontage on the north shore of Lake Ontario of about 3160 m. Darlington NGS occupies half of the site west of Holt Road in Lots 21 to 24 inclusive (refer to
- Figure 14 and Figure 16 below).
- A water lot was provided for the water intake tunnel and the discharge pipe from Lake Ontario.

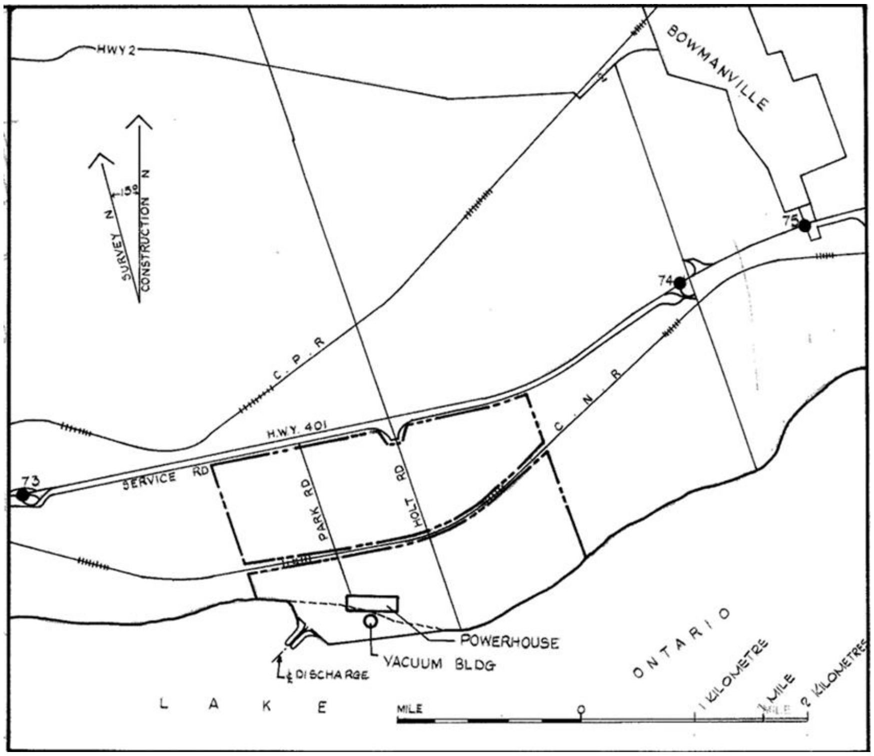


Figure 14: Darlington Site and Surrounding Area

The site is easily accessed for supply of off-site emergency aid and for ease of evacuation of non-essential personnel in case of an emergency. The site may be easily reached by car or rail. The multi-lane Macdonald-Cartier freeway runs east/west, immediately north of the site. There are three controlled entries to the Macdonald-Cartier freeway; one directly through Holt Road and two others less than 3 km on either side of the Darlington NGS facility. Rail access can be provided by the Canadian National Railway's (CNR) main line, which bisects the site in an approximate east to west direction. A rail siding area has been provided at the east boundary limit of the OPG Property.

The Darlington NGS site is situated in an undulating to moderately rolling limestone till plain, spotted with remnants of a lake plain deposit. Over most of the site, bedrock is covered by deep soil deposits. The bedrock elevation north of the powerhouse area near the CNR tracks is about 91 m while the bedrock at the shoreline is around 88 m. At a distance of 1000 m from the shoreline, the bedrock elevation is about 85 m. The bedrock is composed of nearly flat lying sedimentary rocks of Middle Ordovician age. The upper rock unit consists of dark brown, very thin to medium bedded shaley limestone of the Whitby Formation. The Whitby Formation ranges in thickness from 8 m to 1.5 m, thinning towards the eastern part of the site. The shaley limestone is underlain by grey, thick to massive bedded, fragmental limestone of the Lindsay Formation, which has thin inter-beds of shaley limestone throughout. The Lindsay Formation has a confirmed thickness of about 61 m at the site. The nuclear containment structures are founded on hard and sound shaley limestone of more than adequate bearing capacity to carry the structural loading without any adverse response. A detailed description of all site characteristics is provided in NK38-SR-03500-10001, *Darlington Safety Report Part 1 and 2*.

Darlington NGS has a campus plan in place, which details site infrastructure improvement activities through to the end of 2030 supporting the current and future needs of the Darlington NGS site including Refurbishment. The campus plan includes consideration of the impact that activities relating to development of the Darlington New Nuclear Project lands are likely to have on the rest of the site.

2.5.3 Facility Design

Darlington NGS is located on the north shore of Lake Ontario at Raby Head in the township of Darlington. The site location is shown in Figure 15 below:

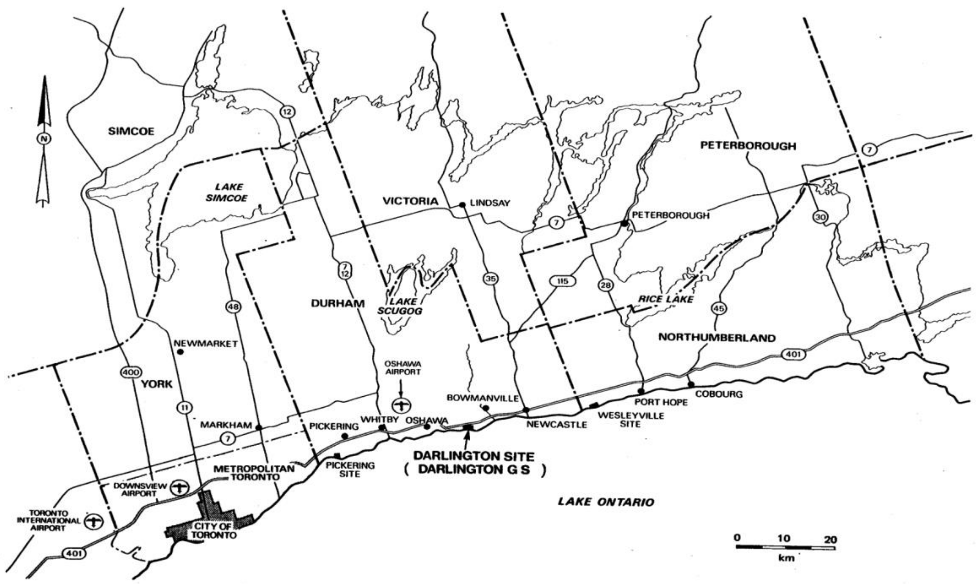


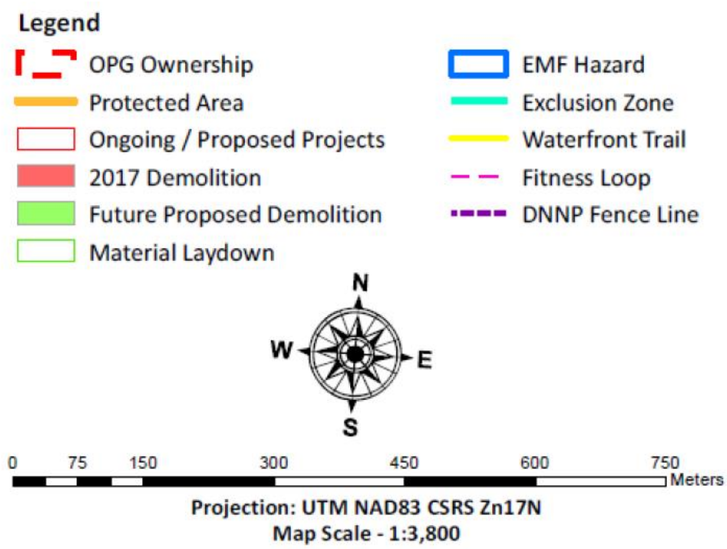
Figure 15: Site Location (from Darlington Safety Report, Part 1)

A summary of the station size and type is as follows:

- Four reactor unit station.
- CANDU pressurized heavy water nuclear steam supply system.
- Reinforced-concrete containment structure.
- Core fission power of 2776 MW(th) per unit.
- Nominal net unit output of 881 MW(e).

Darlington NGS comprises four nuclear reactors and four turbine generator sets, along with associated equipment, services and facilities arranged as shown in the site layout in Figure 16. The heat balance table for a reactor is shown in Table 9, and a simplified flow diagram for one unit is shown in Figure 17.


504
1ST LINE
SF6
502
HOLT RD
COOT'S POND
CN RAILWAY
OLD HOLT RD
2ND LINE
444
EMF
PARK RD
450
P414
423
424
443
401
P456
P403
P412
513
411
512
416
P355
P331
P332
357
356
359
362
313
F5N
F5S
F2N
415
8
R1
R2
WTP
P3
P4
1
10
329 / 330
P353
P354
358
363
312
311
F2SW
F2SE
208
207
T204
P455
16
15
17
18
20
23
WF
U1
U2
0
U3
U4
EF
9
WTP PARKING
302
PARKING
364
3RD LINE
RMA
UFDS3
F6
F7
F9
F8
300
VSF
138
22
65
36
41
42
43
45
46
47
PW
RPC
RCC
63
51
50
58
59
32
31
38
39
61
40
T44
CSVS
48
54
55
56
62
125
124
141
128
131
136
140
143
UFDS4
142
LAKESHORE ROAD
D9
PARKING
112
113
114
116
118
201



Operating Island Buildings		Site Buildings		Site Buildings	
0	Unit 0	107	(Project and Mod) Building Maintenance Shop	400	Baseball Diamond
1	Powerhouse	112	Turbine Parts Shop	401	Information Centre
U1	Unit One	113	Field Skills Facility	403	West Parking Lot
U2	Unit Two	114	Drawing Storage Facility	411	Operations Support Building (OSB)
U3	Unit Three	115	Computer Development Facility	412	East Parking Lot
U4	Unit Four	116	Project Office	414	Upper & Lower Parking Lot
WF	West FFAA	118	Lakeshore Garage	415	Bill Gearing Guardhouse
EF	East FFAA	119	Surplus Furniture Warehouse	416	Main Security Building
P1	Pumphouse One	124	Hydro Transformer Substation DS2	420	Chlorine Addition Station
P2	Pumphouse Two	125	Steamheating Boiler House	421	Domestic Water Pumphouse
P3	Pumphouse Three	126	Steam Relief Stack	422	Settlement Pond
P4	Pumphouse Four	128	Site and Facility Maintenance Shop #1	423	Hydro Transformer Substation
WTP	Water Treatment Plant	130	Warehouse Annex	424	DWMF Firewater Backflow Preventer Shed
8	FPS Firehall - Building #8	131	East Warehouse	432	Emergency Vehicle Garage
9	Construction Change Room	134	Sewage Treatment Plant	440	Rail Siding North
10	Retube Waste Processing Building	136	Flammable Storage building	441	Rail Siding South
T11	Recycle Shed	137	Gas Bottle Storage	443	MISA HUT
14	Lube Oil Tanks	138	HMS & HWS Facilities	444	Emergency Equipment Storage Bldg #1
15	EPS Building	140	Warehouse Yard	500	Soccer Fields
16	ESW Pumphouse/Chlorine Addition Bdg	141	Maintenance Computer Development Facility	502	Fitness Trail Parking Lot
17	Circulating Water Discharge Structure	201	Yard Maintenance Shed	504	SF6 Building
18	Emergency Power Generator (EPG) #1	T204	Hydrogen Trailer	505	Holt Road Guardhouse
19	Stairwell Enclosure (to EPG Tunnels)	206	Heavy Sand Shed/Facilities	506	Hepcoe Garage
20	EPG #2	300	Auxiliary Security Building	507	Hepcoe
21	Stairwell Enclosure (to EPG Tunnels)	301	Modification and CMO Office	508	Meteorological Tower
22	EPG Fuel Management Building	302	Pipe Fab/Machine Shop	509	Domestic Water Meter and Valve Station
23	EPG #3	305	Facilities Storage Building	510	Radiation Emission Monitor STA#2
T27	NTS Periodic Inspections Trailer	306	Paint Shop	511	Radiation Emission Monitor STA#1
29	Reactor Maintenance Building	311	Facilities Vehicle Garage #2	512	Radiation Kiosk
T30	Reactor Maintenance CCTV Trailer	312	Quonset Building	513	Covered Walkway
31	Sheet Metal Shop	313	BBH Building	514	Seismic Monitoring Station
32	Inactive Liquid Waste Storage	323	Cable Reel Yard		
36	Standby Generators Fuel Storage	324	Pipe Hanger Storage Shop		
T37	TRF Maintenance Offices	325	Warehouse Yard (YD 26)		
38	Standby Generator One	326	Warehouse Yard (YD 25)		
39	SG1 and SG2 Fuel Management Building #1	327	Warehouse Yard (YD 27)		
40	Standby Generator Two	329	Darlington Learning Centre (DLC)		
41	HWMB West Annex	330	Engineering Service and Support Building (ESSB)		
42	D20 Management Building (TRF)	331	OSB Parking Lot		
43	Stairwell Enclosure (to SG Tunnel)	332	ESSB Parking Lot		
T44	Hydrogen Trailer	353	ESSB Parking Lot		
45	Stairwell Enclosure (to SG Tunnel)	354	Executive Parking Lot		
46	Vacuum Building	355	MSB Parking Lot		

47	Stairwell Enclosure (to SG Tunnel)	356	DWMF Amenities Building		
48	Stairwell Enclosure (to SG Tunnel)	357	Bus Shelter		
T49	Service Maintenance Storage Trailer	358	UFDS Sampling Station Bldg		
50	Compressed Gas Bottle Storage	359	DWMF Process Building		
51	Service and Storage Building/Vehicle Maintenance Garage	362	DWMF Storage Building		
T53	Security Personnel Access and Gate	363	DWMF Storage Building #2		
54	Standby Generator Three	364	Retube Waste Storage Building		
55	Standby Generator Fuel Management Building #2	208	Refurbishment Project Office (RPO)		
56	Standby Generator Four				
58	Island Garage				
59	Standby Generators Fuel Storage				
61	Inergen Fire Protection System Enclosure (Standby Generators 1, 2)				
62	Inergen Fire Protection System Enclosure (Standby Generators 3, 4)				
63	Scaffold Storage Building				
65	Retube and Feeder Replacement Island Support Annex				
T96	T-G Hall Relocatable Outage Trailer				
T97	T-G Hall Relocatable Outage Trailer				
T98	T-G Hall Relocatable Outage Trailer				
T99	T-G Hall Relocatable Outage Trailer				
C24	Firewater Pumphouse				
CFVS	CFVS: Containment Filtered Venting System				

NOTE: This figure is for general reference only. Not all buildings on site may be shown or labelled.

Figure 16: Darlington Site - General Layout

Table 9: Heat Balance for one Darlington NGS Unit (from Darlington Safety Report, Part 1)

Heat Generation Balance (By Fission) in MW(th)	
Fuel channels	2651
Moderator and reflector	108
Miscellaneous, including reactor components shields and structures	17
Total heat generated by fission	2776
Heat Removal Balance (Heat Transport)	
Heat removed from fuel channels by coolant	2651
Heat losses to moderator, end shields, piping and Heat Transport Purification System	20
Total	2631
Heat gain from heat transport pumping energy	26
Total	2657
Heat Balance (Turbine Cycle)	
Heat transferred to steam generators	2657
Heat losses to blowdown and main steam pipes	7
Net heat input to turbine cycle	2650
Generator output from turbine cycle	936
Energy rejected in turbine cycle	1714
Total Unit Energy Balance	
Generator output from turbine cycle	936
Station service including exciter	55
Net unit output	881

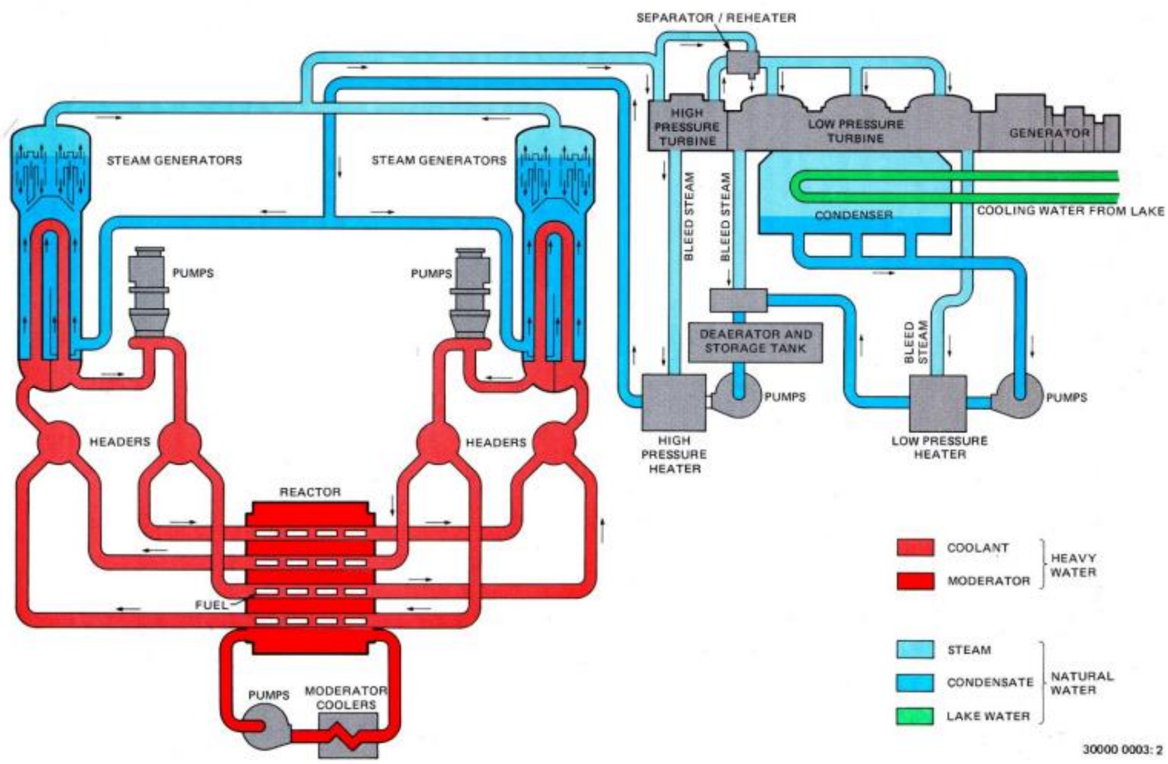


Figure 17: Simplified Unit Flow Diagram

The description of the systems and equipment at Darlington NGS, including the system objectives, functional and performance requirements, interfacing systems, and design and operating conditions are provided in the following documents:

- Darlington Safety Report Part 1 and 2 (updated every 5-years as required by REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants*). The latest update of the Safety Report Part 1 and 2 was completed in November, 2023.
- Design Manuals.
- System design drawings.
- Design Guides identifying requirements and standards, which must be met in the design of various systems of a Nuclear Power Plant (NPP).

The Safety Report (Part 2, Section 1) describes the development of Canadian Nuclear Safety Design and Regulation. It contains a detailed description of the design philosophy and safety design requirements of the Darlington NGS.

N-LIST-01300-10000, *Bounded Document Set*, lists the sets of documents that shall be maintained when modifying the plant or when modifying other bounded document set documents. The bounded document set provides for a consistent set of configuration managed documentation across OPG Nuclear. The bounded document set lists the set of documentation or data that:

a) Represents physical plant.

b) Represents design (design input or output).

c) Ensures physical plant is operated consistently within the design envelope (including training) and licensing basis.

d) Maintains physical plant in a state consistent with the design requirements or assumptions used in analysis and assessments.

e) Establishes acceptability or suitability of detailed design and physical entity.

f) Should be controlled to ensure that the physical plant is consistent with the paper plant and its operation and maintenance.

2.5.3.1 Design Principles and Requirements

OPG is responsible for ensuring that the station is designed, constructed, and operated to meet safety requirements that protect the public. To this end, OPG has constructed a station, which meets all safety requirements and regulations, and will do adequate in-service inspections, maintenance, and improvements throughout the life of the station to ensure that it remains safe and reliable. Details of the safety philosophy followed are provided in the Darlington Safety Report.

The design of Darlington NGS utilizes a defence-in-depth methodology with redundant safety systems and barrier to control the reactor power, cool the fuel, and contain radioactivity, for the protection and safety of workers, the public, and the environment. The design of the fuel has five layers of defence-in-depth that prevent radioactive exposure as listed below:

- The UO_2 fuel pellets, which bind the majority of radioactive fission products within its solid matrix.
- The fuel sheath, which contains fission products not retained in the fuel matrix.
- The Primary Heat Transport (PHT) system boundary, which contains any leakage from the fuel sheath.
- Negative Pressure Containment System (NPCS) including concrete containment and associated structures (e.g. vacuum structure), which contains any release from the PHT system.
- The exclusion zone surrounding the facility, which provides for dilution of any release from containment.

The first three barriers prevent radioactive release accidents and ensure that, while they are intact, very little radioactive material will escape into the reactor building. NPCS and the exclusion zone come into play to mitigate doses in scenarios where all of the first three barriers are breached, such as in a severe loss-of-coolant accident.

Primary heat production control and heat removal control are performed using dual digital computers for critical functions such as reactor power control and boiler pressure control. The system consists of two independent computers, each capable of complete unit control, and contains a digital control computer, with annunciation and command processing. The software and hardware operations are continuously monitored by a combination of internal self-checking software and hardware plus an external watchdog timer.

Darlington NGS has four special safety systems as listed below. The special safety systems have the purpose of shutting down the reactor, cooling the fuel, and preventing radioactive releases following any abnormal events. The special safety systems are, as far as practical, independent of the process systems so that any process system impairment will not adversely impact the functionality and performance of a safety system.

- Two independent and diverse Shutdown Systems (SDS) (SDS1 and SDS2), which rapidly shut down the reactor by introducing sufficient negative reactivity to make the reactor subcritical with the aid of two independent and diverse neutron absorbers.
- Emergency Coolant Injection (ECI) system, which ensure fuel cooling is maintained.
- NPCS, which is designed to prevent the release of radioactive material to the environment.

To protect against common mode events, independent and redundant equipment has been incorporated into the design of the station. These redundancies in the design ensure essential safety functions are maintained and will be performed during a postulated event. There are several other systems with important safety related functions such as Emergency Service Water (ESW), Steam Generator Emergency Cooling, Emergency Power System, Standby Class III Power, Interunit Feedwater Tie, Post Accident Hydrogen Ignition System, Containment Filtered Venting System (CFVS), Shutdown Cooling (SDC), and Powerhouse Steam Venting.

Systems and components classified as systems important to safety and components important to safety are listed in NK38-REP-03611-10100, *Darlington NGS Systems and Components Important to Safety*. Systems classified as Safety Related are listed in NK38-LIST-06937-10001, *List of Safety Related Systems and Functions*. Detailed descriptions of these systems are provided in Part 2 of the Darlington NGS Safety Report. CSA N290.0-11, *General requirements for safety systems of nuclear power plants*, compliance is achieved through design governance and is applied to modifications.

Plant states and operational configurations considered in design of the Darlington NGS facility are described in the Darlington NGS Safety Report. Part 3 of the Safety Report provides the detailed description of the accident analysis for Darlington NGS. This section presents the analysis of all Design Basis Accidents (DBAs) to demonstrate that the safety design objectives of all postulated accidents are met.

Code effective dates of various design codes and standards at the time of issuance of the Construction Licence for the station are identified in the System Classification List. Ongoing modifications for pressure-retaining systems and components will be done in accordance with the version of CSA N285.0, *General requirements for pressure-retaining systems and components in CANDU nuclear power plants*, in the current licence. The applicable codes and standards used in the nuclear and conventional design of Darlington NGS is provided in the Darlington Safety Report.

Safety and Design Envelope are the boundary conditions provided by the licensing basis for the Darlington NGS facility. OPG nuclear standard N-STD-MP-0016, *Safe Operating Envelope*, defines the processes, organizational responsibilities, and key program elements to ensure that the SOE is defined and documented in a correct, complete and consistent manner and reflected in the station operating documentation. Refer to Section 2.3.5 for more details.

Design for reliability and safety design concepts incorporated into the Darlington NGS are described in Part 2, Section 1 of the Safety Report. Furthermore, reliability targets to meet the requirements of REGDOC-2.6.1, *Reliability Programs for Nuclear Power Plants*, are discussed in Section 2.6.

Station and system design considers mitigation of acute radioactive releases, Severe Accident (SA) initiators, and post-accident actions. Beyond Design Basis Accident (BDBA) management includes the use of Emergency Mitigating Equipment (EME), Severe Accident Management Guidelines (SAMG) and Emergency Heat Sink (EHS). Use of EME has a primary focus on fuel cooling and is used to mitigate accident progression when design basis equipment is unable to provide adequate core cooling, intending to prevent an event from progressing to a SA. SAMG has a focus on both containment integrity and fuel cooling, and its use is initiated if an event has progressed to the SA stage. The EHS is a new connection installed on all post-refurbishment units that allows ESW or water from the forebay directly into the PHT system. Emergency response planning is also undertaken and emergency drills are run on a periodic basis to ensure staff are prepared to respond as required.

Radiation Protection (RP) is a critical factor and requirement which is considered as part of the ECC process when completing modifications. The limitation of external and internal radiation exposures to plant staff is ensured by several design features incorporated into the station design, and by adherence to a set of approved operating procedures and the *Radiation Protection Regulations*. Radiation exposure is limited by controlling access to areas where high radiation fields and radioactive contamination may exist, by plant layout and structural shielding arrangements, and by the use of protective equipment and decontamination facilities. Personnel monitoring and dosimetry facilities are provided to monitor the individual's exposure. A detailed description of the RP design elements incorporated into the Darlington NGS design is in Part 2, Section 12 of the Safety Report. Refer to Section 2.7 for more details.

OPG has a robust Foreign Material Exclusion (FME) program, and has controls in place through the design and modification process to ensure the requirements of the program are met. The goal of the FME program is to cultivate a focus on prevention among workers and contractors, and to plan and execute work activities to include precautions for preventing introducing foreign material into plant equipment. This applies to the plant, warehouses, calibration labs, and on-site fabrication facilities.

2.5.4 Structure Design

The Darlington NGS consists of four units with one Main Control Room and a Central Service Area. Each unit consists of a single reactor housed in a reinforced-concrete vault, with the steam generators protruding into shielded access-controlled rooms above this vault, and a single turbine/generator housed in an adjacent powerhouse. The station is close to the lake with the nuclear portion of the station and the vacuum structure located on the south side of the powerhouse. All nuclear structures are on bedrock.

The Darlington NGS site contains the following buildings and structures:

1. Four reactor building structures.
2. Four reactor auxiliary bays.
3. A powerhouse comprising four turbine halls, four turbine auxiliary bays, and a central service area.
4. A vacuum structure.

5. Four combined cooling and service water pumphouses.
6. An emergency electrical power and water supply complex, consisting of an ESW pumphouse, Emergency Power Supply (EPS) generator sets buildings, EPS fuel management structures, and emergency electrical rooms and associated tunnels.
7. Two administrative buildings (OSB and ESSB/DLC).
8. A Water Treatment building.
9. Two Fuelling Facility Auxiliary Areas (FFAAs), including two Irradiated Fuel Bays (IFBs).
10. Four Standby Generator buildings.
11. A Heavy Water Management Building (HWMB).
12. Tritium Removal Facility.
13. Flammable Storage building.
14. High-Pressure Gas Cylinder Storage building.
15. Sewage Treatment Plant.
16. Emergency Response Team Facility.
17. Hazardous Material and D2O Storage Building.
18. Security Access through the Main Security Building (MSB), Auxiliary Security Building (ASB) and the Refurbishment Project Office (RPO).
19. Nuclear Sustainability Services – Darlington.
20. Auxiliary Heating Steam Boiler House.
21. CFVS Outdoor Shielding Space.
22. HWMB West Annex.

The reactor building is a rectangular reinforced-concrete building, which serves as a support and an enclosure for the reactor and some of its associated equipment. The portion of the reactor building, which forms part of the containment envelope, is called the reactor vault.

The fuelling duct, which is connected to each of the reactor vaults, runs the length of the station under the vaults. It serves as a connection between the reactor and the FFAAs at each end of the duct. A provision for future plant extension has been provided in the end wall of the fuelling duct in the east FFAA. A Pressure Relief Duct (PRD) connects the fuelling duct to the vacuum structure.

The containment envelope comprises the four reactor vaults, the fuelling duct, the PRD, the pressure relief valve manifold, the vacuum structure, the fuelling machine head removal area, and a fuel handling and service area at each end of the fuelling duct.

Each reactor vault is surrounded by a reactor auxiliary bay. This building contains reactor auxiliaries and secondary circuits of low temperature, pressure, and generally of low radioactivity level. The reactor auxiliary bay consists of a basement with concrete floors below elevation 100 m, and a conventional steel-frame structure with concrete floor slabs above elevation 100 m.

The central service area is divided into the central service area-nuclear and the central service area-conventional. The central service area serves the entire station. The central service area-nuclear contains facilities for fuelling machine head removal, treatment and storage of heavy water, spent ion exchange resins, and active wastes. It is located below grade in the south portion of the central service area and is of reinforced-concrete construction. The central service area-conventional contains stores, laboratories, workshops, electrical and air conditioning equipment, and the central control area. For the most part, it is of steel-frame construction with concrete floors. The central control area is located above the central service area-nuclear and is enclosed on all four sides by reinforced-concrete walls. The control area also has a reinforced-concrete roof.

The emergency electrical power and water supply complex is of reinforced-concrete construction throughout. The other buildings listed are of conventional steel-frame construction on reinforced-concrete foundations.

The design criteria and description of station structures is provided in Part 2, Section 3 of the Darlington Safety Report. Further information regarding design and physical characteristics of plant structures is provided in the Design Manuals for each respective structure.

CSA N291, *Requirements for safety related structures for CANDU nuclear power plants*, compliance is generally achieved through the ECC and Design Management programs. Inspection requirements of N291-19 are achieved through N-PLAN-01060-10004, *Aging Management Plan for Concrete Containment Structures and Safety Related Structures.* Darlington NGS containment structures are routinely inspected at regular intervals in accordance with CSA N285.5-18, *Periodic inspection of CANDU nuclear power plant containment components* and CSA N287.7-08, *In-service examination and testing requirements for concrete containment structures for CANDU nuclear power plants*. Refer to Section 2.6.5 for information on Darlington NGS inspection programs.

2.5.5 System and Component Design

The following subsections describe details on the physical design of the station, design and performance requirements of systems and components, key results from the current licensing period, and ongoing and future activities over the next licencing period, which collectively support that:

- SSCs at the station are fit to continue commercial operation and programs will ensure fitness-for-service during the next license period.
- OPG continues to invest in Darlington NGS to support the assurance of fitness for service through procurement, fuel inspections, and improvement/upgrade modifications.
- Nuclear safety is assured by maintaining the plant’s Pressure Boundary (PB) and ensuring key safety and mitigating equipment is qualified.

Appendix B provides additional details on specific systems such as the functional and performance requirements, nuclear safety requirements, and projects and modifications on each system or various components within the system.

2.5.5.1 Pressure-Retaining Structures, Systems and Components

N-PROG-MP-0004, *Pressure Boundary,* manages the processes that control the quality of PB activities at OPG Nuclear with a goal of no failure of pressure retaining parts. The program establishes the infrastructure and defines the activities necessary to maintain a sustainable managed process that allows OPG to perform activities associated with repairs, replacements, modifications and alterations to pressure retaining items, components and systems, including installation of new systems.

The OPG PB Program ensures PB activities at Darlington NGS are in accordance with the codes and standards required by the Darlington NGS PROL. The PB program is a mature program that is compliant with the mandated codes and standards. Darlington NGS Engineering and Maintenance are responsible for implementing the program at the Darlington NGS site.

N-MAN-01913.11-10000, *Pressure Boundary Program Manual*, describes the program used to control the quality of PB activities at OPG Nuclear facilities and stations including Darlington NGS. It complies with CSA N285.0-08 and update no. 2, *General requirements for pressure-retaining systems and components in CANDU nuclear power plants*, and CSA B51-09, *Boiler, Pressure Vessel and Piping* Standards. PB requirements for all states of work, from design through procurement, installation and testing, are implemented through OPG Nuclear governing documents.

Based on the agreement reached with the CNSC (Reference 2.5-1), all PB activities at Darlington NGS are compliant with CSA N285.0-08 and update no. 2. until the end of the Darlington NGS Refurbishment Project. In addition, as per the current LCH and N-LIST-00531-10003, *Index to OPG Pressure Boundary Program Elements*, OPG maintains a PB Program Document roadmap that is in compliance with Annex N of CSA N285.0-12 and update no. 1. The index is a document that correlates OPG's processes and procedures to the PB program elements identified in CSA N285.0-12 and update no. 1, Annex N, Table N.1.

Darlington NGS has been using the Technical Standards and Safety Authority (TSSA) as the Authorized Inspection Agency (AIA), under a contract between OPG and TSSA, to comply with CNSC requirements for inspection of pressure boundaries. Darlington NGS reports all PB degradations to CNSC (immediate and quarterly) as per REGDOC-3.1.1.

Darlington NGS has had four successful PB Certificate of Authorization (CofA) renewal audits conducted by the TSSA demonstrating PB processes to be in compliance with the OPG Nuclear Pressure Boundary Program Manual since the last license application. The four audits were conducted in 2014, 2017, 2020 and 2023 respectively. OPG's PB CofA has been renewed and new certificates have been issued by the TSSA. These certificates will expire on April 15, 2026, before which the 3-year rolling renewal process will continue.

Annual internal self-assessments and internal audits are performed as per requirements of the Pressure Boundary Program Manual, which have contributed to further improvement of the PB program and associated procedures. The audit findings and self-assessment report observations have generally shown compliance to the Pressure Boundary Program Manual. The results of self-assessments and internal audits are documented and associated corrective action plans are developed to address the Areas for Improvement (AFIs).

As was done for Units 2 and 3 refurbishment, Enterprise Project Contractors (EPC) perform PB activities under their own CofA for the refurbishment of Units 1 and 4. OPG issued a Letter of Authorization to the EPC to prepare registration and reconciliation packages and to submit them to the AIA for registration on OPG's behalf. OPG then receives the registration package. The EPC is also required to prepare Code Classification and Exemption evaluation packages. Should a variance or deviation from code be required, the EPC prepares and submits the proposed resolution to the AIA for evaluation on OPG's behalf.

OPG is accountable for all communications with the CNSC related to code class approvals and notifications regarding registration and changes to PB documentation.

Darlington NGS Class 1 systems were assessed for life extension in which formed part of the Darlington NGS Refurbishment Integrated Safety Review (ISR). This assessment recommended the implementation of a transient/fatigue monitoring program to support Darlington NGS life extension. NK38-PLAN-01060-10015, *Fatigue Monitoring of Nuclear Class I Piping Systems at Darlington NGS*, documents Darlington's formal Fatigue Monitoring program which was accepted by the CNSC. The Fatigue Monitoring Project was initiated as part of this plan to develop a program to track fatigue usage of Class 1 components inclusive of environmental factors. The project has been in-service as of 2022. Darlington NGS has chosen FatiguePro 4, an industry standard software for fatigue monitoring.

2.5.5.2 Environmental Qualification of Equipment

Per CSA N290.13-05 and update no.1, 2009, *Environmental qualification of equipment for CANDU nuclear power plants*, Environmental Qualification (EQ) shall demonstrate that equipment will perform its required function during and following a DBA, taking into consideration stressors associated with all service conditions.

N-PROG-RA-0006, *Environmental Qualification,* establishes an integrated and comprehensive set of requirements that provides assurance that essential equipment can perform as required if exposed to harsh DBA conditions and this capability is preserved over the life of the plant. Implementation of these program requirements provides consistent methodology, programmatic controls, and interfaces for establishing and maintaining EQ of equipment and components at Darlington NGS. The EQ program is in accordance with CSA N290.13-05 and update no. 1, 2009.

Effectiveness of the EQ program at Darlington NGS is evaluated using the EQ Program Health Report, and the current status of the program meets requirements and is sustainable. A fleetview health report is also performed for the program encompassing both the Darlington and Pickering stations.

EQ program controls are integrated into the engineering change governance to ensure engineering changes conform to EQ requirements.

Ongoing improvements continue from the combination of the Darlington, Pickering, and Corporate EQ groups. Learnings are shared and incorporated into the daily processes at each site to increase the effectiveness of benchmarking between sites and improve implementation of the program.

2.5.5.3 Electromagnetic Interference

OPG has guidelines in place for Electromagnetic Compatibility (EMC) testing in conjunction with the ECC process. The guidelines provide design engineering teams with International Electrotechnical Commission (IEC) standards and test levels to consider in their design and testing requirements for instrumentation and electrical equipment. This allows for the mitigation of potential Electromagnetic Interference issues (EMI), and appropriately considers the criticality and safety classification of the SSCs.

Both susceptibility and emission aspects are considered to ensure SSCs are protected from EMI-induced faults without introducing significant electromagnetic disturbances to other equipment within the plant. Considerations for grounding and shielding are covered through the ECC process, which includes references to design guides that provide strategies and best practices.

Due to evolving technologies and increased EMI boundaries with new technology, the OPG guidelines for EMC are in the process of being revised to take into account guidance from Electric Power Research Institute TR-102323, *Guidelines for Electromagnetic Interference Testing in Power Plants*, and updates to the IEC 61000 series, *Electromagnetic Compatibility*, of standards.

2.5.5.4 Seismic Qualification

Darlington NGS is designed and constructed to ensure that the effects of an earthquake do not lead to unacceptable radiological releases as specified in the Nuclear Safety and Control Act, as a minimum requirement. Seismic qualification is demonstrated in accordance with the requirements of CSA N289.1-08, *General requirements for seismic, design and qualification of CANDU nuclear power plants*, for those SSCs which ensure that, as a minimum, the following safety functions are provided:

a) In the event of an applicable earthquake (generally referring to the Design Basis Earthquake (DBE) or Margin Design Earthquake (MDE)):

    1) Safely shut down the reactor and maintain it in that state indefinitely.
    2) Remove decay heat from the fuel and maintain pressure integrity of the primary coolant system PB during the shutdown period.
    3) Contain radiological releases in the NPCS within the specified limits.
    4) Monitor performance of the functions specified in Items 1) to 3).
    5) Limit consequences of potential failure of those SSCs that are not servicing the reactor, but are containing or preventing the release of radioactive materials; and
    6) Prevent seismic interaction of other SSCs that can lead to substantive damage impairing the safety function of any of the SSCs included in Items 1) to 5).

b) In the unlikely event of a Loss of Coolant Accident (LOCA) due to an applicable earthquake, necessary portions of the ECI system, SDSs, NPCS, monitoring equipment, and supporting systems shall remain functional following the Site Design Earthquake (SDE) during the recovery period after the LOCA.

The ECC program ensures that modifications to seismically qualified SSCs are subjected to the applicable stakeholder review process and that the seismic qualification is not degraded by a proposed design change. It also reviews and ensures that the qualified systems are located in (or in the vicinity of) structures that are likewise qualified, and seismic interaction by unqualified SSCs is prevented. Furthermore, plant modifications are controlled to not compromise the function of the seismic routes. Seismic routes are marked on floors or ground to provide assured operator access to safety-related SSCs for which short term actions (in the first 2 to 3 hours) are credited following an earthquake. Procedures are in place at Darlington NGS to ensure plant operations do not interfere or degrade the function of the seismic routes.

In addition to the seismic qualification of the safety-related SSCs to the DBE/MDE and SDE, the SSCs are also assessed for Beyond Design Basis Earthquakes (BDBE) for seismic robustness, which is to assure redundancy of the SSCs and defense-in-depth through common cause failures and to meet the seismic requirements stated in CSA N289.1. These assessments provide an estimate of the overall frequency of predetermined plant-level damage states, such as core damage frequency and frequency of large release of radioactive materials to the environment. As a means to evaluate the seismic robustness of the SSCs for redundancy and defense-in-depth beyond the DBE and MDE, the Seismic Probabilistic Safety Assessment (SPSA) is performed for Darlington NGS to assess the risks of severe core damage and large releases. Two risk metrices are evaluated, Severe Core Damage Frequency (SCDF) and Large Release Frequency (LRF), and compared to the OPG safety goals specified in N-PROG-RA-0016, *Risk and Reliability Program*. In the scenario where the SPSA results indicate that design modifications are required to meet the OPG safety goals, the modifications would be executed in a timely manner.

The last Darlington NGS SPSA (also known as DARA Seismic) was submitted to the CNSC in 2020, and the next submission will be in 2025 per the 5-year submission requirement of REGDOC-3.1.1. The SPSA demonstrated that the seismic SCDF and LRF meet the OPG safety goals. Refer to Section 2.4.3 for details.

Darlington NGS maintains a list of seismically qualified SSCs that are credited to fulfill the safety requirements mentioned above. It compiles all the seismic qualification requirements including seismic classification and categorization for the SSCs which have been documented within the bounded document set.

Depending on required safety functions during and following the DBE, the seismically qualified SSCs are classified into the following four categories, which exceed the minimum requirements of CSA N289.1:

- Category-A: Those SSCs which must retain their PB integrity during and following an applicable earthquake. This category also includes containment boundary.
- Category-B: Those SSCs which must retain a specified performance capability during and following an applicable earthquake.
- Category-C: Those SSCs which must retain a specified performance capability following an applicable earthquake.
- Category-D: Those structures and components which must maintain their structural form and support function during and following an applicable earthquake.

The original investigations of the historical seismicity in the region of the Darlington NGS site were undertaken to provide an estimate of the design basis ground motion. These studies resulted in the original definitions of the DBE and SDE for the Darlington NGS. Seismically qualified SSCs are capable to resist the DBE and SDE without compromising the required safety functions. In addition to the DBE and SDE requirements, MDE is introduced into the seismic qualification of applicable SSCs. The MDE is defined as 1.5 times the DBE, which provides additional safety margin above the DBE and is to align with new requirement of the design basis earthquake defined in CSA N289.3, *Design procedures for seismic qualification of nuclear power plants*. Darlington NGS has a seismic design guide which is utilized in determining seismic qualification requirements for SSCs and modifications, and provides delineation of the uses of DBE and MDE requirements. Seismic qualifications at the Darlington NGS are primarily done by analysis, testing, or a combination of analysis and testing in accordance with the requirements of CSA N289.1, N289.3, and N289.4, *Testing procedures for seismic qualification of nuclear power plant structures, systems and components*. The code-over-code reviews of the seismic qualification standards CSA N289 series are performed to identify significant technical changes due to evolutions of new standard editions. The ECC process requires that any significant technical changes are addressed, as appropriate, for any planned modifications to existing SSCs or new installations.

In-plant seismic instrumentation is installed in the plant to monitor and record in-plant seismic motions in compliance with the requirements of CSA N289.5, *Seismic instrumentation requirements for nuclear power plants and nuclear facilities*. Within the plant facilities, seismic motions are recorded if the vibrations exceed a threshold level. Outside the plant facilities, the seismic motions are recorded by the Southern Ontario Seismic Network (SOSN) that records detailed free-field seismic activities covering Southern Ontario. The in-pant seismic monitoring network includes eight accelerometers spreading over critical nuclear structures. In addition to the in-plant seismic monitoring network, two accelerometers locate on free field near the Darlington NGS property boundary, which are part of the SOSN. Recorded seismic motions are assessed against the DBE, MDE, and other seismic design bases. The records of the SOSN are also used to support the probabilistic seismic hazard assessment.

Seismic qualifications of the SSCs are reviewed periodically as part of the Periodic Safety Review (PSR) process and as part of N-CHAR-AS-0002, *Nuclear Management System*, for their overall effectiveness and opportunities for improvement. PSRs have been performed systematically at the Darlington NGS to review the design, condition, and operation of the plant and identified gaps for code compliances and improvements. All the seismic qualification gaps identified by the recent PSR have been either closed by addressing the issues or re-classified as acceptable deviations. The combination of the original seismic designs and the current seismic practices provide high confidence that Darlington NGS can withstand applicable design and reference earthquakes.

N-PROC-TR-0008, *Systematic Approach to Training*, ensures that engineering, operations, and maintenance staff are aware of station requirements including seismic qualification while performing their respective duties, and that they receive the appropriate training on seismic qualification. N-PROG-MA-0004, *Conduct of Maintenance,* outlines precautionary measures to counter incidents that could impact the operation of seismically qualified equipment and seismic routes. N-PROG-MP-0008, *Integrated Aging Management,* requires seismic qualification requirement be considered during condition assessment of critical SSCs as the plant ages.

2.5.5.5 Fire Safety and Fire Protection System

As part of its PROL, the Darlington NGS is required to implement and maintain a Fire Protection Program (FPP). The OPG FPP establishes provisions to prevent, mitigate and respond to fires such that fire risk to OPG Nuclear workers, public, environment, nuclear physical assets, and power generation is acceptably low and controlled. For additional FPP details, refer to Section 2.10.

The FPP goals are to:

- Minimize the risk of radiological releases to the public due to fire.
- Protect plant occupants from death or injury due to fire.
- Minimize economic loss resulting from fire damage to structures, equipment, and inventories.
- To manage impact to the environment resulting from fire.

In the event of a fire, the plant shall be capable of achieving the following nuclear safety objectives:

- Achieving and maintaining the reactor in sub-critical conditions.
- Achieving and maintaining decay heat removal.
- Maintaining the integrity of the fission product boundaries.
- Limiting the release of radioactive materials that are located outside the reactor.

The following life safety performance objectives shall be met during all operational modes and plant configurations:

- Fire hazard controls shall be included in design and operational stages.
- Fire notification means shall be provided.
- Safe egress and/or areas of refuge shall be provided for occupants for use in the event of a fire.
- A safe environment and other required support shall be provided for essential staff so they can perform all necessary plant control functions during and following a fire.
- Protection for personnel performing emergency services shall be provided both during and following a fire.
- Access and emergency lighting shall be provided for all areas where manual fire fighting, evacuations, or operator field actions are excepted.

The overall approach to the FPP is based on the defense in depth provisions of fire prevention, fire detection and suppression, and limiting or mitigating the effects of fires.

CSA N293-12, *Fire protection for CANDU nuclear power plants*, provides the fire protection requirements for design, construction, commissioning, operating, and decommissioning of NPPs, including SSCs that directly support the plant and protected area.

Fire Protection Assessment (FPA) are engineering evaluations that assess the plants or facilities against the requirements of CSA N293 to ensure safety in the event of a fire in any plant or facility location. The evaluations are documented for each station in three assessments which are updated every 5-years:

1. Fire Protection Code Compliance Report (CCR) including Third Party Inspection, Testing, and Maintenance (ITM) Reports.
2. Fire Safe Shut Down Analysis (FSSA) report.
3. Fire Hazard Assessment (FHA) report.

The Fire Protection CCR assesses the as found fire protection conditions against the relevant codes. Although most of the buildings were constructed prior to Darlington NGS obtaining its current operating license, the CCR examined the station from the lens of new construction given the intent to operate the station for an additional 30-years. The CCR covered all buildings inside the protected area except buildings exempted from CSA N293 per NK38-LIST-78000-10001, *Application of CSA N293 to Structures, Systems and Components for Darlington Nuclear*. It was the general conclusion of the 2023 CCR, with the resolution of the outstanding deviations, that Darlington NGS is in compliance with the requirements of CSA N293-12 (R2017), National Building Code of Canada (NBCC)-2015, and National Fire Code of Canada (NFCC)-2015.

The ITM portion of the CCR consists of two reports:

- Fixed fire protection systems (detection and suppression).
- Manual fire protection equipment (firefighting equipment such as fire hose and nozzles, fire vehicles etc.).

The ITM activities for fixed fire protection systems and manual fire protection equipment are intended to document the state of compliance of the station with the ITM requirements of CSA N293, NFCC, and other applicable codes and standards. It is the general conclusion of the 2024 fixed fire protection systems and manual fire protection equipment ITM Reports that the station is in compliance with the applicable codes and standards, and that the Darlington NGS ITM Program meets the objectives defined in CSA N293-12 (R2017). These reviews are conducted every 5-years.

The FHA is a set of analyses and assessments for evaluating potential fire hazards, as well as the appropriate fire protection systems and features used to mitigate the effects of a fire. The FSSA is an analysis conducted for NPPs to demonstrate that at least one means of achieving nuclear safety objectives and performance criteria is available. The FHA and FSSA are contained within the FPA report. The 2021 FPA concluded that the station is provided with effective design, construction, fire protection features and operational controls to mitigate the fire hazards present and maintain the fire, life and nuclear safety goals defined in CSA N293.

Third-party audits have been conducted on OPG's Nuclear Fire Protection Program, with respect to the requirements of CSA N293. As per CSA N293-12, the audit is required to be conducted at least once every 3-years by a qualified third party. The 2023 audit results confirmed that the FPP was in good overall health and effective, and that Darlington NGS meets the objectives defined in Clause 8.3.4 of CSA N293-12 (R2017).

Annual plant condition inspections are performed to confirm compliance to CSA N293-12 and the NFCC per Clause 8.3.5 of CSA N293-12 (R2017). The 2023 Annual Plant Condition Inspection (APCI) saw sufficient evidence to conclude that the fire protection program was being followed and effectively maintained the condition of the plant in compliance with requirements of CSA N293, NFCC, and NBCC.

During the current licence term, significant projects / modifications have been undertaken to improve the reliability and performance of fire safety and the fire protection system. These projects have and will continue to ensure safe operation. Specific projects include:

1. Upgrade of fire panels from conventional to addressable:

   Conventional fire panels throughout the plant are being upgraded to addressable fire panels to improve system reliability and maintainability.

2. Upgrade of Public Address (PA) System:

   Darlington NGS PA System provides paging for voice instructions, fire alarm signals, emergency warning signals to all areas of the generating station, associated buildings, and outdoor areas. The PA System is being upgraded to ensure reliability, and maintainability. Refer to Section 2.10, for further information on PA System status and ongoing improvements.

3. Transformer Deluge System increased coverage:

   As part of the Darlington NGS Refurbishment Integrated Safety Review (ISR), the currently installed transformer fire protection was evaluated against CSA N293-07 and a code gap was identified that the non-absorbing ground areas adjacent to the main output transformer, unit service transformer, and system service transformer were not protected by automatic water spray systems. Each deluge system is being upgraded in their respective Refurbishment outage to increase coverage. There is no impact to fire safety prior to completion of the modification.

4. Installation of additional detection in higher-risk areas:

   As a result of the FHA and FSSA, it was recommended to provide additional fire detection coverage in the following areas: Instrument Air compressors room, PHT pumps, silicone filled transformer in room R-321, PHT system auxiliary room, Annulus Gas System room, ECI low pressure pumps, ECI high pressure pumps, ESW pumps.

5. ESW Pump Oil Spill Containment Dikes:

   As a result of the FHA and FSSA, a 25 ft^2 dike which can contain at least 125% volume of oil was installed around each of the four (4) ESW pumps. The purpose of the dike is to limit the spread of a potential oil fire from a failed ESW pump, and addresses the economic and safety risks associated with multiple ESW pump failures.

2.5.5.6 Reactor and Reactor Coolant Systems

The reactor is contained in a cylindrical, horizontal, single-walled stainless steel vessel called the calandria. It provides containment for the heavy water moderator and reflector. It is axially penetrated by 480 calandria tubes. These tubes contain the pressure tubes, which contain the fuel and heavy water coolant. The calandria, the two end shields, and the shield tank form an integral, multi-compartment structure.

The subsections below provide further details on the design and performance of reactor and reactor coolant systems, along with improvements made during the current licence term and planned improvements for the upcoming licence term.

Design of Fuel System

N-PROG-MA-0016, *Fuel*, establishes a formal and systematic process for integrating and reviewing information related to fuel, and reporting its performance, condition, and compliance with fuel design basis documents.

The fuel is in the form of compacted and sintered natural uranium dioxide pellets, sheathed and sealed in zirconium alloy tubes. Thirty-seven tubes or elements are assembled between two end plates, forming one fuel bundle. Each of the 480 channels contains 13 bundles.

There was no change to the design of the fuel bundles used by Darlington NGS during this period and Modified 37-element (37M) bundles continue to be used for running units in both “standard” and “long” lengths. Small numbers of depleted 37M bundles also continue to be used when required to ensure compliance with core physics parameters, e.g. the fresh core load after each Refurbishment outage.

The design capability to execute fuel recycling (fuel shuffling) during the post-refurbishment pre-equilibrium period of operation has been re-introduced at Darlington NGS by means of a minor change to Fuelling Machine software. A fuel recycling campaign has been successfully executed in Unit 3 (2023) after its return to service following refurbishment, with good fuel performance and a significant reduction in the number of low irradiation fuel bundles prematurely discharged to the bay.

Fuel Handling and Storage

The reactor is refuelled on-power by two remotely controlled Fuelling Machines (FMs). One is located at each face of the reactor. They work at opposite ends of the same fuel channel, inserting new fuel and accepting irradiated fuel while the reactor continues to operate. The irradiated fuel is transported by the fuelling machine trolleys to the ends of the fuelling duct to be discharged into one of the two IFBs in the FFAAs. Storage of the discharged fuel is maintained in the adjacent storage bays until ready for dry storage in the Waste Management Facility. There are three pairs of fuelling machine heads shared by the four reactors. Safe, reliable, and predictable performance of the fuelling machines is necessary to maintain core reactivity and support outage activities. Online refuelling operation on a routine basis is required to ensure sufficient reactivity to maintain reactor operation at full power and maintain average zone levels in the target range for optimum control.

The objectives of the Fuel Handling and Storage program are to:

- Ensure FMs are available to maintain average zone levels across the four operating units.
- Support execution of outage activities related to reactor inspection and maintenance.
- Provide safe handling and storage of fuel.
- Maintain fuel accounting.

Completed projects, modifications, and initiatives which have improved reliability and performance of the Fuel Handling (FH) Systems over the term of the current operating licence include:

- FM vessels/supports reanalysis/qualification.
- FM D_2O circulation and auxiliary circuit sub-system components replacement.

- FH process computer peripherals and components replacement.
- New Fuel Transfer Mechanism transporter assembly replacement for large-scale unit defuel upgrade.
- IFB heat exchanger replacement for large-scale unit defuel upgrade.
- Inverter motor drive sub-system replacement.
- FH Irradiation Fuel Port isolation valves replacement.
- FH Control System power supplies replacement.
- FM Input Drive upgrade modification.
- FH Powertrack carrier track and roller components replacement.
- FH control power auto transfer relays replacement.
- Fuel Inspection Facilities modification, including upgrade of Module Unloader mechanisms.
- FH Control Room alarm window annunciation sub-system replacement.

In-progress and planned projects, modifications, and initiatives for continued improvement in reliability and performance of the FH Systems include:

- In-progress and planned replacement of FH equipment and components such as motors, pumps, controllers, relays, valves, digital cards, actuators, hard drives, cables, and Reactor Area Bridge ball screws.

Design of the Reactor Internals

Darlington NGS refurbishment resulted in complete replacement of all 480 calandria tubes and all 480 pressure tubes during each refurbishment outage. Replacement pressure tubes are nominally thicker: 4.29 mm (0.169”) versus 4.19 mm (0.165”) in the original Unit 2 design.

Additionally, design changes have also been made to the fuel channel annulus spacers for post-refurbishment Darlington NGS units. All fuel channels have been installed with the novel Zr-Nb-Cu tight fitting garter springs to eliminate known material degradation issues with pre-refurbishment Inconel X-750 annulus spacers.

For Unit 2 (2020) and Unit 3 (2023), there was no change in the design of the adjuster rods - “like-for-like” replacement with new rods of the same types, and each reactor core was confirmed to be consistent with existing design documentation during return to service activities. Refer to subsection below for discussion on cobalt adjuster rods.

A minor change for Unit 2 reactor internals is associated with installation of the Molybdenum-99 Isotope Irradiation System (Target Delivery System) following CNSC approval of the licence amendment (PROL 13.03/2025). Due to their low neutron absorption properties and low mass, both the permanent in-core TDS components and the moveable molybdenum targets did not change core characteristics.

Nuclear Design and Core Nuclear Performance

A design change has been successfully implemented in Darlington Units 2, 3 and 4 to use Enriched Boric Acid (EBA) instead of natural boron as the moderator liquid poison of choice, while maintaining the existing capability to add gadolinium. Unit 1 conversion to EBA will be completed during its refurbishment outage. The details of this design change (required concentration of EBA and insertion rate) were chosen such that reactor control was not affected and operating procedures were not significantly impacted. Using EBA as the poison of choice for reactivity banking (fuelling ahead) has facilitated longer maintenance windows to improve the reliability of FH equipment, as well as improved coordination with refurbishment activities.

A permanent core design change is planned to replace existing adjuster rods with cobalt adjusters of similar reactivity worth in all units. This modification is planned to be first commissioned in Unit 1 return to service, subject to the Commission decision on the Darlington NGS PROL amendment for the production of the Cobalt-60 radioisotope. This design change is of a nature that does not significantly affect core characteristics, including flux and power distributions, reactivity coefficients, reactor control or reactor stability. Refer to Section 3.4 for further information on isotopes, including Cobalt-60.

Modifications and Projects for Reactor and Reactor Coolant Systems

The following modifications and projects have been completed or are in progress during the current and upcoming licence terms:

1. Auxiliary Shutdown Cooling (ASDC) Pumps: the installation of two completely diverse ASDC Pumps per unit is a safety improvement that provides a maintenance cooling mode and a supplement to the currently installed SDC main pumps.
2. Emergency Heat Sink Alternate Supply to PHT system: this modification provides an alternate supply of cooling water to the PHT system from the ESW system.
3. Loss of Moderator Accident (LOMA) due to End Fitting Ejection (EFE) and random failure of ECI: this modification provides a permanent pipe connection to provide water to the PHT system.
4. End Shield Cooling (ESC) Tank Make-Up Water and Level Monitoring & Water to PHT: instrumentation was installed to provide level monitoring of the end shields and shield tank water level post BDBA.
5. Fixed Vibration Monitoring replacement: the Vibration Monitoring System (VMS) at Darlington NGS is designed to warn operations staff of vibration problems and requires replacement due to aging, obsolescence, and spare parts issues.
6. ESC Shield Tank Overpressure Protection (STOP) modification: a rupture disc was installed on the End Shield and Shield Tank Cooling System in Units 1 to 4 to provide overpressure protection in the event of a BDBE.
7. Single Loop Controller replacements: existing controllers are used to monitor and control variables such as temperature, level, flow, and pressure and require replacement due to aging and obsolescence.
8. PHT liquid relief valve (LRV) replacements: during refurbishment, the existing PHT LRVs are being replaced with new valves that have slower opening and closing times to reduce water-hammer to an acceptable level, while maintaining overpressure protection requirements.
9. Spectacle Flange installation: the purpose of the modification is to install a spectacle flange in the D_2O Collection System downstream of various Pressure and Inventory Control (P&IC) vent/drain valves to maintain leakage rates and D_2O Collection tank temperatures to within acceptable limits.

10. Moderator Main Isolators replacement: the main and auxiliary Moderator pump and heat exchanger isolation valves have been, or are scheduled to be, replaced during the refurbishment outages.
11. PHT Isolators replacement: this modification ensures D_2O supply to the PHT system is maintained via the D_2O transfer header for operating units during refurbishment, without the risk of spilling tritiated D_2O into the outage units.
12. P&IC Heater Controllers replacement: this modification replaces the existing pressurizer heater controllers with new variable controllers. The controllers are required to control the pressurizer variable heaters output which in return controls the pressure of the PHT system.
13. PHT Pumps, Seals and Pump Motors replacement: these replacements were made to improve reliability performance with reduced leakage to collection.
14. Feeder Scanner System modification: due to obsolescence and aging issues, the feeder scanner system has been upgraded to a new system with improved data quality and data interpretation technologies to ensure reliable detection of fuel defects during outages.
15. Gaseous Fission Product (GFP) modification: the GFP detection computer had an alternative power supply installed to ensure availability and reliability.
16. Primary Side Clean (PSC) to restore PHT system Reactor Inlet Header (RIH) temperature margins: due to corrosion induced magnetite deposits, the Primary Side (tube side) portion of all Steam Generators were cleaned during refurbishment to improve heat transfer capacity, coolant flow, and by extension RIH Temperature Margins.
17. Moderator Pump Motor procurement and first-time replacement during the refurbishment of Unit 1 as part of 4kV motor refurb project: these motors at Darlington NGS are reaching end of recommended service life and are being proactively refurbished/replaced to ensure reliable operation.
18. PHT feed pump spare procurement and first-time replacement as part of 4kV motor refurb project: these motors are reaching end of recommended service life and are being proactively refurbished/replaced to ensure reliable operation.
19. Upgrade PHT Feed Pump Seals to Diamond faced model to eliminate risk of leakage to collection: due to a history of mechanical seal leaks, these seals have been replaced with an upgraded model.

2.5.5.7 Waste Treatment Control

Waste is generated at Darlington NGS as a result of daily operations and maintenance activities, and during execution of outage activities. Waste is characterized as either radiological or conventional depending on the radiological zones of its origin, and from radiological surveys and analysis that are performed on it as it is generated. The Waste Management Program ensures that adequate provisions are in place to limit the production of radioactive and conventional waste, and to control its handling, storage, and disposal. This is done to continuously improve environmental performance in support of OPG's Environmental Policy. All activities involving handling, processing, transportation and storage of waste are performed in a manner that protects the workers, the public and the environment, and ensures compliance with applicable regulatory and license basis requirements. Refer to Section 2.11 for more details on the Waste Management Program.

2.5.5.8 Class II Nuclear Facilities

A Class II nuclear facility, or Radiation Calibration Facility (RCF), is located within the Darlington NGS and contains a J.L. Shepherd gamma irradiator. The irradiator contains three Cs-137 sources; one 37000 GBq, one 370 GBq and one 3.7 GBq. It is used to irradiate radiation detection instrumentation and thermoluminescent dosimetry (TLD) badges for the purposes of calibration and quality assurance. This facility is licenced in accordance with the Class II Nuclear Facilities and Prescribed Equipment Licence 12861-18-26.7.

The RCF is located within the Darlington NGS (S-003 and S-004) in the Powerhouse and, as a result, has the security controls of a Class I Nuclear Facility. Access control keys for the facility and irradiator controls are issued by Operations. The RCF adheres to OPG's RP program along with the associated governance procedures. OPG's RCF physical design is in compliance with the Class II Facilities and Prescribed Equipment Regulations Section 15.

2.5.5.9 Laboratories

The Darlington NGS chemistry laboratory focuses on providing timely and accurate results to support station operation. Laboratory staff participate in interlaboratory blind samples programs run by the CANDU Owners Group once per year. The objective of the interlaboratory comparison is to check OPG's analytical capability relative to a group of peer laboratories. A range of proficiency testing blind samples are prepared and distributed by a program administrator which also provides a statistically derived acceptance criteria to participating laboratories.

The Darlington NGS chemistry laboratory also has an intralaboratory blind sample program which continuously assesses the performance of laboratory staff. This internal program consists of six rounds per year of analytes consisting of blind samples for Quality Control Level 1 parameters. A Quality Control Level 1 parameter is one which an Operating Policies and Principles limit applies or has a safety limit in the Operational Safety Requirements.

Chemistry fundamentals are consistently reinforced during pre-job briefs to ensure safe and accurate laboratory operation. Monthly checks of chemical storage are also performed. Darlington NGS regularly reviews and reports sub-indicators in the Chemistry Laboratory Quality Control Indicator (CLQCI) which is an overall measure of the Chemistry Quality Management System. The CLQCI is calculated by equally weighting five sub-indicators (Instrument Availability, Control Chart Usage, Intralaboratory Proficiency, Laboratory Reporting and Laboratory Safety) and determining the monthly score as a percent against a rolling yearly target of 95%. Since the inception of CLQCI in 2018, Darlington NGS Chemistry has exceeded the annual rolling average of >95%, showing a robust Quality Management program.

The laboratory has upgraded instrumentation during the current licence term in order to ensure redundancy and refine accuracy through newer technologies. Equipment that has been upgraded include gamma spectroscopy equipment, ion chromatographs, gas chromatographs, UV visible spectrophotometers, total organic carbon analyzers, inductively coupled plasma spectrometer and fourier transformer infrared spectrometers. Darlington NGS will continue to evaluate and make upgrades to equipment throughout the upcoming licence term to ensure the requirements of the chemistry laboratory are met with safety as the top priority, while adapting to new technologies and analysis methods.

Section 2.6

Fitness for Service

2.6 Fitness for Service

The Darlington NGS fitness for service program ensures 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 Darlington NGS remain available, reliable, effective and consistent with design, analysis and quality control measures.

The reliability, maintenance and aging management programs at Darlington NGS meet the requirements of CNSC regulatory documents REGDOC-2.6.1, *Reliability Programs for Nuclear Power Plants*, REGDOC-2.6.2, *Maintenance Programs for Nuclear Power Plants*, and REGDOC-2.6.3, *Aging Management*, respectively.

The OPG documents in the table below require written notification of change per Darlington NGS Licence Conditions Handbook, LCH-PR-13.03/2025-R005:

Table 10: SCA 6 – Fitness for Service

Document	Title
Maintenance	
N-PROG-MA-0004	Conduct of Maintenance
N-PROG-MA-0017	Component and Equipment Surveillance
N-PROG-MA-0019	Production Work Management
N-PROG-MP-0008	Integrated Aging Management
N-PROC-MA-0013	Planned Outage Management
N-PROC-MA-0049	Forced Outage Management
Reliability	
N-PROG-MA-0026	Equipment Reliability
N-PROG-RA-0016	Risk and Reliability Program
N-STD-RA-0033	Reliability and Monitoring of Systems Important to Safety
NK38-LIST-06937-10001	List of Safety Related Systems and Functions
Aging Management	
N-PROG-MA-0025	Major Components
N-PLAN-01060-10001[1]	Feeders Life Cycle Management Plan
Feeders	
NK38-PIP-33160-10001	Darlington Nuclear Unit 1 Fuel Channel Feeder Pipes Periodic Inspection Program Plan
NK38-PIP-33160-10002	Darlington Nuclear Unit 2 Fuel Channel Feeder Pipes Periodic Inspection Program Plan
NK38-PIP-33160-10003	Darlington Nuclear Unit 3 Fuel Channel Feeder Pipes Periodic Inspection Program Plan
NK38-PIP-33160-10004	Darlington Nuclear Unit 4 Fuel Channel Feeder Pipes Periodic Inspection Program Plan
Pressure Boundary	
N-PLAN-33110-10009	Steam Generators Life Cycle Management Plan
Stream Generators	
NK38-PLAN-33110-00001[2]	Darlington Units 1-4 Steam Generator Life Cycle Management Plan
Fuel Channels	
N-PLAN-01060-10002	Fuel Channels Life Cycle Management Plan

Document	Title
NK38-PIP-31100-10001	Darlington Nuclear 1-4, Unit 1 Fuel Channel Pressure Tubes Periodic Inspection Program Plan
NK38-PIP-31100-10002	Darlington Nuclear 1-4, Unit 2 Fuel Channel Pressure Tubes Periodic Inspection Program Plan
NK38-PIP-31100-10003	Darlington Nuclear 1-4, Unit 3 Fuel Channel Pressure Tubes Periodic Inspection Program Plan
NK38-PIP-31100-10004	Darlington Nuclear 1-4, Unit 4 Fuel Channel Pressure Tubes Periodic Inspection Program Plan
N-PLAN-01060-10003	Reactor Components and Structures Life Cycle Management Plan
NK38-PLAN-31160-10000[3]	Long Term Darlington Life Management Plan for Inconel X-750 Spacers
Periodic Inspection Plans	
NK38-PIP-03641.2-10001	Darlington Nuclear Generating Station Periodic Inspection Plan for Unit 1
NK38-PIP-03641.2-10002	Darlington Nuclear Generating Station Periodic Inspection Plan for Unit 2
NK38-PIP-03641.2-10003	Darlington Nuclear Generating Station Periodic Inspection Plan for Unit 3
NK38-PIP-03641.2-10004	Darlington Nuclear Generating Station Periodic Inspection Plan for Unit 4
NK38-PIP-03642.2-10001	Darlington Nuclear Generating Station – Periodic Inspection Program for Unit 0 and Units 1 To 4 Containment Components
NK38-PIP-03643.2-10002	Darlington Nuclear – Unit 0 Containment Periodic Inspection Program
N-PLAN-01060-10004	Aging Management Plan for Containment Structures
NK38-PIP-03643.2-10001	Darlington Nuclear – Reactor Building Periodic Inspection Program
NK38-PIP-03643.2-10003	Darlington Nuclear – Vacuum Building Periodic Inspection Program
NK38-TS-03643-10001	Inspection of Post Tensioning Tendons on DNGS Vacuum Building
N-PROC-MA-0066	Administrative Requirements for In-Service Examination and Testing for Concrete Containment Structures
NK38-PLAN-01060-10010[4]	Aging Management Plan for Darlington NGS Non-Containment Building Structures
Balance of Plant	
NK38-REP-34200-10066	Darlington NGS Main Containment Structure In-Service Leakage Rate Test Requirements in Accordance with CSA N287.7-08
NK38-REP-26100-10005	Darlington NGS Vacuum Structure In-Service Leakage Rate Test Requirements in Accordance with CSA N287.7-08

Notes:
1. OPG recommends N-PLAN-01060-10001 be moved under the *"Feeders"* section of the table.
2. OPG recommends N-PLAN-33110-10009 be removed from the table as this is the technical basis document and not the LCMP.
3. OPG recommends NK38-PLAN-31160-10000 be removed from the table as it is no longer in use and information is now included in N-PLAN-01060-10002.

4. N-PLAN-01060-10010 has been superseded by N-PLAN-01060-10004, *Aging Management Plan for Concrete Containment Structures and Safety Related Structures*.

2.6.1 Equipment Fitness for Service / Equipment Performance

Equipment Reliability

The objective of the Equipment Reliability (ER) program, N-PROG-MA-0026, *Equipment Reliability*, is to ensure high levels of equipment reliability and reduce forced loss rate by ensuring reliable performance of critical components important to nuclear safety and production.

The ER program leverages various activities to ensure ongoing high levels of reliable performance of critical components. This includes identification of critical components and maintenance strategies, executing Predictive Maintenance (PdM) and Preventative Maintenance (PM) programs, monitoring system and component condition, identifying and predicting aging and obsolescence issues on important components and embedding mitigating strategies and actions into the business plan.

The Plant Health Committee (PHC), provides oversight, direction, and leadership for resolving ER issues and implementing actions from System and Component Health Plans. The PHC consists of managers and/or directors from the key functional organizations at Darlington NGS involved in implementing ER actions. The key activities for the PHC are conducted in accordance with N-PROC-MA-0097, *Equipment Reliability Implementation*.

The ER key performance indicator through 2023 was the Equipment Reliability Index (ERI). CANDU Owners Group (COG) established the ERI, which the industry used to assess health of a plant's reliability program and equipment performance and enabled benchmarking against other plants. The ERI provided a measure of long-term trends of ER improvements and sustainability, utilizing a composite of key sub-indicators that have a weighed value to add up to 100 as the highest score.

Figure 18 below depicts the ERI score trends from 2015 to 2023 for Darlington NGS in comparison to the target. Darlington NGS's ERI greatly improved over the current licence term. The 2023-year-end ERI score for Darlington NGS was 91, which is an improvement from the 2022 Q4 score. Darlington NGS has maintained an average ERI score of 86 points since 2017. Darlington NGS has focused on several initiatives to sustain an improved ER. Key actions include backlog reduction, PM program sustainability, establishing System Health Teams (SHTs), improvements to scheduling of critical PM work orders to ensure equipment reliability.

In 2024, the ER key performance indicator transitioned from ERI to the Institute of Nuclear Power Operators (INPO) Equipment Performance Index (EQP). This standardized metric for ER performance is utilized for INPO reporting stations from Canada, USA, Mexico, Romania, UAE, and South Africa, allowing for broader comparison and industry benchmarking. Five weighted sub-indicators measuring equipment reliability performance balanced across both a 12-month (EQP12M) and 18-month (EQP18M) rolling period add to a score of 100, with performance measured at the unit level and station level.

Darlington NGS has performed benchmarking against other plants through physical and virtual benchmarking of CANDU and non-CANDU station best practices as well as participation in the COG ER Working Group and Fuel Handling Equipment Reliability Working Group, INPO ER Peer Group, and various technical committees from the Electric Power Research Institute (EPRI) to continuously improve performance.

Over the current licence term, Darlington NGS has undertaken a multi-year, multi-phase, multi-unit refurbishment project that will enable continued safe and reliable operation through 2055. This program includes replacement of life-limiting critical components, equipment upgrades, and rehabilitation of components. Darlington NGS refurbishment project is expected to be complete in 2026, which will return to service all four units fully refurbished.

In addition, Darlington NGS has made a considerable investment ($800M+) in the past two years in projects to improve equipment reliability and address aging and obsolescence. These initiatives will improve system and equipment reliability, redundancy in support of safe and reliable operation for years to come. For examples of these initiatives refer to Section 2.5 and Appendix B.

Darlington NGS is actively advancing multiple initiatives to enhance ER for the future. These initiatives aim to reinforce a robust safety and human performance culture, ensure high plant reliability of station systems and equipment, and enhance work planning and execution. They also support sustainability and the future development of the station. Throughout 2024, Darlington NGS is committed to driving continuous improvement in ER by focusing on enhanced oversight and monitoring of plant reliability risks and cross-functional ER behaviors. Efforts include implementing actions to prevent consequential events such as stronger cross-functional support, stronger mitigating strategies, and stronger bias to risk elimination. Additional strategies involve cross-functional engagement for identifying and mitigating system vulnerabilities, optimizing the preventive maintenance program, and strengthening organizational resilience and depth with qualified, competent staff to meet the station's needs.

Darlington NGS has intensified its focus on Fuel Handling Equipment Reliability (FH ER), supported by a cultural shift towards a 'Fuel First & for the Future' mindset. This initiative is overseen by the monthly Fuel Handling Oversight Committee, which monitors risks and Key Performance Indicators (KPIs). As a result, FH ER has shown improvements in Q4-2023, with continued enhancements anticipated in future years.

Additionally, Darlington NGS has established dedicated SHTs for critical systems that have historically contributed to significant equipment-related events. These systems include main power output, fuel handling, turbine, generator, and primary heat transport. The SHTs facilitate cross-functional analysis and collaboration, enhancing equipment reliability through improved self-awareness and proactive self-correction.

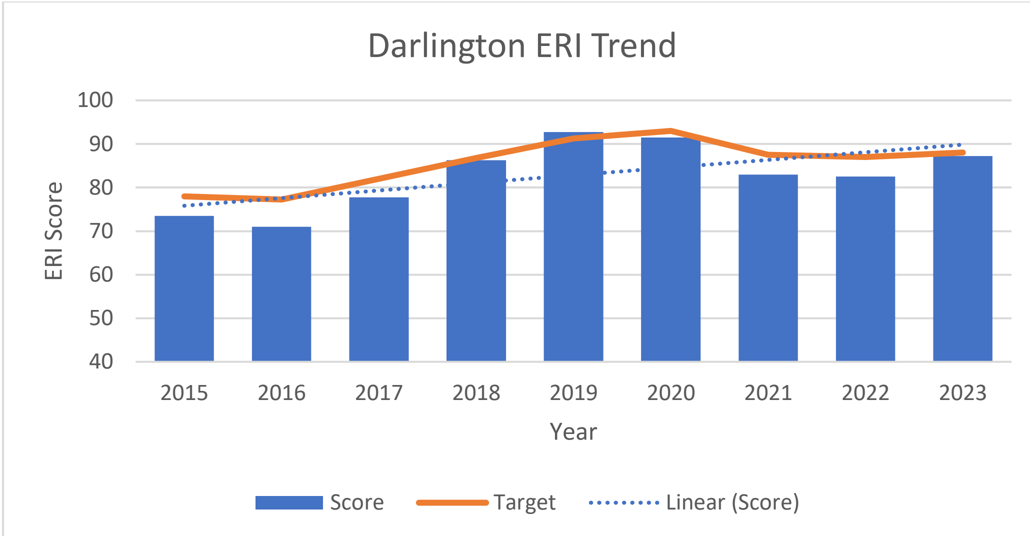


Figure 18: ERI Trend from 2015 to 2023

Reliability of Systems Important to Safety

The Risk and Reliability Program, N-PROG-RA-0016, ensures Systems Important to Safety (SIS) and Components Important to Safety (CIS) are identified and their performance measures and targets are established with Probabilistic Safety Assessment (PSA) insights being used in the process. SIS and CIS are those station systems and components which contribute significantly to the initiation, prevention, detection, or mitigation of any failure sequence which could lead to damage of fuel or associated release of radionuclide or both.

The program requires operational performance of SIS be monitored, assessed and reported and component reliability data be compiled, analyzed and applied to maintain unavailability models. Nuclear standard N-STD-RA-0033, *Reliability Monitoring and Reporting of Systems*, provides requirements for reliability monitoring and reporting of SIS and CIS, and is consistent with CNSC regulatory documents REGDOC-2.6.1 and REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants*.

The SIS/CIS list is developed using all available plant PSA studies. Expert panel reviews are completed to ensure that deterministic insights, historical licensing practices and industry reviews are considered while finalizing this list. This methodology for generating the initial SIS/CIS list is based on COG document COG-15-2068, *Developing List of Systems & Components Important to Safety*. The SIS and CIS at Darlington NGS are listed in NK38-REP-03611-10100, *Darlington NGS Systems and Components Important to Safety*.

Darlington NGS has identified 14 SIS as listed below. Individual components which were not part of a SIS but found to exceed risk-importance thresholds were designated as CIS. There are currently 49 CIS at Darlington NGS.

Of the 14 total SIS, the following 11 systems were designated as being important to safety based on deterministic insights and historical licensing practices and contributions to Control, Cool and Contain functions, and were agreed upon during the expert panel review.

Special Safety Systems:

1. Shutdown System 1;
2. Shutdown System 2;
3. Emergency Coolant Injection System;
4. Negative Pressure Containment System;

Standby and Emergency Heat Sinks:

5. Emergency Service Water to the Steam Generators;
6. Inter-Unit Feedwater Tie;
7. Steam Generator Emergency Cooling System;
8. Shutdown Cooling System;

Backup and Emergency Electrical Systems:

9. Emergency Power System;
10. Standby Class III Power;

Additional Systems:

11. Powerhouse Steam Venting System;

The three remaining systems were selected based on probabilistic methods. Specifically, system importance was calculated using SYSImp (System Importance), which is an industry standard tool used to calculate collective importance of basic events in a given PSA model. The calculated system importance was then held against industry standards thresholds which are used as recommended indicators of SIS.

12. Low Pressure Service Water;
13. Emergency Service Water to the Calandria;
14. Class 1 Power.

Per REGDOC-3.1.1, the reliability and performance of SIS/CIS is documented and reported through the Annual Risk and Reliability Report (ARRR). The ARRR discusses changes to the SIS/CIS list and their reliability targets, SIS/CIS performance, updates to unavailability models, reviews of surveillance activities, the number of initiating events, and major changes in failure modes/failure rates. SIS performance is measured using unavailability models, which incorporate internal and external component failure data to reflect current design, operation, and maintenance practices to calculate the Predicted Future Unavailability (PFU) of each system. Furthermore, SIS operational performance is evaluated through routine testing per the requirements described in N-STD-OP-0018, *Operability Testing of Safety-Related-Systems*. The field reliability data collected from operability testing and other sources is then incorporated into system unavailability models to improve the accuracy of PFU calculations.

ARRRs have been submitted to the CNSC each year of the current licence term, where annual SIS performance is documented and directly compared to respective reliability targets. As per the 2023 Darlington NGS ARRR, all 14 SIS were operating within their defined reliability targets.

The strength of the reliability program and its implementation at Darlington NGS is demonstrated through inspections and audits, such as the 2022 Nuclear Oversight audit of OPG's reliability program. An assessment of SIS reliability monitoring and reporting practices were within the scope of this audit and the audit team did not identify any findings and assessed the overall implementation and performance of the program across OPG to be fully effective.

2.6.2 Maintenance

Darlington NGS meets the requirements of REGDOC-2.6.2, which states that effective maintenance is essential for the safe operation of a nuclear power plant. Specifically, the Darlington NGS facility must be monitored, inspected, tested, assessed and maintained to ensure that Systems, Structures, and Components (SSCs) function as per design. Various maintenance concepts are used to form the Darlington NGS Maintenance strategy and the relevant documentation that supports the strategy is summarized in the following sections.

The majority of maintenance activities are divided into preventive or corrective maintenance. Where the performance or condition of an SSC does not allow it to function as per design, corrective action is taken. The results of all maintenance activities are fed back through an optimization process which enables the continuous improvement of the program.

The Programs, Procedures and Standards documentation described here are used to implement the maintenance strategy and cyclically reviewed and/or updated as required to ensure that the information and instructions are aligned with all regulatory requirements. A typical review cycle is 5-years, however, when changes occur within the normal cycle, documentation is updated and issued prior to the normal cycle. Additionally, each document used has a retention period with defined review parameters for supervision as well as storage timeline requirements. This provides transparency for internal/external audits and becomes the basis for assurance that work is executed safely, consistently and with quality.

The Darlington NGS Maintenance program, directed by N-PROG-MA-0004, *Conduct of Maintenance*, is designed to ensure personnel and public safety, protection of the environment and reliable operation. The program includes work planning, work execution, tool calibration and control, personnel and training as well as performance indicators and assessment. This document also provides authority for N-PROC-MA-0015, *Tool Control*, whereby, it is the expectation that anyone who uses, handles or manages/administers tooling tracked in the Tool Control System shall comply with the processes/requirements outlined. Managed tools encompass those deemed high value, those with issuance/return tracking and those that require inspection and/or calibration as defined by this procedure.

The Darlington NGS Maintenance program interfaces with N-PROG-MA-0019, *Production Work Management* to support the process by which maintenance, modifications, surveillances, testing, engineering support and any work activities that require plant coordination or schedule integration are implemented.

The Component and Equipment Surveillance program, N-PROG-MA-0017 is a set of activities to assure the health of a select group of nuclear facility components. Darlington NGS Maintenance implements standards and procedures in support of component and equipment performance which further supports the overall safe, reliable and economic operation of OPG Nuclear.

The outage management processes for preparation and execution of planned and forced nuclear unit outages within OPG Nuclear receive authority from N-PROG-MA-0019, *Production Work Management*. Governance associated with planned outages is in accordance with N-PROC-MA-0013, *Planned Outage Management* and governance associated with forced outages is in accordance with N-PROC-MA-0049, *Forced Outage Management*. Refer to Section 2.3.4 for additional information on outage management.

The maintenance program is organized to align closely with the Engineering, Work Management, Operations and Supply Chain organizations to support equipment fitness for service requirements.

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

Maintenance is key to equipment reliability. Maintenance at Darlington NGS largely consists of preventative maintenance with a focus on condition-based maintenance, wherein systems with the ability to measure or monitor parameters that determine when the maintenance is required are used. This allows for efficient work scheduling and completion of maintenance on a time-based approach.

The Maintenance organization works closely with the work group responsible for planning and scheduling of work – known as Work Control. Through N-PROC-MA-0002, *Work Planning*, Work Control establishes the process of planning work to ensure common base requirements are uniformly supported across nuclear. Through a collaborative and cross functional series of meetings, required tasks are prioritized and scheduled to preserve, repair and/or test equipment that supports safe operation of the Station. In addition, this process is benchmarked against the industry standard to ensure alignment with top performing nuclear stations.

Through N-PROC-MA-0006, *Work Performance*, Maintenance establishes the process of performance of maintenance activities within OPG to repair or replace malfunctioning SSCs to re-establish conformance with program requirements. This allows Maintenance and Work Control to optimize the planning and execution of work that directly and indirectly supports continued operation and/or maintaining the safe operation envelope within licence limits.

Upon completion of maintenance activities, Post-Maintenance Tests (PMTs) are conducted as per N-STD-MA-0008, *Station Material Condition and Housekeeping* which establishes the PMT process and specifies the requirements.

Corrective Maintenance

Darlington NGS's goal is to ensure that maintenance backlog levels are inline or better than industry benchmark targets. The volume of maintenance backlogs have improved annually since the creation of the backlog dashboard that provides granular details of overall performance. Since 2020, the backlog has been reduced from a peak total of approximately 500 Work Orders (WOs) to the end of year projection to meet the station target of 70 WOs in 2024.

Preventative Maintenance Activities

The Predefined Process, N-PROC-MA-0020 (or PM process) provides a formal means to facilitate planning, scheduling, and execution of work of a recurrent nature. The associated rigors and controls of the process generate administrative demand, so predefineds are established to meet station needs. Nuclear refurbishment PMs are PMs that have been created, scheduled, and accepted for execution during the nuclear refurbishment outage (including return to service) and are managed by the nuclear refurbishment organization to meet the needs of the project.

PM program improvements have focused on changing behaviours and reinforcing expectations around performance metrics that promote a healthy, and sustainable living program. Key performance indicators have been established and are reviewed weekly at the oversight forum, or Preventative Maintenance Review Board (PMRB), to monitor progress and take actions as required.

Key cross-functional initiatives driven through Engineering, Work Management and Maintenance include:

1. Maintenance consistently achieving greater than 95% as found condition compliance, which prompts engineering to evaluate and refine PM strategies. This ensures maintenance is performed at the correct frequency.
2. Reduced PM Modification Requests (PMMRs) Backlog: minimize the backlog of PMMRs, maintaining a “live zero”. This translates into PM strategy changes to the program on an on-going basis.
3. The PMRB focuses on operating experience and critically evaluates PMMRs modification requests, challenging their necessity, enabling factors, and required resources. This ensures that each modification is justified and aligned with the overall goals of the PM Program.

The target due date for every PM is followed by a “late” date where the PM must be executed. The time between the target due date and the late date is known as “grace”. Grace is divided into two halves with the second half referred to as being “deep in grace”. The number of PM WOs completed during the second half of the grace period was reduced from 417 in Q1 2022 to 207 in Q3 2023 which was attributable to the monitoring and updating of each Unit as they return to service post refurbishment.

Enhancing the management and reduction of time spent working on equipment that impacts online Unit operation is another opportunity for improvement. This will be achieved by explicitly identifying and emphasizing T-reviews that include maintenance activities to ensure the risk is known and the recall time is sufficient. This will facilitate improved management of critical handoffs, increase robust tracking, and improve oversight of work with detailed risk reviews and challenge meetings.

In this context, T-reviews refers to work being executed in an upcoming work week. T-8 refers to work being executed 8 weeks in the future. A T-review is required prior to execution and T-meetings are held at regular intervals to determine if the schedule needs to be adjusted due to impacts such as available resources and/or materials.

The station team has also undertaken a Plant Reliability Station Excellence Initiative to systematically review the PM program. Under this initiative the team will review and update the frequencies of PM WOs based on available operating experience.

Maintenance Program Assessment

The Darlington NGS Maintenance program demonstrates a commitment to continuous improvement through the Self Assessment (SA) process. Darlington NGS Maintenance conducts annual department SA on maintenance fundamentals and technical skills to identify improvement opportunities where focused actions will sustain performance. In addition, specific programmatic elements are reviewed on a rotating cycle to ensure that documentation, performance and behaviours are aligned with the expectations of those processes. These assessments demonstrate that Darlington NGS is a self learning organization that seeks continuous improvement.

By participating in divisional SAs, Darlington NGS Maintenance ensures that they contribute to cross-functional teams that work to achieve and sustain high levels of plant reliability. In 2023 a comprehensive self assessment addressed actions to improve cross-functional risk recognition, mitigation, and elimination behaviors at Darlington NGS, lowering the number of equipment-related consequential events. The Darlington NGS demonstrated improvements in applying the recommendations and applied a multi-pronged approach to close the gap to excellence. This includes but is not limited to a communication campaign to raise awareness for all stakeholders as to how they can contribute to high-level plant reliability, identification and prioritization of highest risk equipment to ensure mitigating and/or bridging strategies are in place and an examination of potential parts issues related to procurement lead times and obsolescence. These proactive efforts align with the overall maintenance strategy of balancing preventative and corrective maintenance in the desired proportions.

Maintenance continues to actively perform SA at divisional and departmental levels to intrusively evaluate the effectiveness of individual aspects of the program (eg. FME, Hoisting and Rigging, Work Protection) as well as overall program effectiveness using N-PROC-RA-0097, *Self-Assessment and Benchmarking*. By overtly demonstrating a commitment to self identification of preventative and corrective actions, Darlington NGS Maintenance effectively merges the requirements set forth by the regulator with evidence that supports continuous learning and improvement initiatives across a broad spectrum of programmatic oversight. The effort to self identify and transparently report out to oversight bodies is further validated through their independent reviews, audits and inspections. Proactive initiatives, corrective actions and development of leading and lagging indicators better inform our continuous improvement plan and provide a path to consistent improvement, with supporting evidence both internally and through independent sources that are external to Maintenance.

2.6.3 Aging Management

The Integrated Aging Management (IAM) program is an overarching and comprehensive program, which provides the framework for managing aging at OPG and demonstrates how the current processes and programs meet the requirements for effective aging management in accordance with REGDOC-2.6.3. Program document N-PROG-MP-0008, *Integrated Aging Management* is the governing program and procedure N-PROC-MP-0060, *Aging Management Process* is the implementing program for aging management at OPG.

The objective of the IAM program is to ensure that the condition of critical nuclear facility equipment is understood and that required activities are in place to ensure the health of these components and systems while the plant ages. This is accomplished by establishing an integrated set of programs and activities to ensure that the performance requirements of all critical station equipment are met on an ongoing basis. The IAM program covers all SSCs defined as critical based on a nuclear safety, production, environment and cost significance perspective. The IAM process is summarized in Figure 19.

To ensure effective implementation and management of the IAM program at Darlington NGS, roles and responsibilities are defined in Section 2.0 of N-PROG-MP-0008. The responsibilities for the IAM program are split between corporate groups and the station.

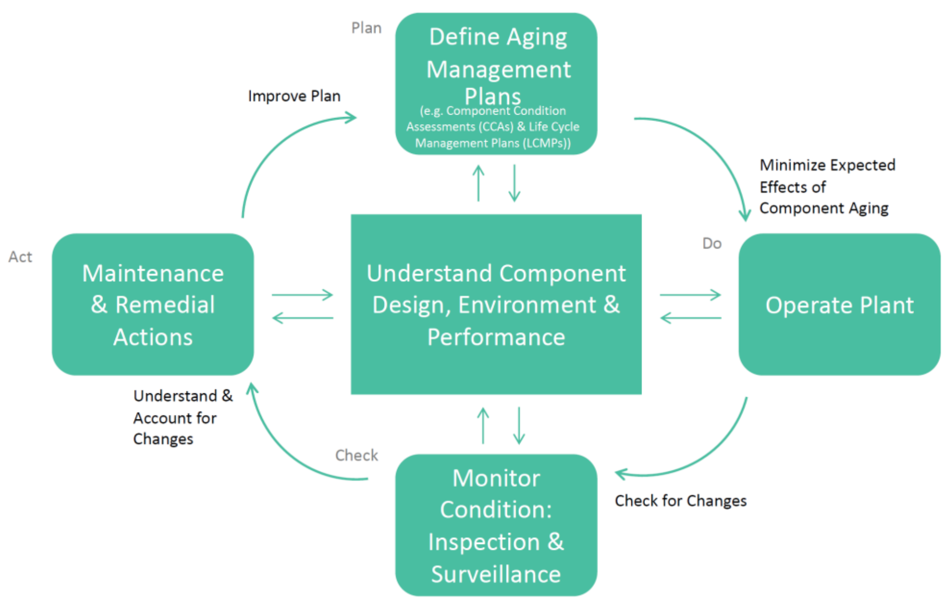


Figure 19: Integrated Aging Management Process

Implementing procedure N-PROC-MP-0060 describes the process for performing the following aging management activities:

- Effective aging management planning for SSC.
- Scoping to identify and group SSCs based on aging related characteristics.
- Screening to determine the method of Condition Assessment (CA) (whether an SSC within aging management scope requires a CA report to be developed), and.
- CA to identify actions required to ensure the health of SSCs as the plant ages and to maintain the overall effectiveness of the aging management plans (CAs are prepared as per N-GUIDE-01060-0001, *Component Condition Assessment Preparation Guide*).

The aging management process uses a systematic and comprehensive approach to assess the effectiveness of an SSC's aging management plan and address any aging related issues.

An SSC's CA report provides a "road map" of its respective aging management plan through the application of the nine attributes in REGDOC-2.6.3, which are embedded within the CA process. The method of CA is determined and defined in N-PROC-MP-0060 and is accomplished through the following:

- Component and system surveillance for components important for safe and reliable operation.
- Fitness for service assessments and Life Cycle Management Plans (LCMPs) for major components such as fuel channels, steam generators, reactor components, turbine generators, and other strategic and long-lead SSCs.
- CA records for the balance of AM critical plant equipment.

To ensure effective implementation and management of the IAM program at Darlington NGS, roles and responsibilities are defined in Section 2.0 of N-PROG-MP-0008. The responsibilities for the IAM program are split between corporate groups and the station.

Sections 4.0 and 5.0 of implementing procedure N-PROC-MP-0060 set the requirements for data collection and record-keeping in support of the IAM program. Data and records relevant to aging management are divided into the following categories:

- Baseline information consisting of data on the design and condition of the SSC at the beginning of its service life.
- Operating history regarding test and service data on the availability and failure of the SSC.
- SSC maintenance history.
- Records of SSC screening, Condition Assessment (CA) reports, and LCMPs.

The aging management process requires SSC screening and CAs to be appropriately documented, per N-PROC-MP-0060. The following data is recorded and stored in such a way that it is secure and retrievable:

- Screening records retained in Asset Suite.
- CAs documented and retained in Asset Suite as controlled documents.
- Recommended actions to be traceable; for example, as action tracking assignments, in respective health report action plans, or in work management.

All reports are required to be complete, valid, legible, retrievable, and traceable to the parts and activities to which they refer, as outlined in CSA N286-12, *Management System Requirements for Nuclear Facilities*, Section 4.7. Management of data is conducted in accordance with OPG-PROG-0001, *Information Management* and all records are maintained in an approved records repository, in accordance with OPG-PROC-0019, *Records and Document Management*.

Aging Management Interfacing Programs

The following aging management interfacing programs are in place to support reliability and availability of required safety functions of SSCs throughout the service life of Darlington NGS. This includes programs that ensure all equipment is available to perform its intended design function.

N-PROG-MA-0025, *Major Components*: this interfacing program establishes an integrated set of processes and activities to demonstrate fitness for service for the four major component areas: fuel channels, feeders, steam generators, and reactor components and structures. Developing a long-term LCMP is one of the primary objectives of this program. It provides a framework for integrating and reporting of the component performance, condition, and compliance with the licence requirements. This program ensures that these four major components will perform safely and reliably until the end of commercial operations, maintaining design and licensing bases and operational safety requirements while optimizing production and cost effectiveness.

N-PROG-MA-0017, *Component and Equipment Surveillance*: this interfacing program document describes the program elements that establish a focused surveillance monitoring process. Implementation of these programmatic requirements provides a consistent methodology for performing component and equipment surveillance for select components at all OPG nuclear stations and Nuclear Sustainability Services Facilities. It consists of activities to evaluate, inspect, test and report on the health of a select group of nuclear facility components. The effectiveness of the component and equipment surveillance engineering programs are periodically evaluated against the nine attributes of an effective aging management program as listed in REGDOC-2.6.3.

N-PROG-MA-0026, *Equipment Reliability*: this interfacing program established the process for maintenance activities and system performance monitoring of critical components. The Equipment Reliability program and its implementing procedures ensure that critical components meet their defined or desired level of reliability for the lifespan of the station.

N-STD-MA-0024, *Obsolescence Management*: this interfacing process takes authority from the aging management governance. The purpose of this standard is to define and implement a sustaining process to manage the proactive and reactive obsolescence issues associated with critical equipment and components. The process activities should interface with equipment reliability and life-cycle management strategies designed to sustain continued safe and reliable plant operation.

N-PROG-OP-0004, *Chemistry*: this interfacing program specifies processes, requirements, and staff accountabilities to ensure effective control of plant chemistry, including provisions for analytical services. Systems are operated and consistently tested using approved operating procedures and chemistry specifications to ensure aging degradation remains as documented in the design basis and completed condition assessments.

There are several other programs, processes and activities implemented throughout the facility's life cycle, including design, construction, commissioning, operation (including extended shutdowns) and decommissioning. The description of these programs and their purpose in supporting aging management are described in Section 1.6 of N-PROG-MP-0008, and include such programs as Environmental Qualification, Fuel, Design Management, Engineering Change Control, Performance Improvement, Nuclear Operations, Conduct of Maintenance, Reactor Safety, Risk and Reliability, Decommissioning, Nuclear Waste Management, and Items and Services Management.

OPG Nuclear's comprehensive monitoring of component and equipment aging is accomplished through the implementation of all the above programs and the integration of interfacing activities that are managed under the various programs listed above.

2.6.3.1 Systems, Structures or Components-Specific Aging Management Plans

An SSC-specific Aging Management Plan (AMP) defines all relevant aging mechanisms, current condition, any accredited engineering, inspection, or maintenance programs, and preventative actions to maintain or improve the health of the SCC and minimize degradation.

AMPs are addressed via LCMPs for major components (listed below) as per the guidelines described in procedure N-PROC-MA-0100, *Major Components Life Cycle Management Plan*, which is based on the methodology presented in N-PROC-MP-0060, and compliant with the requirements of REGDOC-2.6.3. A 10-year outlook detailing the required inspection and maintenance activities is provided within each of the following plans and updated annually to capture the operation of Darlington NGS Units 1 to 4 into and out of refurbishment.

The LCMPs for the Major Components are:

- N-PLAN-01060-10001, *Feeders Life Cycle Management Plan*;
- N-PLAN-01060-10002, *Fuel Channels Life Cycle Management Plan*;
- N-PLAN-01060-10003, *Reactor Components and Structures Life Cycle Management Plan*;
- N-PLAN-33110-10009, *Steam Generators Life Cycle Management Plan*.

Fuel Channel Aging Management

Fuel channel aging management is a comprehensive program of in-service inspection, maintenance, engineering assessments and research and development for fuel channels. The fuel channel LCMP describes and summarizes the major known fuel channel aging mechanisms, identifies expected life limits posed by each aging mechanism, and provides strategies required to manage fuel channels to station specific target operating life. Detailed reports regarding the status of aging mechanisms, compliant with REGDOC-2.6.3, are available as separate documents for Darlington NGS. Some of the aging-based inspection and maintenance activities are as follows:

- Flaw monitoring;
- Body of tube and rolled joint scrapes;
- Elongation measurements;
- Diametral expansion;
- Wall thinning;
- Rolled joint predictions;
- Pressure tube fretting;
- Pressure tube to calandria tube (PT-CT) gap measurements;
- Pressure tube volumetric inspection;
- Annulus spacer fitness for service.

The fuel channel LCMP is updated annually to capture new information from outage inspections, research, and operating experience, in addition to activities planned in compliance with CSA N285.4, *Periodic inspection of CANDU nuclear power plant components*. With the implementation of the fuel channel LCMP, OPG will continue to demonstrate that aging mechanisms are understood and confirm that component condition remains acceptable via monitoring and inspection for post-refurbishment operation.

Improvements to the manufacturing process of pressure tubes installed during Refurbishment for all Darlington NGS Units are expected to mitigate known major life-limiting aging mechanisms. Trace amounts of impurities including hydrogen and chlorine remain in the pressure tube from the manufacturing process which contribute to decline of pressure tube material properties over the operating life of the unit. Reducing the level of impurities during manufacturing is expected to control initial concentration levels to improve fracture toughness of the pressure tubes and reduce susceptibility to delayed hydride cracking.

Design changes have been made to the annulus spacers for post-refurbishment Darlington NGS units. All fuel channels will be installed with the novel Zr-Nb-Cu tight fitting garter springs to eliminate known material degradation issues with pre-refurbishment Inconel X-750 annulus spacers.

Reactor Components and Structures Aging Management

The Reactor Components and Structures LCMP, N-PLAN-01060-10003, establishes the strategy or identify necessary actions to ensure that the effects of aging on reactor components and structures are appropriately managed for the operating life of OPG's fleet of nuclear units. The aging management of the components addressed within the reactor components and structures section are as follows:

- Calandria and shield tank assembly;
- Calandria tubes;
- Calandria Tube to Liquid Injection Shutdown System (CT/LISS) nozzle clearance;
- Guide tubes;
- Moderator inlet nozzles/pipes;
- Calandria end shield support;
- Lattice tubes;
- End fittings;
- Calandria relief ducts;
- Other reactor internals to maintain fitness for service.

The reactor components and structures LCMP is updated annually to capture new information from outage inspections, research, and operating experience, in addition to activities planned in compliance with CSA N285.4.

Manufacturing improvements were made to the calandria tubes installed during Darlington NGS refurbishment. The changes are to increase the overall integrity of the fuel channel during accident scenarios. Potential contact between the calandria tube and LISS nozzle was eliminated with the replacement of the calandria tubes for post-refurbishment operation. OPG expects that continued inspections and monitoring confirm the reactor components fitness for service to the target end of life through the existing LCMP.

Feeders Aging Management

The feeder piping system aging management program, documented in N-PLAN-01060-10001, contains the CSA N285.4 periodic inspection program, in-service inspection, and PROL compliance inspection activities during and post Darlington NGS refurbishment, the overall strategy to maintain the system integrity, and the fitness for service guidelines. The most significant feeder aging management programs are listed below:

- Flow Accelerated Corrosion, managed through scheduled wall thickness measurements and stress analysis;
- Fretting damage, managed through visual or clearance inspections and chafing shield installations on the reactor face and in the feeder cabinets.
- Instrument line fretting inside the feeder cabinet, managed through visual inspections.
- Feeder replacement, in place for feeders that are not expected to reach the end of the planned operating life of the unit.

The feeders LCMP is updated annually to capture new information from outage inspections, research, and operating experience, in addition to activities planned in compliance with CSA N285.4. The LCMP is updated annually to incorporate changes to these requirements that may be warranted from inspection results on the rates and extent of active degradation, as well as significant feeder related operating experience from OPG and other CANDU stations. The plan also contains strategies to deal with plausible aging mechanisms that are not active but may become active. In the plan, the operational risk, areas of vulnerability in the piping system, and mitigating actions to ensure that feeders remain within the design basis are identified.

Feeder replacements were performed during refurbishment with the elimination and mitigation of major degradation mechanisms achieved through improved material, fabrication, and installation specifications. Continued monitoring of feeders through the LCMP is performed to ensure that the aging effects are appropriately managed to support post-refurbishment operation.

Steam Generators Aging Management

The Steam Generator (SG) aging management program, documented in N-PLAN-33110-10009, ensures all units operate safely and reliably with the existing steam generators through the service life of the station, while maintaining the design and licensing bases, and optimizing station reliability, production, and cost-effectiveness.

SGs are closely monitored by an inspection program to manage active and plausible degradation mechanisms. The main goal of the steam generator LCMP is to maintain thermal performance by means of an effective inspection and maintenance program to prevent or mitigate steam generator degradation and failures (i.e., tube leak). Inspection of pressure boundary shell welds, nozzles and external vessel supports is prescribed in the periodic inspection program specific to each unit in compliance with CSA N285.4 and the in-service inspection plan.

Through comprehensive life extension assessments, the existing Darlington NGS steam generators were retained and endorsed for post-refurbishment operation. The SG LCMP is optimized to support extended life beyond design and the detailed planning phase for mid-life refurbishment of these components being pursued by OPG.

Completed and planned replacements of the Primary Moisture Separators for all SGs are being performed to address active degradation mechanisms for the long-term, operation of Darlington NGS. Additionally, post-refurbishment operating margins are being managed through primary side cleaning of all units during refurbishment.

Periodic and In-Service Inspection Programs

Periodic Inspection Programs (PIP) define the inspection plans required to ensure acceptability of specific nuclear power plant and containment components, in accordance with the relevant edition of standards CSA N285.4, *Periodic inspection of CANDU nuclear power plant components*, N285.5, *Periodic inspection of CANDU nuclear power plant containment components*, N285.8, *Technical requirements for in-service inspection evaluation of zirconium alloy in pressure tubes in CANDU reactors*, and N287.7, *In-service examination and testing requirements for concrete containment structures for CANDU nuclear power plants*.

The PIP plans are developed and maintained within the relevant governing programs identified above and include non-destructive examination techniques and procedures developed and implemented as per the CSA standards, specific program requirements, the nature of the degradation, and the regulatory requirements, as applicable. The Darlington NGS CSA N285.4 PIP is divided into four system/component groups addressing specific clauses of CSA N285.4 including the general pressure boundary components, fuel channel pressure tubes, fuel channel feeder pipes, and SGs tubes. See Section 6.5 for further details on PIP.

2.6.3.2 Review and Improvement Process for Aging Management Programs

OPG ensures that AMPs are reviewed periodically to ensure continued effectiveness and that they meet the following requirements:

- Supplement the ongoing engineering surveillance activities.
- Are implemented in accordance with the overall IAM program framework.
- Address the nine attributes of an effective aging management program as listed in REGDOC-2.6.3.

Since OPG completed REGDOC-2.6.3 (2014) implementation in July 2017, two effectiveness reviews (in 2018 and 2019) to support compliance with REGDOC-2.6.3 (2014) have been performed and these reviews have confirmed that the implementation of Darlington NGS's IAM program is effective and sustaining, compliant with its governance and REGDOC-2.6.3 (2014).

In addition, a recent review of Aging Management was performed under the Darlington Periodic Safety Review (D-PSR) under Safety Factors 2 and 4. Refer to Section 3.3 for further details on the D-PSR.

2.6.4 Chemistry Control

Chemistry control refers to the control of chemical impurities which contribute to degradation and accelerated aging in plant systems. Plant fitness for service is adversely affected when uncontrolled chemistry results in equipment damage and reduced system availability. Through implementation of management system programs and procedures, OPG maintains a robust system of processes to control plant chemistry, allowing plants to remain fit for service.

OPG implements a chemistry program via N-PROG-OP-0004, *Chemistry*, which specifies processes, overall requirements, and staff accountabilities to ensure effective control of plant chemistry, including provision of analytical services. These activities are performed in order to ensure critical plant equipment performs safely and reliably over the life of the station. The chemistry program complies with CSA N286-12 and also interfaces with the environment program through NK38-MAN-03480-10001, *Environment Manual*, to limit and monitor the release of chemicals and radioactive material.

The technical basis for chemistry control is defined under a set of technical standards under N-STH-01807-10000, *OPG Nuclear Systems Chemistry Specification Manual* and reports N-REP-01807-10010, *OPG Chemistry Rationale and Operating Experience.* N-STH-01807-10000 and the chemistry program establishes requirements for effective chemistry control during operating and lay-up states.

Control of system chemistry and chemistry work management procedures establish the chemistry surveillance program to detect undesirable trends and consequences. It is implemented through the suite of OPG Nuclear systems chemistry specification manuals, NK38-OM-09160, *Chemical Control*, and suite of chemistry laboratory procedures.

N-PROG-OP-0004 and the following implementing documents capture the requirements to have defined chemistry specifications for systems, procedures for chemistry parameter monitoring, trending and monitoring activities, and procedures for the storage and handling of chemicals: N-PROC-OP-0012, *Control of Process Chemicals*, OPG-PROC-0126, *Hazardous Material Management*, and N-TS-01806.5-100XX, *Material Specifications* series manuals outline storage and handling requirements of chemicals. N-PROC-OP-0013, *Control of System Chemistry* defines processes to be followed to control system chemistry during all plant states and includes instructions regarding maintenance of chemistry specifications, monitoring of system chemistry conditions, control actions required to maintain optimum chemistry, and monitoring of actual performance. N-PROC-OP-0014, *Chemistry Laboratory Work Management* defines requirements for laboratory equipment, sampling and analysis, and quality control in order to perform chemistry monitoring.

Online Monitoring

Consideration is given to utilize online monitoring where possible through OPG nuclear systems chemistry specification manual and chemical control, under which specifications and corrective actions against online out-of-range chemistry are defined. The online instrumentation availability is tracked through performance indicator online analyzer availability to drive visibility and improvements throughout the station. The calibration and maintenance program for online and laboratory instrumentation is captured under chemistry work management.

Analytical Service Availability

The Darlington NGS chemistry laboratory ensures analytical services are available at all times. Defense in depth is employed through redundant instrumentation and satellite laboratories in the Tritium Removal Facility and an external laboratory.

Post Accident Sampling

In the case of post-accident sampling, NK38-OM-09013E, *Abnormal Incidents Manual - Part E - Post-Accident Response* requires sampling and analysis of emergency filtered air discharge system radiation monitor to be initiated to monitor noble gases, iodine, particulate, tritium and gross gamma in containment. The emergency response procedure is as per N-PROG-RA-

0001, *Consolidated Nuclear Emergency Plan*, which is implemented in the chemistry laboratory through D-INS-03490-10006, *Chemistry Laboratory – Emergency Response* to assign personnel emergency response tasks, and to sort, analyze and report samples.

Implementation and Management of Process Chemicals and Hazardous Materials

OPG has established procedures for the processes to prevent use of impure or ineffective process chemicals through the control of process chemicals procedure, and OPG-PROC-0126, *Hazardous Material Management* which outlines the approval, labeling, and training protocols to safeguard OPG employees and OPG supervised contract workers from risks related to working with or near hazardous materials. These procedures ensure the required quality of chemicals is maintained throughout their usage. OPG also maintains a list of approved process chemicals as specified by N-TS-01806.5-100XX, *Material Specifications*, and documented by the chemistry colour classification as per control of process chemicals procedure.

Chemistry Performance

The chemistry program is a Tier 1 program and oversight on program execution performance is provided through quarterly program fleetveiw reports (as per N-PROC-RA-0023) which is approved by the program authority and presented at the Nuclear Executive Committee for endorsement. The Chemistry Corporate Functional Area Manager (CFAM) provides oversight on station chemistry performance and operational chemistry control effectiveness is assessed using a set of KPIs; CNSC CI (Chemistry Index) and CCI (Chemistry Compliance Index) are reported in the Fleetview Program Health and Performance Report as one of the KPIs of the chemistry program functional area summary and in station program health reporting.

CANDU Owners' Group Intra Laboratory Studies (COGIS):

CANDU station laboratories are subject to routine inter-laboratory blind testing once per year. The purpose of this program is to evaluate laboratory methods, compared to industry peers. Results are evaluated by an external agency.

2.6.5 Periodic Inspection and Testing and Structural Integrity

The objective of the PIP is to ensure structural integrity of the nuclear plant systems and components, including containment components in Darlington NGS. The programs are documented in specific PIP plans and associated inspection schedules, and they are administered under corporate and station governing documents. The main objective of the PIPs is to ensure they satisfy the associated CSA standards as outlined in the sections that follow.

Periodic inspections shall be conducted to provide assurance of the improbability of:

a) A failure that can produce radiological conditions exceeding the health and safety limits for normal operation as stated in the safety report (CSA N285.4)

b) The structural failure of containment components when the containment system is required to perform its function as defined in the safety report (CSA N285.5).

c) Concrete components and their parts failing, and leading to: 1) compromising the leak tightness of the containment envelope; 2) adversely affecting the operability and structural integrity of the concrete containment systems (CSA N287.7).

d) The failure of structural components of non-containment, safety-related structures that could negatively impact nuclear safety systems (CSA N291).

Darington NGS CSA N285.4 and N285.5 Periodic Inspection Programs

The CSA N285.4-14 program requires inspection of approximately 1578 locations across four units. Each location is inspected once within each unit's 10-year inspection interval. Inspected components include, piping and vessel welds, pumps, valves, piping, and component supports, and mechanical couplings.

The CSA N285.5-18 program consists of approximately 1907 inspection locations across Units 0 and 1 to 4. Each location is inspected once within each unit's 10-year inspection interval; except for components whose inspection requires a Vacuum Building Outage (VBO), where inspections are performed at least once every 12-years. Inspected components include containment penetration seal welds, pipe supports, piping/ducting, valves, containment dampers and other containment components.

Inaugural inspections are performed for newly installed components in accordance with the requirements in the CSA N285.4 and CSA N285.5 standards. These inspections are performed to establish the condition of the components at the time it was placed into service. This ensures that when periodic inspections are performed, there will be at least one previous result for each component, thus allowing for comparative analysis between the inspection results.

Darington NGS CSA N287.7 Periodic Inspection Program

The CSA N287.7-08 program addresses inspection and testing of concrete containment structures. Separate PIP plans have been created, submitted to and accepted by the CNSC for the vacuum building, reactor buildings, and Unit 0 concrete containment components. These inspection plans identify the civil containment structures and components to be inspected, describe relevant mechanisms potentially affecting these components, identify inspection methods and acceptance criteria, and define reporting requirements.

The last N287.7 PIP inspections included:

- The reactor buildings (Units 1 to 4) were inspected between 2017 and 2023 (including refurbishment scope), in accordance with the relevant PIP plan. Overall concrete condition was found to be acceptable.
- The vacuum building interior was inspected during the 2015 planned VBO. Inspection scope during this outage included major concrete structures of the vacuum building: dousing water storage tank, main floor, dome, support structures, etc. Concrete condition was found to be overall acceptable and comparable to previous results.
- The Unit 0 containment components were inspected in 2022 and areas included the Central Service Area-Nuclear and the West Fuelling Facilities Auxiliary Area. Results showed that structural and containment integrity were in acceptable condition overall.
- The vacuum building post-tensioning system was inspection in 2021-2022. Overall, the inspection results were found to be acceptable.

Darlington NGS CSA N291 Periodic Inspection Program

CSA N291:19, *Requirements for nuclear safety-related structures* specifies requirements for the material, analysis and design, construction, fabrication, inspection, examination, and aging management of nuclear non-containment, safety-related structures. The N291 PIP plan, NK38-PIP-03643.2-10004, *Darlington NGS, In-service Inspection Periodic Inspection Program for Non-Containment Buildings and Safety-Related Structures and Components*, was prepared to describe requirements for performing inspections, evaluating the results, and documenting inspection reports for the non-containment, safety-related structures at Darlington NGS. This PIP describes the processes and activities required to monitor, evaluate, and document aging effects on safety-related structures to ensure they will maintain their performance throughout the life of the plant to withstand design basis loads. The goal of inspection is to provide observations which lead to identification of deficiencies associated with building facades, concrete structures and components, masonry wall, roofings and steel structure condition. Selected components shall be inspected at no more than 6-years. For inaccessible areas, inspection shall be at frequency agreed upon by the CNSC.

2.6.5.1 Structural Integrity

The stations principal structures are discussed in Section 2.5.4.

Inspections to confirm structural integrity are performed in accordance with the associated PIP documents and to the requirements of CSA N285.5-18, CSA N287.7-08, and clauses 9 and 10 of CSA N291:19.

OPG carries out inspections and tests of the inaccessible components of the vacuum building, the dousing system and the pressure relief duct at least once every 12-years. A Vacuum Structure Positive Pressure Test and a test to measure the leakage rate, at full positive design pressure, of the Main Containment Structure is also be repeated every 12-years.

In addition, OPG inspects the accessible portions of the concrete structures of the Main Containment Structures and their components once every 6-years in accordance with the CSA N287.7-08 PIP.

Section 2.7

Radiation Protection

2.7 Radiation Protection

Darlington NGS has an effective Radiation Protection (RP) program that meets or exceeds all applicable regulatory requirements and related objectives. The health and safety of persons is protected through the implementation of the RP program, which ensures that radiation doses are kept below regulatory dose limits and are optimized and maintained As Low As Reasonably Achievable (ALARA). Radiological impacts of plant operation to workers and the public will continue to be of an acceptable level.

The RP program, N-PROG-RA-0013, *Radiation Protection* implements a series of standards and procedures for the conduct of activities within nuclear sites and with radioactive materials intended to achieve and maintain high standards of RP including the achievement of the following objectives:

1) Controlling occupational and public exposure.
    a) Keeping individual doses below regulatory limits.
    b) Avoiding unplanned exposures.
    c) Keeping individual risk from lifetime radiation exposure to an acceptable level.
    d) Keeping collective doses ALARA.
2) Preventing the uncontrolled release of contamination or radioactive materials from the nuclear sites through the movement of people and materials.
3) Demonstrating the achievement of (1) and (2) through monitoring.

The OPG documents in the table below require written notification of change per Darlington NGS Licence Conditions Handbook, LCH-PR-13.03/2025-R005:

Table 11: SCA 7 – Radiation Protection

Document	Title
N-PROG-RA-0013	Radiation Protection
N-STD-RA-0018	Controlling Exposure As Low As Reasonably Achievable
N-REP-03420-10001[1]	Occupational Radiation Protection Action Levels for Power Reactor Operating Licenses
N-PROC-RA-0019	Dose Limits and Exposure Control
N-PROC-RA-0027	Radioactive Work Planning, Execution and Close Out
N-MAN-03416-10000	Radiation Dosimetry Program – General Requirements
N-MAN-03416.1-10000	Radiation Dosimetry Program – External Dosimetry
N-MAN-03416.2-10000	Radiation Dosimetry Program – Internal Dosimetry
OPG-PROC-0132	Respiratory Protection

Note:
1. N-STD-RA-0044, *Occupational Radiation Protection Action Levels for Power Reactor Operating Licences* supersedes N-REP-03420-10001, *Occupational Radiation Protection Action Levels for Power Reactor Operating Licenses*.

2.7.1 Application of ALARA

Management of facility collective dose is implemented in tHe ALARA program and strategy. Annual collective dose targets established by the facility are developed based on the business planning cycle, planned maintenance scope, routine operations, and CANDU industry guidelines. The target accounts for anticipated dose savings from implementation of dose reduction initiatives, application of ALARA principles, and past operating experience and performance. The ALARA section provides oversight on the facility's performance against the established targets and establishes corrective actions, where required, with support from senior plant management. Another key element of the ALARA program is to develop a 5-year or long range ALARA plan to document specific strategies for reducing personnel exposures.

The Darlington NGS site ALARA strategy identifies initiatives, actions and programs that support achieving these objectives, and the means by which the effectiveness of these initiatives are measured. The strategy applies to all Darlington NGS units, whether the unit is operating (online), shutdown for planned maintenance, or in refurbishment, and applies to all Darlington NGS personnel, contractors and visitors.

The following subsections further demonstrate OPG's commitments to improving the ALARA culture and objectives.

Dedicated RP Division

Allocating appropriate resources, both financial and personnel, is necessary for the organization to support radiation protection and financial means to implement ALARA initiatives. The RP organization at Darlington NGS consists of a Department Manager, Section Managers (Field & Programs/ALARA), Senior (Responsible) Health Physicist, Health Physicists (with various program area specific qualifications), Field Supervisors and RP Technicians. Health Physicist qualifications can include program areas such as instrumentation, dosimetry and ALARA. Health Physicists with the ALARA qualification primarily support the ALARA program and long-term strategy to implement reduction initiatives and provide oversight to minimize collective dose.

ALARA Culture

The ALARA department plays an important role in managing the station Collective Radiation Exposures (CRE) and ensuring it is ALARA. To perform this function effectively, the ALARA department advocates for the workforce to be cognisant of the core ALARA principles by facilitating work groups to minimize their collective exposures for every task they perform. By providing expertise and knowledge in dose reduction and minimization efforts to all station departments and work groups, the station can achieve lower CRE and continue to be a high performing nuclear station with the highest ALARA standards.

Frequent updates of department RP performance are communicated to the station with an optimized dashboard, highlighting key RP metrics, latest RP events and current status of department's RP score. The department RP score is based on metrics such as collective dose and contamination control events. Departments are placed in various levels of oversight, depending on current RP performance and score.

Lessons Learned

The majority of annual station collective dose occurs during major planned maintenance outages. N-PROC-MA-0013, *Planned Outage Management* outlines key milestones required to be met prior to and following planned maintenance outages including a review of lessons learned identified during planning and execution. RP and ALARA stakeholders play integral roles in reviewing lessons learned from all outage campaigns. They contribute valuable insights to a report that consolidates these lessons, outlining a strategic plan for their implementation in future outages. Online projects follow the same process for capturing lessons learned, the integrated online work schedule provides guidance and timelines for implementation. Darlington NGS executed the replacement of shutdown cooling heat exchangers across all units over multiple years. Implementation of dose reduction initiatives, lessons learned and ALARA oversight contributed to a 4-fold reduction in project collective dose per replacement.

Radiological Exposure Permit Dose Constraints

Radiological Exposure Permits (REPs) are one of the primary administrative controls by which radiological work is planned and controlled. Radiological controls are applied to all hazard levels of radioactive work and a graded approach is applied to higher risk work. Requirements to use full-scale mock-ups, participate in training and simulations are in place to familiarize workers prior to execution to minimize dose during actual execution. Additional radiological controls also include stay time limits, stay time keeping and remote dosimetry monitoring, to further reduce collective exposure.

The permitted dose and dose rate constrains are subjected to a thorough understanding of the workplace conditions based on radiological surveys and operating experience. In the latter, historical dosimeter records are periodically reviewed, and constraints are updated using industry guidance. Over the licensing period, the use of dose constraints in OPG has ensured no internal Administrative Dose Limits (ADLs) or regulatory dose limits have been exceeded (for all sources of radiation).

ALARA Input to Facility Design Changes

The standards for accommodating new designs or proposed engineering changes which may affect radiation exposure are supported through interfacing programs from Radiation Protection and Engineering. This interfacing processes of N-STD-RA-0018, *Controlling Exposures As Low As Reasonably Achievable*, and N-PROG-MP-0001, *Engineered Change Control*, drive the use of tools and checklists for radiological safety to ensure a comprehensive, robust review is performed during the design phase. These reviews help to understand how exposures can be eliminated or hazards reduced. When appropriate, the administrative controls within the RP program help bridge areas within the chosen design features. Extensive RP oversight has been present during the design of a medical radioisotope delivery system to produce Molybdenum-99 (Mo-99) during routine unit operation. Radiological safety aspects in design targets were established to include occupational and public dose during commissioning, routine operations, maintenance and upset conditions, dose rates around shielded components and accessible areas, surface and airborne contamination and environmental emissions.

Enhanced Pressure Tube Inspection Tooling

A new tooling design was developed to replace conventional sampling tools used to conduct CANDU pressure tube inspections during planned maintenance outages. Periodic inspections of pressure tubes are required according to CSA standards and are typically performed each outage, contributing to the majority of outage collective dose. The new tooling design minimizes required time spent at the reactor face, where dose rates are higher, and thus significantly minimizes personnel exposure for pressure tube inspections. The new inspection tooling in post refurbishment outages is expected to achieve a 6-fold dose reduction compared to previous outages.

Darlington Nuclear for the Future (D4F)

This station-wide initiative, implemented post-refurbishment, benefits from newly replaced core components to reduce overall station outage dose. Post-refurbishment, component replacements have also reduced outage radiological source term, resulting in lower dose rates from reactor components and lower airborne tritium concentrations inside containment. Together, this reduces both collective external and internal exposures for all maintenance outage activities inside containment and further reduces outage collective dose targets.

Continuous Improvement

The ALARA program drives continuous improvement to align with industry best practices and latest technological development that can be used to minimize dose. ALARA performs annual assessments of the process and performance of the ALARA program to be self-critical and self-identify areas for improvement. Assessments focus on specific ALARA processes such as establishment of facility dose targets, radioactive work planning process, dose control events, source term and dose reduction efforts, and use of operating experience.

Continuous improvement is also driven through the RP dashboard, which identifies early indicators in decline of department-level RP performance. Additional oversight is provided to improve performance and lessons learned are shared with other station departments to drive overall station RP performance improvements.

2.7.2 Worker Dose Control

Individual worker doses, including those for contractors and visitors are managed to Exposure Control Levels (ECLs) that are below administrative control levels that are in turn below the regulatory limits. N-PROC-RA-0019, *Dose Limits and Exposure Control* specifies requirements to manage dose within ECLs and ADLs to control any worker's dose below CNSC regulatory limits. It receives authority from N-PROG-RA-0013, *Radiation Protection*.

Exposure to radiation is managed through:

- Limiting individual worker dose.
- Establishing facility design consistent with ALARA principles.
- Assessing hazards for planning and maintaining knowledge of conditions.
- Planning and performing radioactive work to keep exposures ALARA.
- Avoiding unplanned exposures and controlling the use of licensed radioactive devices and equipment.

N-INS-08965-10012, *Requirements for Radiological Respiratory Protection*, and OPG-PROC-0132, *Respiratory Protection*, reference the requirements for the selection, care and use of respiratory protection. OPG-PROC-0132 identifies conventional respiratory protection requirements (e.g. fit testing) while N-INS-08965-10012 outlines RP program requirements.

Collective dose performance targets for each facility are established annually by station management and consider the reductions achievable through the application of ALARA techniques. As work is planned in detail, collective dose projections shall be reviewed, and actions taken to ensure dose is ALARA. Actual performance against targets is reviewed and corrective actions taken where warranted. Management of collective dose is implemented in N-STD-RA-0018.

When making engineering changes, engineers maintain or improve upon designs that reduce occupational exposures throughout the lifecycle of the facility, taking into account social and economic factors. RP staff review engineering changes to provide input for achieving these goals in accordance with N-PROC-MP-0083, *Constructability, Operability, Maintainability, and Safety (COMS).* Certain areas of the station are subject to high radiation fields as a result of normal reactor operation, irradiated fuel transfer, equipment operation or exposure of calibration sources. Accidental entry to these areas is prevented through the use of locked access points. When work is required in these areas, workers use procedures and physical controls to ensure the access hazards are not present or, if present, are strictly controlled.

All radioactive work is planned and includes anticipation and evaluation of radiation hazards, selection of appropriate protective measures and dosimetry. The degree of formalization of the planning process and the approval levels for a job is proportional to the potential for exposure. Plans include back-out conditions and contingencies. RP planning decisions are documented in a REP. When radioactive work is assigned, the supervisor ensures all workers have the appropriate radiation qualifications or that a qualified worker is assigned to provide RP to those that are not qualified to work independently. The supervisor ensures persons assigned to the work will not exceed exposure control levels in the course of performing the work as planned. The requirements for planning and execution are implemented in N-PROC-RA-0027, *Radioactive Work Planning, Execution and Close Out.*

Radiation Personal Protective Equipment (RPPE) is provided for workers and used by workers based on anticipated exposure conditions and maintained in accordance with N-PROC-RA-0096, *Lifecycle Management of Radiation Personal Protective Equipment*. The procedures for usage of RPPE are implemented in N-PROC-RA-0025, *Selection of Radiation Personal Protective Equipment.*

Action Levels

Action levels are either a specific radiation dose or other parameter that, if reached, may indicate a loss of control of part of the RP program. Action Levels have been established for CNSC issued licences. Events or conditions identified through these mechanisms that indicate real or potential deficiencies are filed as Station Condition Records (SCRs). SCRs are categorized, given a significance rating, and where warranted, evaluated for corrective actions to be taken to address deficiencies. SCRs are processed in accordance with N-PROC-RA-0022, *Processing Station Condition Records*. Any event that results in exceeding an action level is filed as a SCR and is reported to the CNSC within time frames specified in the applicable licence. Action levels for the PROL are provided in N-STD-RA-0044, *Occupational Radiation Protection Action Levels for Power Reactor Operating Licences* document.

Radiological Hazard Surveys

Radiological hazard surveys are performed using approved instruments on both a routine basis and prior to performance of radioactive work. Instruments used for performing surveys are approved by the Health Physics department to ensure they are appropriate and effective for use in measuring hazards encountered at the nuclear power plant and those facilities supporting its operation, namely the Tritium Removal Facility (TRF) and Heavy Water Management Building. The process for ensuring approved instruments are used, maintained and calibrated is implemented in N-PROC-RA-0066, *Lifecycle Management of Radiation Protection Instruments.*

As per the N-INS-09071-10009, *Requirements for the Calibration and Maintenance of Radiation Protection Instruments*. All RP instrument, fixed or portable, shall be calibrated at least once a year. An instrument record shall be generated each time an instrument is calibrated and a label indicating the calibration date shall be applied to the instrument. Darlington NGS uses a software solution for tracking of maintenance and calibration of RP instruments through N-PROC-MA-0070, *Calibration of Field* Equipment and N-PROC-MA-0015, *Tool Control*. When surveys are performed for Unconditional Transfer Permits, the initial surveyor and the verifier are required to document the serial number of the survey instrument.

Routine surveys are performed to support the early discovery of unexpected hazards and to identify longer term trends in hazard conditions. The location, type and schedule of routine surveys are approved by the Responsible Health Physicist (RHP). Airborne contamination monitoring is routinely carried out in order that hazards can be accurately assessed. In areas where variable high gamma radiation fields or high airborne radiological hazards could occur, area alarming monitoring equipment is provided, and set to warn against sudden unexpected increases in radiation levels, to prevent a significant acute dose to an individual. Hazard assessment is implemented in N-PROC-RA-0024, *Hazard Surveys Posting and Labeling*.

For more details regarding the TRF, refer to Section 3.1.

Bioassay and Reporting Doses for Workers

Through work planning, workers use dosimetry appropriate to the anticipated radiological hazard. Doses for individuals shall be measured and recorded. The OPG Dosimetry program is documented in N-MAN-03416-10000, *Radiation Dosimetry Program – General Requirements,* N-MAN-03416.1-10000, *Radiation Dosimetry Program – External Dosimetry and* N-MAN-03416.2-10000, *Radiation Dosimetry Program – Internal Dosimetry.* The criteria and methods for use of radiation dosimetry is implemented in N-PROC-RA-0012, *Dosimetry and Dose Reporting.*

All workers are required to wear dosimetry and to submit bioassay samples and perform Whole Body Counts (WBC) as required by procedures. Frequency of bioassay submissions and WBCs are determined based on the type of work performed. Electronic Personal Dosimeters (EPDs) are worn in conjunction with Thermoluminescent Dosimeter (TLDs) to record doses received while performing radioactive work. EPD dose is recorded in the Dose Management System (DMS) when the EPD is downloaded. This provides a record of the dose cumulative dose received by the worker. TLDs are collected and analyzed on a quarterly basis by the OPG dosimetry laboratory, operating in accordance with a CNSC Dosimetry Service License. Bioassay samples and other dosimetry (e.g., personal air samplers, extremity TLDs) are collected frequently and analyzed by OPG dosimetry laboratory. Health Physics staff at site review all EPD dose, bioassay and WBC results as received and investigate any unusual results. All dose data is reviewed on a quarterly basis by the Dosimetry Health Physicist prior to submission to the National Dose Registry. Workers are able to obtain their dose status via the DMS. All worker exposure controls and limits are specified in DMS. Dose reports are sent to all individuals at year-end, to fulfill OPG's obligation to annually provide them with their dose status in writing, as required by the CNSC Radiation Protection Regulations.

Monitoring of Workers During Emergency Conditions

During a station emergency, all staff on site are required to report to designated assembly areas and to refrain from drinking, eating or smoking until RHP approval granted. Frequent surveys are performed of the emergency assembly areas and personnel located there. Hourly habitability surveys are also performed at the Site Management Center (SMC). During an accident or emergency, the Automated Source Term Gamma Monitoring System (ASTGMS) and Automated Near Boundary Gamma Monitoring Systems are available. ASTGMS provides remote gamma dose rates at transfer chambers (incident unit), Vacuum Building AL1 and CSA AL1. ASTGMS data is used for event categorization, adjustment of off-site dose projections, and associated on-site protective actions. Both Source Term and Near Boundary gamma measurement data is used by the Province to determine protective actions required in response to a potential radioactive release. The ASTGMS provides timely data collection, determination of possible fuel damage and eliminates the requirement for manual Source Term surveys. Health Physics Manager (HPM) in the Site Management Centre also reviews data from radiological survey teams, process system sample results, Fixed Area Alarming Gamma Meter (FAAGM) readings and Gaseous Fission Product monitor trends. Fixed Area Alarming Tritium Monitors (FAATM) are strategically located throughout the facility to support response to changing airborne tritium conditions. HPM also provides recommendations for on-site protective measures including issuance of KI pills, ongoing restrictions on eating and drinking and airborne on-site radiological controls. If there are suspected exposures or uptakes, the HPM arranges for expedited readout of bioassay samples or TLDs.

Radiation Protection Training and Qualification

All personnel working at a nuclear site are assigned an RP qualification level based on successful completion of training. Personnel maintain their qualification through the successful completion of periodic retraining and testing. The requirements for achieving and maintaining qualification levels documented in N-TQD-443-00001, *Radiation Protection Training and Qualification*. RP training is delivered in accordance with N-PROG-TR-0005, *Training*. Personnel performing radioactive work are either qualified to perform the associated RP activities, or there is an individual with the necessary qualification assigned to the work to provide RP for personnel performing radioactive work. The working rights and restrictions placed on each qualification level are specified in N-PROC-RA-0010, *Facility Access and Working Rights (Radiological).*

Key positions in the RP program organizations are given additional radiation protection related training to become qualified to perform in their specialized positions within the program.

2.7.3 Radiation Protection Program Performance

The RP program direction is established by the Director, Radiation Safety Division in response to the results of monitoring and oversight and based on recommendations and feedback from site RP managers and other stakeholders. The Darlington NGS RP manager is responsible for ensuring there is a CNSC certified RHP for the site. The RHP is accountable for ensuring that decisions regarding the RP program are technically consistent with sound RP practice and applicable regulations. The RHP approves the execution of specific key activities related to the RP program. The accountabilities of the RHP are documented in role document N-MAN-08131-10000, Sheet CNSC 031, *Responsible Health Physicist.* The Joint Committee on Radiation Protection provides a forum for communication between management and employee representatives on RP topics, and to develop recommendations to senior management for improvements in the RP program.

The design and execution of the RP program is subject to ongoing monitoring through mechanisms including but not limited to:

- Management review and assessment.
- Worker identified problems or errors in the design.

- Implementation or execution of the RP program.
- Reported non-compliances with radiation protection procedures.
- Results of exceptional dosimetry and unusual dose control device measurement results and dose trending.
- RP program self- assessments.
- Independent audits.
- Assessments conducted externally by organizations like the CNSC or other external industry bodies.

RP program self-assessments are conducted to identify opportunities for continual improvement and to confirm that work meets the requirements of the management system. Self-Assessment and benchmarking are utilized to evaluate actual performance against management expectations, industry standards of excellence and regulatory requirements. Reviews of the RP program are conducted in accordance with N-PROC-RA-0097, *Self-Assessment and Benchmarking.*

RP program performance indicators include effectiveness measures commonly used in the nuclear industry and OPG defined indicators established for the purpose of monitoring particular program elements. These indicators are established and tracked in accordance with N-PROG-AS-0001, *Nuclear Management System Administration.* Records generated by the RP program have an established retention period and are only destroyed when they exceed the retention period. Retention periods are consistent with good business practice. Retention and disposal of records meet the requirements of CNSC regulations.

The effectiveness of the RP program with respect to radiological hazard identification and assessment can be measured using collective dose for the facility and compared against industry benchmarks and station targets. These targets are established based on the approved work scope for the year. In some years the target may be impacted from additional approved work activities to maintain high plant reliability.

Collective and individual doses were managed well below administrative and regulatory dose limits in the current licence term. OPG employs exposure control levels to ensure administrative limits are not exceeded.

Darlington NGS's CRE, excluding unit refurbishment project dose, for the current licence term is summarized in Figure 20 below.

The station sustained strong dose performance due to various factors, including strong equipment reliability, reduced radiological source term following unit refurbishment, low unit forced loss rate and implementation of dose reduction initiatives. Some key achievements in radiological hazard identification and assessment during the licence term include:

- Implementation of shielding on areas with elevated radiological hazards; the design was customized such that installation and removal time is optimized. This has short and long-term benefits which will be realized during subsequent unit outages.
- Implementation of portable containment driers to control airborne tritium hazards to supplement current plant drier systems; this reduces dose to

personnel and the environment.

- Upgrades to fixed radiological instrumentation to monitor area conditions and personnel movement through the facility.
- Improvements to processes around liquid radiological hazards, including approvals from a Senior Health Physicist under special circumstances and pre-defined contingency and mitigation actions.

The stacked bar graph illustrated in Figure 20 below shows the contribution from station outage execution (forced and planned) and online routine operations (non-outage). For both planned and forced outages, the main driver for collective dose is outage work scope and duration.

Overall, the effective identification and assessment of radiological hazards has continued to ensure high standards in ALARA work planning, execution, and close-out. For example, in 2021 there were two major planned station outages with large maintenance scopes. This resulted in 91% of annual station CRE being attributed to outage execution dose. In comparison, 2023 had two short outages for Unit 3 and Unit 2 so there was a minor impact to overall station dose in comparison to routine online operations dose.

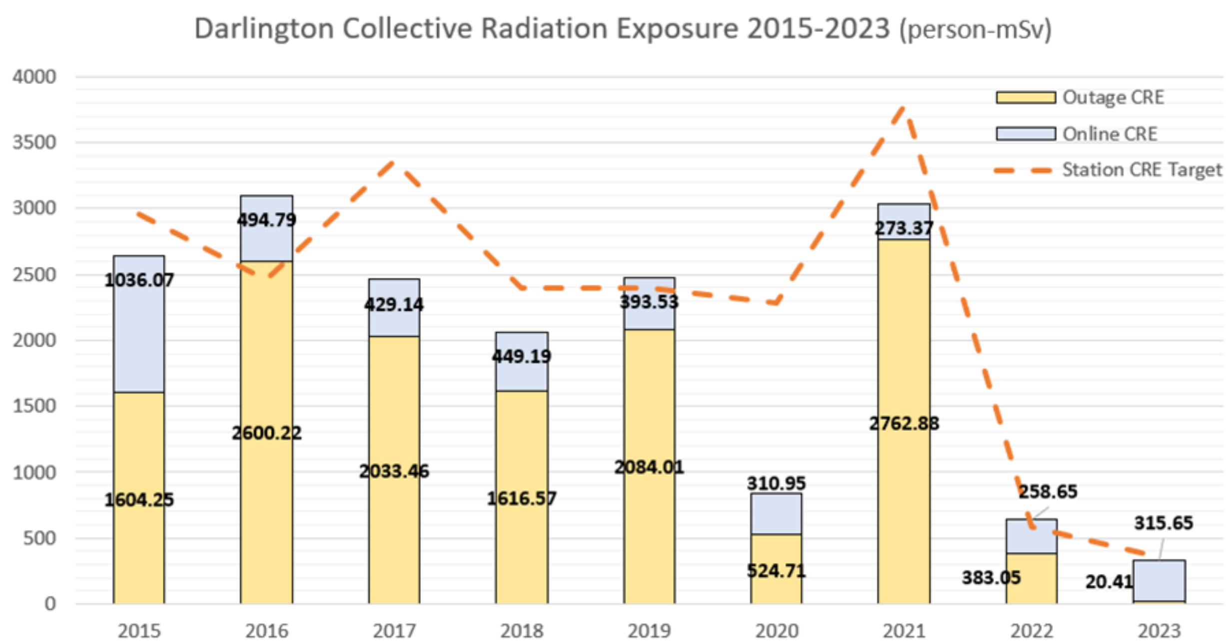


Figure 20: Darlington Collective Radiation Exposure 2015-2023 (person-mSv)

In 2020, there was a delta between the station CRE target and the actual station CRE. An outage was initially scheduled for 2020, which in turn incorporated the outage dose targets into the 2020 station target. However, the outage was deferred to 2021 which resulted in no major planned outage in 2020, thus the lower actual station CRE. Another outage was deferred from 2019 to 2020, to coincide with the start of the Darlington Unit 3 refurbishment outage (starting September 2020). This outage was shorter in duration, less scope and significantly lower dose compared to a major planned outage, hence the large delta for station CRE and the target in 2019.

Comparatively, the scheduling of major planned outages was the main driver for the total station collective dose in the years 2015 to 2019 and 2021. In 2022, there was also no major planned outage scheduled. The drivers for the station CRE target in 2022 were integrated planning group execution and the Mo-99 installation and commissioning mini outage, which required less dose than a major planned outage.

2.7.4 Radiological Hazards Control

The general processes for moving people and materials within and out of radiological zones, and the actions to be taken when contamination is discovered are documented in N-PROC-RA-0014, *Radiological Zoning, Personnel/Material Monitoring*. Workers moving through the radiological zones monitor themselves and material as required when crossing zone boundaries (depending on the direction of travel) and at other designated monitoring points. Loose contamination is not tolerated within the radiological zones except within established contamination control areas. Qualified workers shall ensure a contamination control area is established to control anticipated radioactive contamination in accordance with N-PROC-RA-0015, *Contamination Control While Performing Work.* Workers who detect contamination through monitoring processes work to limit the spread of contamination, take action to identify the source of contamination and ensure that it is contained or removed when found.

The protected area (inside the inner security fence) of the station is divided into zones to facilitate the movement of personnel and materials and control access to areas where radioactive systems are present. Radiological zones are those in which the RP program applies. Indoor areas of the station are divided into three zones (Zones 1, 2 and 3) based on the presence of radioactive systems and the potential for radioactive contamination in each area. Outdoor areas at ground level within the security perimeter, but outside the powerhouse are referred to as ‘Unzoned Areas’. Boundaries of the zones are marked and changes to the boundaries are approved by the RHP. The consumption of food and beverages are not permitted in radiological zones except under circumstances approved by the RHP. All materials released into Zone 1 or public domain are monitored for contamination. Certain areas within the protected area are designated as clean laydown areas for materials that are contamination free and awaiting shipment off-site. The requirements for usage of these laydown areas shall be approved and documented by the RHP.

The requirements for transferring inactive material and material containing naturally occurring radioactive material under a permit are documented in N-PROC-RA-0124, *Transfer of Materials from Radiological Zones to Zone 1/Public Domain.* When approving the monitoring methods for determining that material is inactive, OPG meets the constraints specified in N-STD-RA-0029, *Unconditional Clearance of Low-Level Radioactive Materials from OPG Regulated Facilities.*

The objective of radiological hazard identification and assessment is to ensure sources of radiological hazards are assessed such that plant operations and maintenance can be safely conducted. This is primarily carried out through the use of specialized instrumentation for radiation detection and the communication of their results.

In addition, trained and qualified personnel utilize portable instrumentation to provide relevant job-site specific hazards for safely conducting work activities. Day-to-day conditions are routinely monitored by these trained personnel as well to ensure conditions are stable and controlled. The results of hazards are communicated to all workers in the facility through local hazard postings and electronically logged for reference in a common database. This information is used to provide a thorough assessment and plan prior to work execution. The common goal is to ensure work activities are predictable and doses to personnel and the public are kept ALARA.

2.7.4.1 Enhancements and Methods for Improved Radiological Hazards Control

The following outlines the various enhancements and methods OPG implements with respect to improving radiological hazards control.

Minimizing Worker Dose Exposure During Longer Outages

Units 2 and 3 were refurbished during the licence term and involved the replacement of major components in the Primary Heat Transport system, which accumulated some long-lived radionuclides from reactor operation. Following refurbishment, early source term data indicated dose contribution on replaced components are dominated by shorter-lived radionuclides. This created an opportunity to take advantage of radioactive decay and scheduling of radioactive work, especially on outages not dominated by radioactive critical path work.

Advanced Radiation Instrumentation

Periodic use of advanced radiation instrumentation has been used to provide visuals for updated radiological hazards. These updates can support advancements in work planning assessments and worker knowledge of the radiological hazards.

Real-Time Hazard Monitoring with Remote Instrumentation

Remote instrumentation is used to provide real-time hazard information to staff. This information is displayed directly outside certain radioactive work areas, through dedicated software available to qualified workers and supervisors, and includes historical logs for detailed reviews and trending. When applicable, approved radioactive work plans would mandate the use of remote instrumentation such that detailed area hazard maps can be used to optimize personnel exposure conditions during radioactive work activities. This is important for activities which present elevated risks or when multiple areas could be impacted. Monitoring of this instrumentation is conducted by personnel who often have direct line of sight to personnel at the work site through a dedicated audio and video system. Robotic equipment is used by operations staff to reduce exposure during on-power entries and allow for searches in areas previously inaccessible. In one case, robotic equipment was recently used to identify a hot spot and was used in support of its removal.

Procedural Updates on RPPE Usage Working in Wet Conditions

Darlington NGS has updated the procedures including standards and expectations on the use of RPPE when working in wet conditions and actions to be taken to minimize the possibility of skin wetting. Drills and dynamic learning activities have been developed to ensure staff recognize the potential for wetting events. These behaviours are continuously reinforced through approved work plans and management oversight.

Internal/External Operating Experience (OPEX)

Darlington NGS makes use of relevant CANDU operations outside of OPG with its participation in CANDU Owners Group (COG). COG actively collaborates with other CANDU organizations around the world to advance nuclear technologies, including successful RP programs. A recent COG Radiological Protection Task Force has collectively agreed to address management of tritiated hazards, based on common CANDU plant experiences. External and Internal operating experience reviews are completed for relevant radiological application. This includes the disposition of how relevant internal and external plant experiences may help shape radiological hazard identification and assessment during routine and abnormal plant operations.

The organizational drive for continuous improvement within RP is also observed through the site's interface with the broader nuclear industry, including international organizations whose common goal is excellence in operational nuclear safety. This is manifested to the RP program through its own active internal self-assessments which may focus on understanding how industry best practices can be incorporated and taking defined actions following industry peer review evaluations, which provide an unbiased perspective to the site's RP performance. For example, external benchmarking drove improvements in area signage and key control management for radiological areas. Administrative controls through documented process forms support the improvements that drive workers to have increased accountability in their precision to understand area hazards prior to issuance of unique area keys. This change was an important step to align with industry best practices, but to ultimately improve the defenses against unplanned personnel exposure.

Additional methods for Improving Radiological Hazards Controls

- Characterization studies are independently performed by an approved vendor and verified by OPG to ensure the hazards identified remain within its predicted operating envelope.
- Darlington NGS's alignment meetings outline a risk matrix which may include equipment and area impact to radiological safety. These are communicated to the station to ensure work is assessed relative to its risk.
- Periodic review of industry standards are performed to ensure alignment and best practices for dose control events. Darlington NGS has updated the processes for establishing oversight of radiological work. The process for workers using specialized dose tracking technology has been improved to ensure there is accountability for monitoring radiological dose during work execution.
- Catered dose goals are used to anticipate external gamma dose prior to performing radiological work. During a pre-job brief, workers and supervisors discuss the time, distance, and shielding applicable to their assigned work activity. This form of communication is considered fundamental during the work planning and execution processes.
- OPG maintains an instrumentation lifecycle management process. Darlington NGS is currently updating instrumentation in support of personnel monitoring as a result of lifecycle management. Status reports are completed on the health of radiation instrumentation to track emerging issues and trends. Darlington NGS is in pursuit of new instrumentation to support work activities, a new intrinsically safe tritium meter as well as a new neutron instrument are being assessed for support of radiation dosimetry N-PROC-RA-0066, *Lifecycle Management of Radiation Protection Instruments.*
- Routine radiological surveys are performed in the facility at a frequency sufficient to prevent the prolonged presence of an unknown condition in accessible, normally frequented areas. Review of these surveys are performed to ensure there are no unexpected radiological hazards.
- Dynamic Learning Activities (DLA) engage facilitators and observers to examine how workers use their skills and knowledge while performing activities in a

simulated environment (e.g., mock-up). The activities reflect plant conditions as realistically and authentically as possible within a non-radiological environment. A DLA can be used to improve worker proficiency, work processes and procedures. Recent DLAs for radiological protection have included contamination control and radiological hazard identification.

Section 2.8

Conventional Health & Safety

2.8 Conventional Health and Safety

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

OPG's program OPG-PROG-0005, *Environment Health and Safety Managed Systems* puts the Health and Safety Policy into action. The Environment Health and Safety Managed Systems program and supporting governing documents establish process requirements that must be implemented and maintained to ensure that health and safety risks to workers are being mitigated. It also outlines the responsibilities of various levels in the organization to ensure the activities described above are performed to meet the requirements of OPG's *Health and Safety Policy*.

The Environment Health and Safety Managed Systems includes:

- Occupational conditions and factors that could affect the health and safety of workers in all workplaces, or work-related activities under OPG's control.
- Non-occupational health-related conditions and factors that could affect the health of OPG's workers, where it impacts achievement of OPG's business objectives.
- Contractor health and safety.

The goal of OPG's Conventional Health and Safety program is to ensure a healthy and injury-free workplace by managing risks resulting from the activities, products, and services associated with OPG's Darlington NGS operations. Risk reduction is primarily achieved through compliance to the program requirements, by competent workers, to operational controls, developed through risk assessment and safe work planning. Risk reduction is primarily achieved through implementation of the Health and Safety Management System (HSMS) program to manage workplace safety hazards and to protect personnel and equipment. OPG's HSMS program ensures alignment with internal and external specifications or standards such as OPG-POL-0001, *Employee Health and Safety Policy* and ISO 45001 *Occupational Health and Safety Management*. OPG's Health and Safety Management System is structured in accordance with the requirements of the ISO 45001 standard and is documented in the Environment, Health and Safety program document.

The OPG documents in the table below require written notification of change per Darlington NGS Licence Conditions Handbook, LCH-PR-13.03/2025-R005:

Table 12: SCA 8 – Conventional Health and Safety

Document	Title
N-PROG-MA-0015	Work Protection
OPG-POL-0001	Health and Safety Policy
OPG-PROG-0005	Environment Health and Safety Managed Systems
OPG-PROC-0132	Respiratory Protection
N-PROG-RA-0012[1]	Fire Protection
NK38-LIST-78000-10001	Application of CSA N293-07 to Structures, System and Components for Darlington Nuclear

Notes:
1. Refer to Section 2.10, *Emergency Management and Fire Protection*.

2.8.1 Performance

Darlington NGS continuously strives for excellence and continued improvement in our Health and Safety performance. Over the last two years, Health and Safety has focused efforts on benchmarking with industry leaders and has introduced new initiatives and programs for continual improvement in industrial safety.

Manager and employee engagement in personal safety and associated initiatives and programs has instilled behaviors within the organization that have contributed to a performance free of lost time injuries since 2019.

OPG's vision has been to cultivate a value-based culture by continuing to integrate and reinforce the iCare program. Additionally, the Health and Safety culture at OPG has been further strengthened through the station advocacy peer-to-peer coaching program. These initiatives are foundational in driving OPG's "value-based" safety culture shift and is integral in building a healthy and engaged workforce.

OPG's fail safe strategy drives continuous improvement of OPG's performance in HSMS and human performance. It relates to the concepts that OPG's programs afford protection against significant injury and consequence, even in the event of employee error or equipment failure. Our approach to safety and human performance is proactive and focuses on building a resilient organization.

During the current licence term, Darlington NGS has demonstrated excellent safety performance throughout its operations. Below are a few examples:

- Darlington NGS Serious Injury Incidence Rate (SIIR) has remained at zero since the introduction of the new safety performance metric in 2020 up to Q3 2023.
- OPG has been awarded nine times in the last 10-years for the Electricity Canada President's Award for Excellence in Employee Safety.

The following sections illustrate various safety performance metrics for Darlington NGS.

- Accident Frequency Rate.
- Industrial Safety Accident Rate (ISAR).
- Accident Severity Rate (ASR).

Additionally, the following proactive metrics are tracked to demonstrate our commitment to excellence and continuous improvement.

- Serious Injury Incidence Rate (SIIR).
- Timely Completion of Safety Corrective Actions (TCSCA).

Safety Performance Indicators (SPIs) from Conventional Health and Safety – SPI 21, are reported quarterly per REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants* to the CNSC, such as Accident Frequency Rate, ISAR and ASR.

2.8.1.1 Accident Frequency Rate

The Accident Frequency is the sum of the fatalities, lost-time injuries and medically treated injuries multiplied by 200,000 person hours worked at a Nuclear Power Plant, per exposure hours.

OPG's commitment to continuously improve performance is reflected by setting challenging targets for safety performance metrics. Darlington NGS has continually tightened its target rate for disabling injuries, and its safety performance has been below (better than) target since 2019 as illustrated in Figure 21 below.

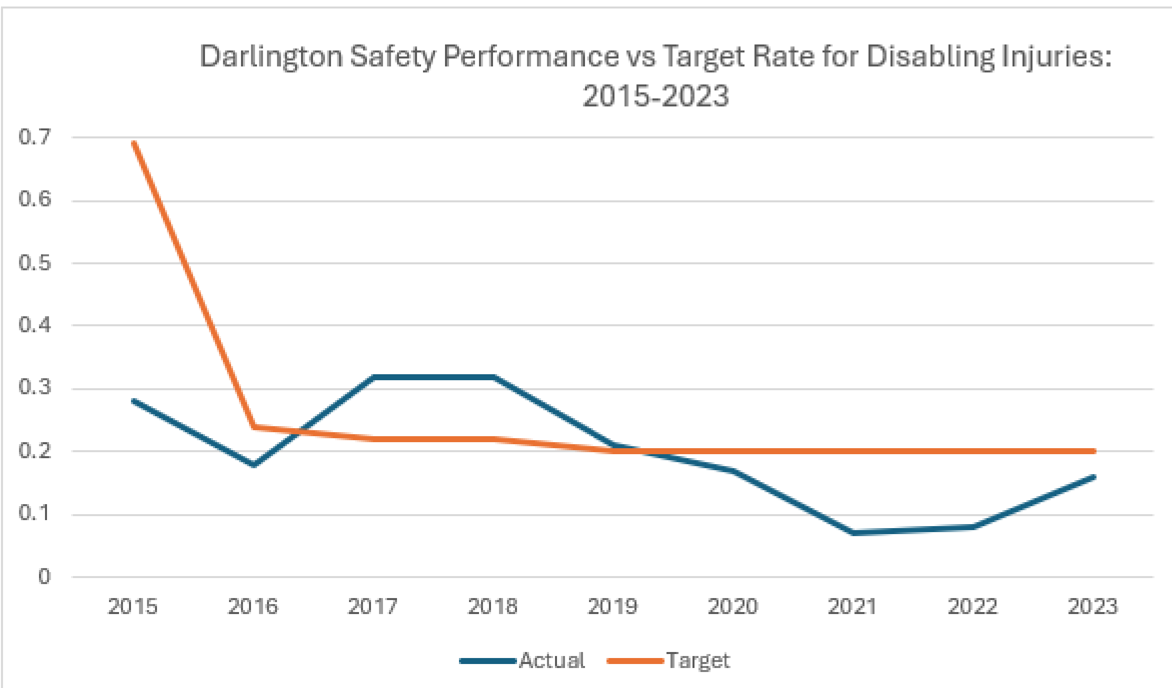


Figure 21: Darlington NGS – Accident Frequency Rate 2015-2023 YTD

2.8.1.2 Industrial Safety Accident Rate (ISAR)

The ISAR is a frequency rate based on the number of lost-time injuries for Nuclear Power Plant personnel per 200,000 hours worked (excluding contractors).

The Darlington NGS has upheld a consistent record of zero lost time injuries up to Q3 2023 since 2018 as shown in Figure 22.

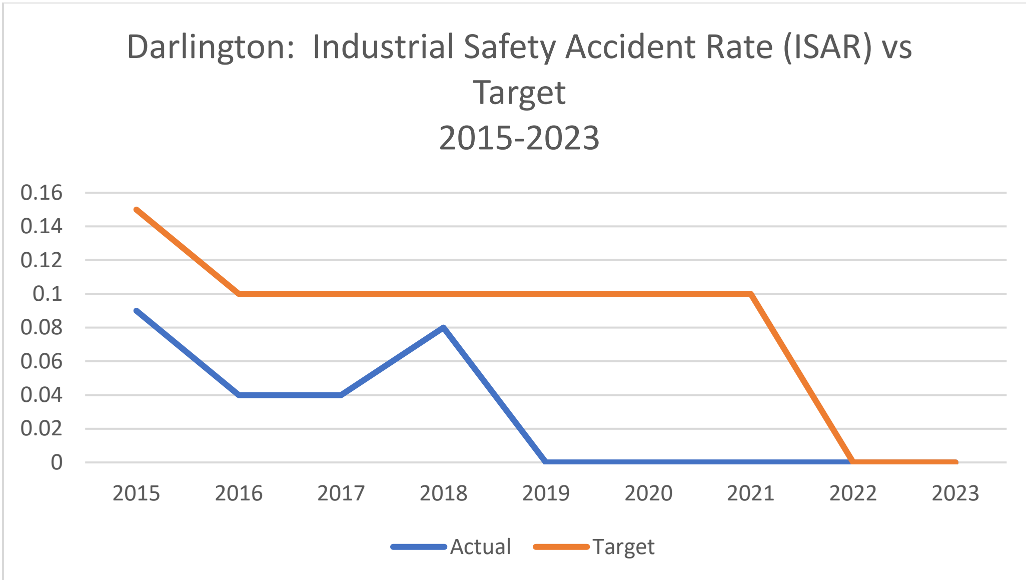


Figure 22: Darlington NGS – Industrial Safety Accident Rate (ISAR) vs. Target 2015-2023

2.8.1.3 Accident Severity Rate (ASR)

The ASR is the number of days lost multiplied by 200,000 person hours worked at a Nuclear Power Plant, per exposure hours.

Darlington NGS has upheld a consistent record of zero lost time injuries, resulting in no lost time days up to Q3 2023 since 2018 as shown in Figure 23. There are no targets set for ASR.

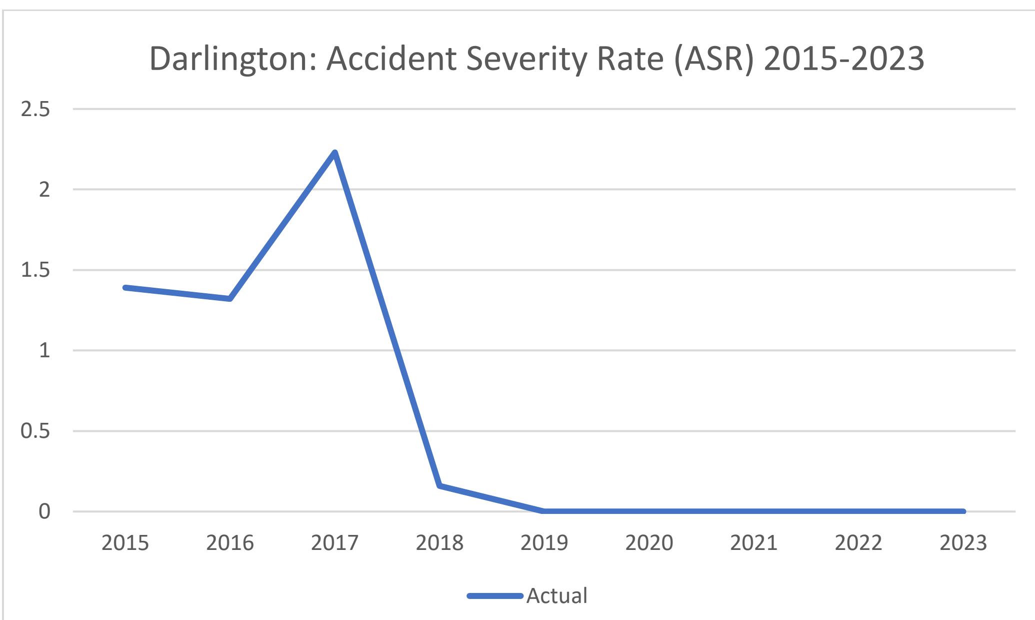


Figure 23: Darlington NGS – Accident Severity Rate (ASR) 2015-2023

2.8.1.4 Serious Injury Incidence Rate (SIIR)

The SIIR is defined as the number of work-related accidents for all OPG employees that result in serious injuries or fatalities, per 200,000 person-hours worked. This metric focuses on more serious injuries, assists in maintaining attention on high-consequence hazards, and accounts for the actual injury instead of the type of medical treatment.

Darlington NGS SIIR has remained at zero (0) since the introduction of the new safety performance metric in 2020 up to Q3 2023.

2.8.1.5 Timely Completion of Safety Corrective Actions (TCSCA)

TCSCA aims to prioritize completion of safety related actions in a timely manner. TCSCA is the percentage of corrective actions, arising from safety events, that are completed on or before the initial due date (zero extensions).

Darlington NGS consistently demonstrates its commitment to prioritizing safety-significant work since the introduction of the leading indicator metric in 2019. Darlington NGS has performed better than target since the introduction of the metric and maintained 100% for the past 3-years as shown in Figure 24.

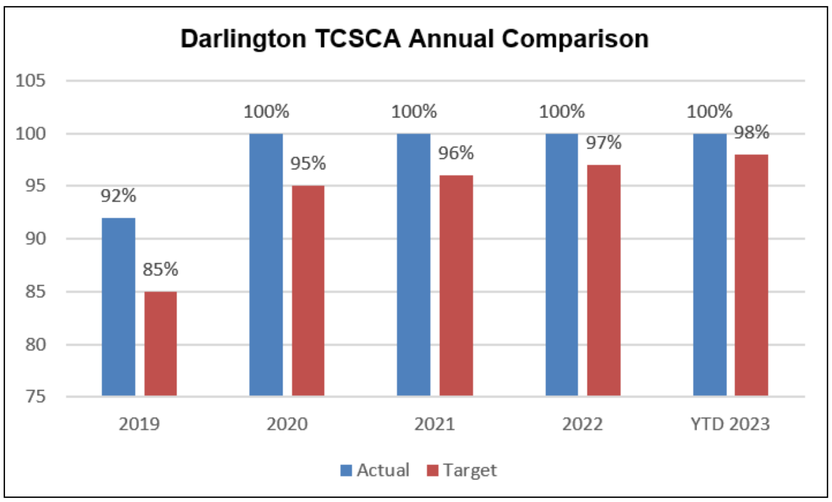


Figure 24: Darlington NGS – TCSCA Annual Comparison

2.8.2 Practices

The *Work Protection* program is governed by N-PROG-MA-0015 which describes requirements that are in place within OPG Nuclear to isolate and de-energize equipment to ensure worker safety. For more details on the *Work Protection* program, refer to Section 2.3.1.

Respiratory Protection, OPG-PROC-0132 references the requirements for the selection, care and use of respiratory protection. For more details on *Respiratory Protection*, refer to Section 2.7.2.

N-STD-RA-0008, *Incident Investigation* provides a systematic and consistent approach for evaluating adverse conditions at OPG Nuclear including determining the cause of an adverse condition or event and developing effective corrective actions to eliminate or reduce the probability of similar events occurring in the future.

OPG is committed to upholding robust workplace health and safety practices aimed at managing risks for both employers and workers. To fulfill this commitment, OPG has established the OPG Corporate Safety rules, ensuring compliance with or exceeding the applicable health and safety legal obligations mandated by the Occupational Health and Safety Act (OHSA) and the applicable regulations (Occupational Health and Safety Act, R.S.O. 1990, c. O.1). The main purpose of OHSA is to provide the legal framework to achieve the goal of protecting workers from health and safety hazards on the job. Many regulations made under OHSA require compliance with standards published by the Canadian Standards Association (CSA) group; these standards define requirements for reducing the risk of workplace injuries.

Continuous improvement opportunities for OPG's Health and Safety Management System program are identified using a "Plan-Do-Check-Review" management cycle. The objective is to ensure conventional health and safety risks, work practices and conditions are appropriately managed to achieve a high degree of employee safety. Leveraging our HSMS, OPG seeks to continuously ensure excellence in everything we do. Our Compliance Assessment functions to monitor Key Performance Indicators (KPI) by conducting field assessments, document reviews and interviews with stakeholders to help identify systematic issues before they result in near-misses, injuries, and events. Compliance assessment objectives include confirming OPG's operations/activities are in alignment with expectations formally set forth by the HSMS and confirming OPG's operations/activities are being performed in conformance with applicable Occupational Health and Safety legal requirements.

To further enhance work safety, the Darlington NGS Joint Health and Safety Committee (JHSC) has been established to work co-operatively to improve health and safety in the workplace, as set out in the OHSA. One of Darlington NGS's goals is to have healthy people working safely in an accident-free environment.

The JHSC assists in achieving the goal by providing a forum for:

- Cooperatively resolving health and safety issues.
- Making recommendations for improvements.
- Providing visible leadership in actively promoting health and safety awareness.
- Ensuring that the Darlington NGS JHSC is in compliance with the legislated and corporate requirements for JHSCs.
- Promoting communication between workers, management and the JHSC on health and safety.
- Looking at environmental concerns in regards to worker health and safety.

In addition, a Building Trades Union JHSC has been established, which supports contractors supporting construction and project work on site; both unions work co-operatively to support their respective workers.

Moreover, the Internal Responsibility System (IRS) is a system applied consistently throughout OPG, where everyone has personal and shared responsibility for working together co-operatively, to prevent occupational injuries and illnesses. The duties for a healthy and safe workplace fall on every individual, to the degree they have authority and ability to do so. Each person is expected to take the initiative on health and safety issues, work to solve problems, and make improvements on an on-going basis. The IRS is based on the principle that employees themselves are in the best position to identify health and safety problems and identify solutions and outlines the appropriate resolution level for timely corrections.

2.8.2.1 WHMIS

Canada's requirements for the hazard classification and communication for workplace chemicals, Workplace Hazardous Materials Information System (WHMIS) were updated in 2015 to incorporate the Globally Harmonized System of Classification and Labelling of Chemicals (GHS). All workplace chemicals must now meet the hazard classification and communication requirements established by WHMIS 2015. OPG is compliant with WHMIS 2015 and has processes in place for the management, handling, and storage of hazardous materials to ensure regulatory compliance and to ensure workers have information to safely work, store and dispose of hazardous materials in the workplace.

2.8.2.2 Training

Nuclear Conventional Safety Training and Qualification on Description on document describes required Initial and Continuing Conventional Safety Training and related qualifications for all major job families and contractors.

2.8.2.3 Environment Health and Safety Audits and Assessments

OPG-PROC-0044, *Environment Health and Safety Audits and Assessments* establishes the methodology, frequency, responsibilities, planning, and reporting requirements for internal and compliance audits on the effective implementation and maintenance of the Environment Health and Safety Managed Systems, in accordance with applicable ISO standards and other regulatory requirements.

2.8.2.4 Refurbishment Health and Safety Practices

Nuclear Refurbishment complies with program OPG-PROG-0005, *Environment Health and Safety Managed Systems* document for both OPG employees and contractors.

Nuclear Refurbishment engages contractors that have proven health and safety programs and experience. This is verified in a prequalification process that review industry experience, historical safety performance, implemented management system elements and prior OPG experience. With respect to Enterprise Project Contractors (EPC), OPG Nuclear Refurbishment is the "constructor" and the contractors will be the "employer" as defined in OHSA, and are governed by the requirements set therein. External construction and support staff work under the "employer" programs and procedures. This allows contractor front line supervisors and workers to work within the programs and procedures they are trained and experienced in, which improves performance and reduces human performance errors related to working with multiple programs and systems. The process aligns with the internal responsibility methodology fostered in the OHSA.

A guide has been developed and build into contracts related to the Nuclear Refurbishment program, which sets the expectations for conventional health and safety elements related to Refurbishment, thereby ensuring the contractor is fully aware of and will be held accountable to OPG's health and safety expectations. OPG reviews the contractor health and safety submissions against our expectations prior to approval and commencement of activities. The document also sets out common elements that will apply to all contractors within the Nuclear Refurbishment, such as:

- Safety performance metrics and key performance indicators.
- Problem/incident notification and investigation requirements.

- Common safety rules.
- Safety culture requirements.
- Communication requirements, and.
- Oversight and surveillance.

The Nuclear Refurbishment team recognizes that effective oversight throughout all stages of the program life cycle is paramount to the program's success. Health and Safety has a dedicated team of advisors who provide daily support and ensure contractors are held accountable to OPG's health and safety expectations.

2.8.3 Awareness

Safety Enhancements and Areas of Strength for the Future

Several health and safety improvement initiatives have been identified for Darlington NGS as part of the continuous improvement cycle of the HSMS. These initiatives remain on-going which include:

- Implementation of Fail-Safe Culture Change initiatives, which aligns with Industry best practice. Fail Safe identifies and strengthens defenses so when an event occurs, we have enough strong defenses in place to ensure the event occurs safely. It shifts our focus to learning; and proactively applies lessons to future work. OPG has streamlined our safe work planning process into one consolidated electronic database with Fail Safe built into the application. OPG has introduced hazard assessment tools including the energy wheel, to better identify hazards in the planning stage to eliminate, control and ultimately protect workers against workplace hazards.
- Continue to maintain the iCare Safety Culture initiatives in areas of Communications, Recognition, Risk Management, Human Performance & Coaching and Total Health Strategies. The initiative's aim is to revamp the delivery of safety messages, moving away from a directive of doing something just because it's required, to encouraging individuals to take actions out of genuine concern, expressing a desire to avoid/prevent injuries.
- Implementation of a Total Health Initiative supporting employees and their families in their efforts to achieve an optimal level of health, primarily through health education, health promotion, disease and injury prevention and crisis intervention. There is a continued focus on mental health and Musculoskeletal Disorder prevention with campaigns to raise awareness in these areas.
- The leading indicator safety performance metric, TCSCA will continue to be reinforced to focus on completing safety related actions in a timely manner. Focusing on safety related actions to ensure completion builds on the iCare safety culture.
- SIIR metric will continue to be reinforced to focus on prevention of serious injuries that have life-altering consequences.
- Implementation of a safety related work order strategy aimed at the timely repair/correction of identified equipment and plant conditions that pose safety risks.
- OPG's commitment to continuously improve performance is reflected by setting challenging targets for safety performance metrics.

Section 2.9

Environmental Protection

2.9 Environmental Protection

OPG's comprehensive environmental protection programs aim to continually minimize impacts from the station operation on the environment and human health. This is achieved by ensuring that there are multiple barriers in place to control and minimize emissions to the environment and to ensure all emissions are monitored.

Darlington NGS has in place environmental protection programs in accordance with CNSC regulatory document REGDOC-2.9.1, *Environmental Protection Policies, Programs and Procedures.* Given OPG's robust programs and processes, it is expected that Darlington NGS will continue to meet or exceed regulatory requirements and expectations within this SCA over the next licence term.

The OPG documents in the table below require written notification of change per Darlington NGS Licence Conditions Handbook, LCH-PR-13.03/2025-R005:

Table 13: SCA 9 – Environmental Protection

Number	Title
Effluent and Emissions Control (Releases)	
N-STD-OP-0031	Monitoring of Nuclear and Hazardous Substances in Effluents
NK38-MAN-03480-10001	Environment Manual
NK38-REP-03482-10001[1]	Derived Release Limits and Environmental Action Levels for Darlington Nuclear Generating Station
N-PROC-OP-0037	Environmental Approvals
Environmental Management System (EMS)	
OPG-POL-0021	Environmental Policy
OPG-PROG-0005	Environment Health and Safety Managed Systems
N-PROC-OP-0044[2]	Contaminated Lands and Groundwater Management
OPG-PROC-0126	Hazardous Material Management
N-PROC-OP-0038	Abnormal Waterborne Tritium Emission Response
Assessment and Monitoring	
N-PROC-OP-0025	Management of the Environmental Monitoring Programs
NK38-MAN-03443-10002	Darlington Environmental Monitoring Program
Environmental Risk Assessment (ERA)	
NK38-REP-07701-00001-R001[3]	Darlington Nuclear Environmental Risk Assessment

Notes:

1. Superseded by NK38-REP-03482-10001, *Derived Release Limits for Darlington Nuclear Generating Station* and NK38-REP-03482-10002, *Action Levels for Environmental Releases – Darlington Nuclear*, effective January 1, 2024.
2. Superseded by N-PROC-OP-0044 R005, *Contaminated Lands Management* and N-STD-OP-0046 R002, *Groundwater Protection and Monitoring Program*, effective December 2022.
3. Superseded by D-REP-07701-00001-R002, *2020 Environmental Risk Assessment for the Darlington Nuclear Site*.

2.9.1 Environmental Management System

OPG maintains an Environmental Management System (EMS), OPG-PROG-0005, *Environment Health and Safety Managed Systems*, which implements the requirements of OPG's Environmental Policy (OPG-POL-0021) and is consistent with the International Organization for Standardization (ISO) 14001 *Environmental Management System Standard.*

The objectives of the OPG Environmental Policy are to:

- Establish an EMS and maintain registration for this system to the ISO 14001.
- Work to prevent or mitigate adverse impacts on the environment, with a long-term objective of continual improvement in its EMS and its environmental performance.
- Strive to be a leader in climate change mitigation.
- Manage OPG's sites in a manner that strives to maintain, or enhance where it makes business sense, significant natural areas and associated species of concern. OPG will work with its community partners to support regional ecosystems and biodiversity through science-based habitat stewardship. Where disruption is required, OPG shall take reasonable steps to manage the residual impact to these areas and species.
- Set environmental objectives as part of its annual business planning process. Performance against these environmental objectives will be monitored and associated documented information will be maintained.
- Communicate its environmental performance to employees, governments, local communities, and other stakeholders.

The current OPG ISO 14001 EMS certificate, issued in 2021 following a successful audit by an external auditor, is valid for 3-years. The recertification audit is scheduled to take place in Q2 of 2024, with Darlington NGS as one of the sites undergoing an audit.

The EMS uses a risk-based approach to identify and assess areas of concern with respect to environmental management. Elements of OPG's activities, products, and services that interact or can interact with the environment are considered environmental aspects per OPG-PROC-0036, *Environmental Aspects Identification and Significance*. Significant environmental aspects, as determined by assessing risks and opportunities, are environmental aspects that have or can have a significant environmental impact.

Identified environmental aspects, including significant environmental aspects, are managed as appropriate through operational controls at the sites. Performance measures are established to ensure the controls perform as designed and are corrected and/or improved under the EMS framework.

Identification of the significant environmental aspects which apply to Darlington NGS allows for more focus on areas where there is the potential to have a negative impact on the environment. The significant environmental aspects that have been identified for Darlington NGS include the following:

- Spills (refer to Section 2.9.4 for details);
- Fish impingement/entrainment/spawning disruption (refer to Section 2.9.6 for details);
- Wildlife habitat: enhancement or disruption;

- Radiological emissions: production or reduction (refer to Section 2.9.4 for details);
- Non-radiological emissions: production or reduction (refer to Section 2.9.4 for details);
- Low or intermediate radiological waste: generation or diversion (refer to Section 2.11 for details);
- Non-radiological waste: generation or diversion (refer to Section 2.11 for details).

Continual improvement of Darlington NGS operations is an ongoing effort under OPG's ISO 14001-certified EMS. Opportunities for continual improvement may be identified through routine EMS audit activities, the performance improvement program, and strategic initiatives such as execution of OPG's Climate Change Plan and Reconciliation Action Plan (available at www.opg.com).

2.9.1.1 Biodiversity

Beyond the impact of operations, the Darlington NGS site has a strong commitment to Indigenous Nations and communities and the public and has numerous programs aimed at embracing the broader principles of biodiversity and habitat stewardship.

OPG's biodiversity conservation program OPG-STD-0119, *Biodiversity Conservation Standard,* meets the requirements of OPG-POL-0021, *Environmental Policy,* and aligns with OPG-PROG-0005.

Some highlights of the Darlington NGS's biodiversity efforts include:

- In 2017, Darlington NGS meadow and pollinator habitats were installed to improve habitat for local pollinators. Over 700 new plants, all of local ecotypes, were added in 2018 and 2019 based on recommendations from the Pollinator Partnership to improve floral diversity and seasonal availability.
- In 2020, a MOTUS tower was deployed on Bobolink Hill next to Coot's Pond, to study migratory birds, bats, and insects that have been electronically tagged and fly on or near the station. The MOTUS tower is a partnership between OPG and Birds Canada. The data collected supports federal migration research. It also provides valuable insights to OPG on which species fly on or near or site and helps to inform conservation stewardship around these species. Since deployment, nine bird species have been noted.
- The tree swallow nest box program is in its 25th year, and since 1998, over 900 chicks have successfully fledged their nests. The nest boxes, installed by Coot's Pond, provide breeding/nesting, foraging, shelter, and water habitat for Tree Swallows. Recent activities included nest box maintenance and bird banding of chicks and adults.
- In 2022, a turtle basking platform was built in partnership with the Courtice Secondary School and installed in Coot's Pond. The raft provides a safe basking habitat for painted turtles and reduces the chances of land predation. Painted turtles were observed using the platform.

Refer to Section 4.4.6 for additional details on OPG's biodiversity initiatives, environmental partnerships and programs.

2.9.1.2 Regulatory Compliance

The Darlington NGS site operates under numerous environmental regulations governing plant operations. The primary regulators from an environmental perspective are the CNSC and the Ministry of the Environment, Conservation and Parks (MECP).

At OPG, infractions are regulatory non-compliances that have moderate potential for regulatory actions and/or involvement. During the current licence term, there were nine infractions (as of February 29, 2024), most of which were related to Environmental Compliance Approvals (ECAs).

2.9.2 Environmental Risk Assessment

Consistent with REGDOC-2.9.1 and REGDOC-3.1.1, OPG is required to update the Darlington NGS site Environmental Risk Assessment (ERA) at least once every 5-years. The purpose of the ERA is to assess potential human health and ecological risks to receptors from exposure to radiological contaminants, conventional contaminants, and physical stressors present in the environment as a result of site operations. This is achieved through completion of a human health risk assessment and an ecological risk assessment. The results of the ERA inform the environmental monitoring program and effluent monitoring programs, as per CSA N288.4, *Environmental monitoring program at class I nuclear facilities and uranium mines and mills,* and CSA N288.5, *Effluent monitoring programs at class I nuclear facilities and uranium mines and mills*. These programs can also inform the ERA by providing information on effluent concentrations and loading, and by providing environmental data to assist in model calibration and validation.

The 2020 ERA, D-REP-07701-00001-R002, *2020 Environmental Risk Assessment for the Darlington Nuclear Site*, was issued in 2021 (and last revised in 2022) in accordance with CSA N288.6-12, *Environmental risk assessments at Class I nuclear facilities and uranium mines and mills*. The ERA focused on activities that occurred during the 2016 to 2019 period.

In April 2024, OPG prepared an Addendum to the 2020 ERA to support the renewal of the Darlington NGS PROL. D-REP-07701-00002 R000, *2024 Environmental Risk Assessment Addendum for the Darlington Nuclear Site*, serves as an interim update to the 2020 ERA ahead of the next routine ERA update in 2026. The 2024 ERA Addendum focuses on activities that occurred during the years 2020 to 2022 (including some of 2023, where data was available at the time of preparation).

The 2020 ERA concluded that the Darlington NGS site is operating in accordance with approved limits and measures are taken to ensure regulatory compliance is maintained. In the 2024 ERA Addendum, OPG found that the Darlington NGS site continues to be operating in a manner that is protective of human and ecological receptors residing in the surrounding area. The 2020 ERA is available on www.opg.com and the 2024 Addendum will also be posted online.

Based on requests from the Williams Treaties First Nations (WTFNs), OPG is committed to facilitating WTFNs engagement on ERAs. A summary of key issues raised by Indigenous Nations and communities during engagement sessions is included in the 2024 ERA Addendum. OPG is sharing the 2024 ERA Addendum report with Indigenous Nations and communities, prior to finalization and submission to the CNSC, and will incorporate any feedback into this, and future assessments, as appropriate. OPG continues to work with Indigenous Nations and communities to develop comprehensive and ongoing engagement around ERAs.

2.9.3 Assessment and Monitoring

OPG maintains an Environmental Monitoring Program (EMP) in the vicinity of Darlington NGS in accordance with licence requirements. The EMP is implemented through N-PROC-OP-0025, *Management of the Environmental Monitoring Programs*, and complies with CSA N288.4-10, *Environmental Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills,* as demonstrated in NK38-MAN-03443-10002, *Darlington Environmental Monitoring Program*. The scope of Darlington's EMP encompasses protection of both the public and the environment from nuclear substances, hazardous substances, and physical stressors resulting from the operation of the Darlington NGS site.

OPG EMPs are designed to satisfy the following primary objectives of CSA N288.4:

1. Assess the impact on human health and the environment of contaminants and physical stressors of concern resulting from operation of OPG nuclear facilities.
2. Demonstrate compliance with limits on the concentration and/or intensity of contaminants and physical stressors in the environment or assess their effect on the environment.
3. Demonstrate the effectiveness of containment and effluent control and provide public assurance of the effectiveness of containment and effluent control, independent of effluent monitoring.
4. Verify the predictions made by the Environmental Risk Assessments (ERAs), refine the models used, and reduce the uncertainty in the predictions made by these assessments and models.

Additionally, environmental sampling and analyses for the Darlington EMP supports the calculation of annual public dose resulting from operation of Darlington NGS, as required by REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants*.

OPG reports the results of its nuclear facility EMPs annually to the CNSC. The report is also made available to the public on www.opg.com.

2.9.4 Effluent and Emission Control

2.9.4.1 Radiological Emissions to Air and Water

The Darlington NGS site effluent monitoring program documented in N-STD-OP-0031, *Monitoring of Nuclear Hazardous Substances in Effluents*, and NK38-PLAN-03480-10001, *Darlington Effluent Monitoring Plan*, is compliant with CSA N288.5-22, *Effluent Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills.* The objectives of the effluent monitoring program are to:

- Demonstrate compliance with authorized release limits and any other regulatory requirements concerning the release of nuclear and hazardous substances from the source.
- Demonstrate adherence to internal objectives and targets set on release amounts, for purposes of effluent control.
- Confirm the adequacy of controls on releases from the source.
- Provide an indication of unusual or unforeseen conditions that might require corrective action or additional monitoring.
- Provide data to assess the level of risk on human health and safety, and the potential biological effects in the environment of the nuclear and hazardous substances of concern released from facility.
- Confirm predictions in the environmental impact statement made through the environmental review process.
- Provide assurance to the public on the effectiveness of effluent and emissions control.
- Provide data which, when combined with the results of environmental monitoring and modelling, can be used to test or refine the models used in the ERA or dose assessments.
- Address any other objective identified by the nuclear facility or licensed activity (e.g., demonstrating due diligence, meeting a stakeholder commitment, or other business reasons).

NK38-PLAN-03480-10001 is developed as a requirement of N-STD-OP-0031 and addresses design requirements, reporting requirements, and sampling/analytical procedures use, in alignment with CSA N288.5.

Derived Release Limits

Derived Release Limits (DRLs) are calculated using CSA N288.1, *Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities,* and submitted to the CNSC. The DRL for a given radionuclide is the release rate to air or surface water during normal operation of a nuclear facility that would cause an individual of the most highly exposed group around Darlington NGS to receive and be committed to a dose equal to the annual regulatory dose limit over the period of a calendar year. DRLs are used to establish controls on the releases of radioactive materials and are calculated for radionuclides of potential dose significance in effluent streams, to facilitate the control, reporting, and regulation of radionuclide emissions. The Darlington NGS DRL values are shown below in Table 14 and documented in NK38-REP-03482-10001, *Derived Release Limits for*

Darlington Nuclear Generating Station. For operational purposes, the airborne DRLs are divided into weekly amounts and waterborne DRLs into monthly amounts.

Table 14: Darlington Nuclear - Derived Release Limits

Release Category	Radionuclide	DRL (Becquerel/year)	Operational DRL (Becquerel/week)
Air	Tritium (HTO)	3.91×10^{16}	7.52×10^{14}
	Elemental Tritium (HT)	6.26×10^{17}	1.20×10^{16}
	Iodine (mixed fission products)	1.74×10^{12}	3.34×10^{10}
	Carbon-14	7.68×10^{14}	1.48×10^{13}
	Noble Gases[1]	3.46×10^{16}	6.66×10^{14}
	Particulate	5.51×10^{11}	1.06×10^{10}
	Gross Alpha	9.82×10^{10}	1.89×10^{9}
Release Category	**Radionuclide**	**DRL (Becquerel/year)**	**Operational DRL (Becquerel/month)**
Water	Tritium (HTO)	6.36×10^{18}	5.30×10^{17}
	Carbon-14	6.97×10^{14}	5.81×10^{13}
	Gross Alpha	4.39×10^{11}	3.66×10^{10}
	Gross Beta-Gamma	3.47×10^{13}	2.89×10^{12}

Notes:
1. Units are in Bq-MeV/year and Bq-MeV/week.

Action Levels

An Environmental Action Level (EAL) for environmental releases is an effluent monitoring level (concentration, activity, rate, etc.) that if exceeded triggers an investigation to determine whether a loss of control of the environmental protection program has occurred and to enable corrective action, if warranted. In 2017, following the recommendations of the CNSC, a standardized methodology for calculating and applying EALs at Class 1 nuclear facilities and uranium mines and mills was developed and documented in CSA N288.8-17, *Establishing and implementing action levels for releases to the environment from nuclear facilities*. The primary changes introduced by the standard are that the scope of the EALs must consider both hazardous and radioactive substances, and the EALs must be calculated based on the historical performance of the station. The Darlington NGS EALs, updated to reflect the guidance and methodology in this CSA standard, are shown in Table 15 and documented in NK38-REP-03482-10002, *Action Levels for Environmental Releases – Darlington Nuclear.* The updated EALs were implemented effective January 1, 2024. Exceeding an EAL requires notification and reporting to the CNSC, investigation of the cause, and corrective action as required.

Table 15: Darlington Nuclear – Action Levels for Environmental Releases

Release Category	Radionuclide	AL: Gaseous Releases (Becquerel/week)
Air	Tritium (HTO)	1.78×10^{13}
	Elemental Tritium (HT)	3.81×10^{13}
	Iodine	6.11×10^{6}
	Carbon-14	1.08×10^{11}
	Noble Gases[1]	3.29×10^{12}
	Particulate	4.51×10^{6}

Release Category	Radionuclide	AL: Liquid Releases (Becquerel/month)
Water	Tritium (HTO)	1.17×10^{14}
	Carbon-14	Not required[2]
	Gross Beta-Gamma	7.99×10^{9}

Notes:
1. Units are in Bq-MeV/week.
2. Qualified for exclusion from an AL – carbon-14 is currently only monitored for controlled batch releases of active liquid waste and dousing water.

During the current licence term, the emissions from the Darlington NGS site have consistently been orders of magnitude below DRL values as shown in

Figure 25 and

Figure 26. Note: The changes seen in 2023 for tritium oxide and elemental tritium emissions, while still very low (slightly above 1% of the DRL), are attributed to the Tritium Removal Facility, as described in further detail below.

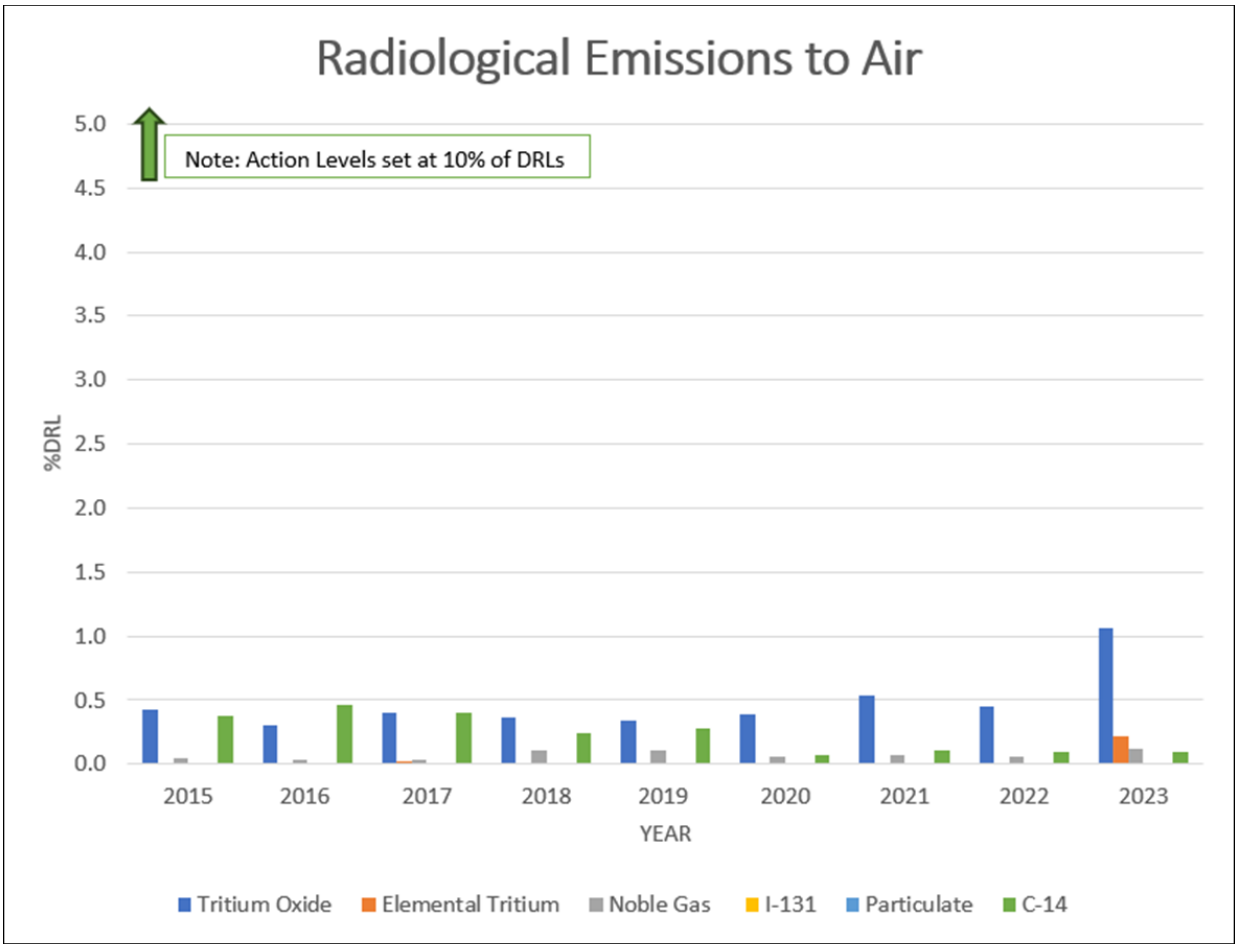


Figure 25: Radiological Emissions to Air

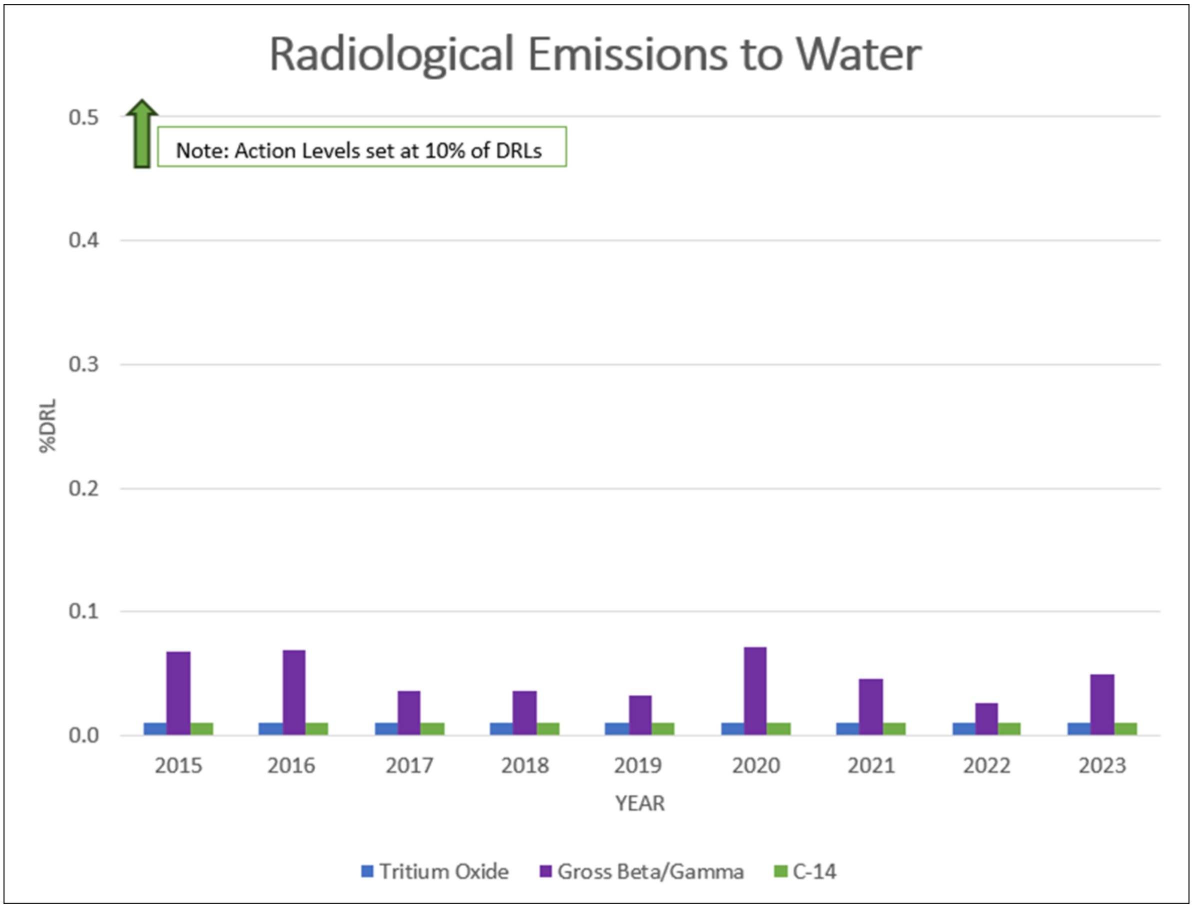


Figure 26: Radiological Emissions to Water

Powerhouse stack ventilation flows are monitored to measure the gaseous effluent releases (tritium, elemental tritium, iodine, carbon-14, noble gases, and particulate). The results are compiled weekly and compared to the applicable weekly DRL.

Waterborne radiological release data are compiled monthly and compared to monthly DRLs. Most radiological releases are routinely managed through the active liquid waste system and monitored prior to discharge.

During the current licence term, there was an exceedance of the weekly airborne tritium oxide (HTO) action level. This exceedance was attributed to an event at the Darlington NGS Tritium Removal Facility (TRF) due to issues with the tritium immobilization system. A Significant Issue Resolution Team was created, and corrective actions were taken to minimize further releases. Longer-term corrective actions are also in place, some of which include creating a cross-functional team to proactively address conditions in the TRF, implementing a design change to improve the robustness of the tritium immobilization system, improving leak check processes, and bolstering organizational support and prioritization of TRF challenges and equipment reliability.

2.9.4.2 Conventional Emissions

The Darlington NGS site also monitors conventional substances emitted to air and water as a result of site operations. Reports on emissions of conventional substances are prepared in accordance with provincial and federal regulatory requirements and submitted to provincial and federal agencies throughout the year.

Sulphur Dioxide, Nitrogen Oxides, and Carbon Dioxide Emissions

Darlington NGS has standby diesel generators to provide back-up electrical power to the station if required. These generators, which produce sulphur dioxide, nitrogen oxides and carbon dioxide emissions, are routinely tested to ensure availability. There were no regulatory non-compliances associated with air emissions from these generators during the licensing period.

Hydrazine and Ammonia

Hydrazine is used in the boiler feedwater systems to prevent corrosion. Ammonia is a resulting by-product. Hydrazine and ammonia are released to the environment when steam is vented to the atmosphere and from station water systems (to Lake Ontario). There were no regulatory non-compliances associated with hydrazine and ammonia emissions during the licensing period.

Ozone-Depleting Substances

Ozone-depleting substances (ODS) are used in refrigeration systems. Refrigerant leaks to air are minimized through routine inspections and maintenance of equipment. ODS releases between 10 kg and 100 kg are reported to Environment Canada in semi-annual halocarbon release reports. During the current licence term, there were six ODS releases.

2.9.4.3 Groundwater Protection and Monitoring Program

The Darlington NGS site has a Groundwater Protection Program (GWPP) and Groundwater Monitoring Program (GWMP), N-STD-OP-0046, *Groundwater Protection and Monitoring Program*, compliant with CSA N288.7-15, *Groundwater Protection Programs at Class I Nuclear Facilities and Uranium Mines and Mills*. Compliance with this standard came into effect on December 31, 2022.

The overall goal of the Darlington NGS GWPP is to protect the quality and quantity of groundwater by minimizing interactions with the environment from activities associated with the site, allowing for effective management of its groundwater resource. To meet this overall goal, the Darlington NGS site has a GWMP to provide timely data confirming that uncontrolled releases are not occurring and, if uncontrolled releases do occur, to signal when and where.

Water level elevation data collected as part of the Darlington NGS site's annual GWMP has shown that groundwater flow patterns remained consistent over the licensing period. The 2022 inferred shallow groundwater contour map is provided in

Figure 27 (NK38-REP-10140-10034, *2022 Darlington Nuclear Groundwater Monitoring Program Results*). Outside of the protected area, groundwater generally is inferred to flow from the north to the south, towards Lake Ontario. Inside the protected area and in the vicinity of the powerhouse, groundwater is inferred to flow west and north towards the Forebay. Further south of the powerhouse, groundwater is inferred to flow toward Lake Ontario.

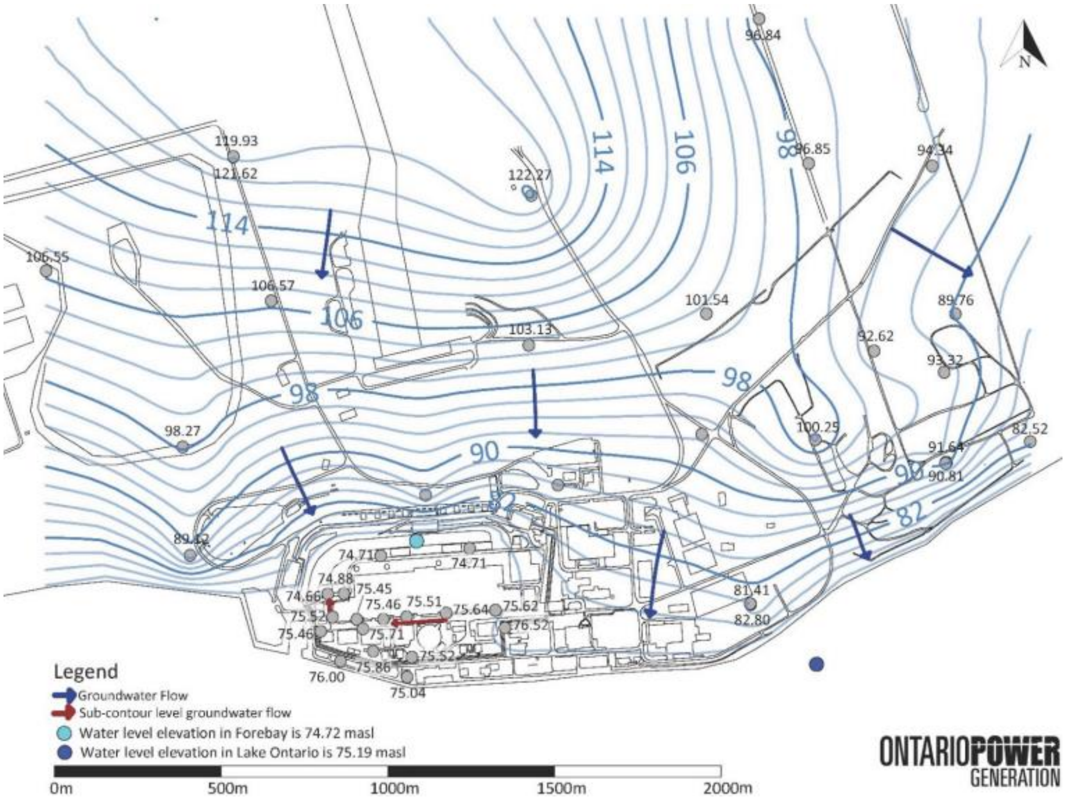


Figure 27: 2022 Inferred Shallow Groundwater Contour Map

On an annual basis, groundwater quality data is collected from monitoring wells located in key areas of the Darlington NGS site (in the protected area, in the controlled area, and at the Darlington NGS site perimeter). The majority of the samples are analyzed for tritium, with some samples also analyzed for petroleum hydrocarbons (PHCs) and benzene, toluene, ethylbenzene, and xylenes (BTEX).

With respect to tritium, results indicate that concentrations have remained relatively constant over time, which points to consistent environmental performance.

Elevated tritium concentrations in groundwater have been found in the Unit 2 area due to an injection water storage tank spill that took place in 2009. Since 2009, the groundwater tritium concentrations in that area have been steadily declining, indicating no new sources.

With respect to the Darlington NGS site boundary, tritium concentrations in groundwater are consistently low, indicating that the potential for adverse impacts to off-site groundwater quality from the Darlington NGS site is low to negligible. In 2022, the majority of perimeter monitoring wells reported tritium concentrations below the method detection limit. Municipal drinking water samples collected from downstream water supply plants as part of the annual OPG EMP were well below the Ontario Drinking Water Quality Objective for tritium of 7,000 Bq/L.

Darlington NGS site groundwater is also sampled to detect underground fuel oil pipeline leaks in key areas (for example, standby generator area). The results of PHC and BTEX sampling did not indicate any concerns during the licensing period.

2.9.4.4 Spill Management Program

The Darlington NGS site has a framework in place per OPG-STD-0152, *Spill Management* to manage spills, ensuring implementation of spill prevention, preparedness, response, clean-up, and remediation process in accordance with applicable regulations. At OPG, spills are classified as either Category A (Very Serious), Category B (Serious), Category C (Less Serious), or Category D (Exempted of Potential Spills). Spills are identified, classified, and reported following OPG-PROC-0041, *Environmental Event Identification, Classification, and Reporting*.

During the current licence term, there were no Category A or B spills. As of February 29, 2024, there were 13 recorded Category C spills. These spills typically involved refrigerant or oil.

Equipment deficiencies leading to the spill events were resolved via corrective action plans and documented in Annual Spills Risk Assessments. This includes an increase in equipment inspections (for potential leak risks), as well as an increase in preventative maintenance of refrigerant units.

Planned improvements were identified during a 2022 self-assessment on the spills program. It was determined that some updates to governance are required to ensure alignment. Actions are in place to address this.

2.9.5 Protection of People

One of the specific objectives of the ERA is to evaluate the risk to off site members of the public resulting from exposure to contaminants of potential concern and stressors related to the Darlington NGS site and its activities. The results of the ERA inform the EMP, which provides data to confirm that the Darlington NGS site is operating in a manner that is protective of people residing in the surrounding area.

The EMP monitors off-site air, water (municipal well, lake/stream), aquatic samples (fish, sediment, beach sand), and terrestrial samples (fruits, vegetables, eggs, poultry, milk, and animal feed). Data gathered from this program, along with emissions data, are used to assess the annual radiological dose to members of the public living or working in the vicinity of the Darlington NGS site.

OPG has also received recommendations from the Williams Treaties First Nations to add a new receptor to adequately assess the radiological dose for Indigenous populations who may live and/or work and/or harvest and consume wildlife, fish and/or plant resources close to the site. OPG will be starting to engage in early 2025 on the next Darlington site ERA and will seek to collaborate with Indigenous Nations and communities on including this a new receptor.

The most recent ERA for the Darlington NGS site concluded that there are no risks to human health as a result of the operation of Darlington NGS. Results of the public dose assessment are published in the annual EMP report. The annual EMP is submitted to the CNSC and made available to the public on www.opg.com.

The effective dose limit for members of the public as set out in the Radiation Protection Regulations, is 1,000 μSv/year. As shown in the logarithmic scale in Figure 28 and illustrated in Figure 29, dose to the public from operation of the Darlington NGS site is a very small fraction of both the annual legal dose limit and the annual natural background radiation in the area.

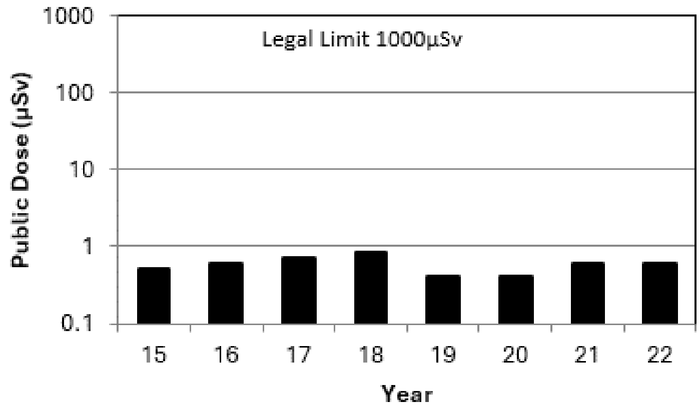


Figure 28: Public Dose Limits

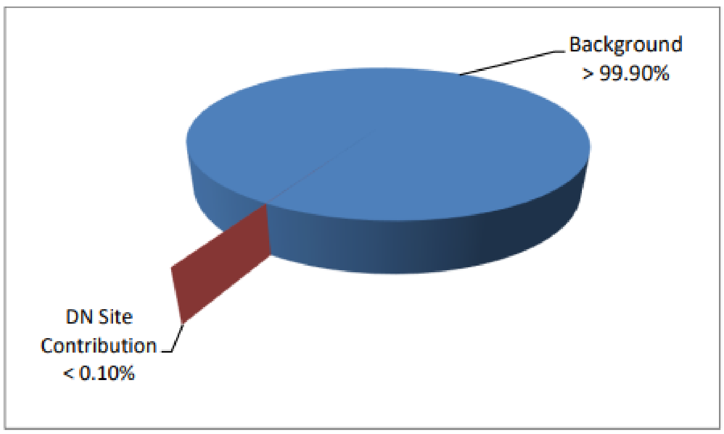


Figure 29: Background Radiation vs. Darlington NGS Site Contribution

2.9.6 Fish Impingement and Entrainment

Fish protection is integrated into the design and location of the intake of the Darlington NGS. The combined mitigation measures of the porous veneer lake bottom design, low approach velocities, and placement 800 m offshore, reduce the potential for impingement and entrainment of aquatic organisms as compared to an open channel shoreline intake design.

As part of the commitments of the Darlington NGS refurbishment follow-up monitoring program and as specified in the amended Darlington NGS Fisheries Act Authorization for refurbishment (Reference 2.9-1), OPG will conduct two years of consecutive fish impingement and entrainment monitoring after refurbishment of all units is completed.

During the current licence term, there were no impingement studies required or undertaken. The impingement and entrainment monitoring will commence in 2027 to align with completion of refurbishment. OPG recognizes that fish impingement and entrainment are important areas of interest to Indigenous Nations and communities, and commits to facilitating engagement and participation on the up-coming studies. Previous impingement studies verify that the intake design and location results in low levels of impingement that are not expected to increase substantially over time but that will fluctuate with natural variation and intake volumes (D-REP-07262-0509778, *Submission to DFO for an Authorization under the Fisheries Act for the Darlington Nuclear Generating Facility*).

During the Darlington Nuclear Refurbishment and Continued Operations Environmental Assessment, OPG committed to undertake entrainment monitoring prior to the commencement of refurbishment to characterize the station's entrainment of ichthyplankton (i.e., fish eggs and larvae) and benthic invertebrates. This year-long entrainment study, a condition of the Fisheries Act Authorization for Darlington NGS refurbishment, was completed during 2015-2016. The data from this study will also be used to establish a baseline to aid in predicting future operational effects from Darlington NGS post-refurbishment with all units operating.

Owing to the more intensive and year long duration, the 2015-2016 entrainment study, NK38-REP-07260-00005, *2015-2016 Entrainment Study: Final Report*, collected both previously documented and new species that were not previously collected in prior entrainment studies. New species included Deepwater Sculpin (a species at risk), Round Goby (a species listed in the Aquatic Invasive Species Regulation), Walleye, and Burbot (both species that are recreationally fished). The study did not capture any Round Whitefish eggs or larvae, suggesting that entrainment of Round Whitefish is not a significant risk to the species. Additionally, as an Environmental Assessment commitment, annualized entrainment of benthic invertebrates was estimated, which had not been done in the earlier studies.

The results reinforced that the experimental design of the entrainment sampling study improved the likelihood of capture relative to prior studies in 2004 and 2006. The detection of new species was, in part, attributed to longer sampling periods (encompassing day/night and seasonal variations) and larger sample volumes yielding greater sample sizes and increasing the likelihood of detectability. The study also concluded that entrainment is not significantly impacting local benthic invertebrate populations.

With respect to next steps, the authorization commits OPG to the completion of a two year impingement and entrainment monitoring program commencing in 2027, shortly after completion of the refurbishment phase and allowing for some time for the environment to readjust to all units operating.

2.9.7 Thermal Plume

The Darlington NGS refurbishment follow-up monitoring program required a study of condenser cooling water plume temperatures to verify that the activities would not adversely affect the survival of round whitefish eggs laid in the plume. Temperature monitoring was conducted in the plume and at a reference location in the winter of 2017/2018.

The results of the thermal plume study documented in NK38-REP-07250-00001, *Darlington Refurbishment Follow-Up Monitoring Program: Thermal Plume Monitoring 2017-2018*, showed that the predicted effect of the plume ranged from a relative survival gain of 0.1% to a loss of 0.4%. This is a negligible effect that is not biologically significant and well below the 10% loss threshold that CNSC requires to implement further mitigation measures. It was concluded that the operation of the site during the refurbishment period has not resulted in an adverse condition to the survival of round whitefish eggs laid in the plume. This confirms the prediction made in the Environmental Assessment, and no additional mitigation measures or monitoring are required during the refurbishment period.

Section 2.10

Emergency Management & Fire Protection

2.10 Emergency Management and Fire Protection

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

The following subsections outline OPG's programs for Emergency Preparedness and Response:

- 10.1 – Conventional Emergency Preparedness and Response;
- 10.2 – Nuclear Emergency Preparedness and Response;
- 10.3 – Fire Emergency Preparedness and Response.

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

- Nuclear safety will be assured such that plant personnel, the public and the environment are protected.
- Staff are qualified and competent to respond to nuclear and fire events at the plant, and this will be maintained though the next licence term (e.g., refer to Section 10.2 regarding ERO performance).
- OPG continues to invest in Darlington NGS to support nuclear safety (e.g., via drills and exercises).
- Transparency and appropriate public consultations have been upheld and will continue (e.g., via public alerting provisions and public awareness campaigns for KI pill distribution).

The OPG documents in the table below require written notification of change per Darlington NGS Licence Conditions Handbook, LCH-PR-13.03/2025-R005:

Table 16: SCA 10 – Emergency Management and Fire Protection

Document	Title
N-PROG-RA-0001	Consolidated Nuclear Emergency Plan
N-PROC-RA-0045	Emergency Preparedness Drills and Exercises
N-PROG-RA-0012	Fire Protection
NK38-REP-09701-10338	Fire Hazard Assessment of the DNGS Retube Waste Processing Building (RWPB)

2.10.1 Conventional Emergency Preparedness and Response

2.10.1.1 OPG Emergency Management

OPG-PROG-0030, *Ontario Power Generation Emergency Management Program*, ensures the security of its facilities and that strategies are in place that allow it to prepare for, respond to, and recover from emergencies that impact its operations or the public.

The objectives of the OPG Emergency Management (EM) program are to protect:

(a) The health and safety of employees, contractors, public and responders;

(b) The environment, OPG property and third party property;

(c) OPG's assets;

(d) OPG's reputation;

(e) Operational continuity.

The OPG Emergency Management program applies the all-hazards approach and Five Pillars of Emergency Management to facilitate: Prevention, Mitigation, Preparedness, Response and Recovery Efforts for all hazards and incidents that pose a risk to OPG's Emergency Management Program objectives. At OPG, incident management is carried out by several individual programs and initiatives spanning multiple Business Units.

2.10.1.2 Security Emergency Preparedness and Response

The Nuclear Security program supports the protection of nuclear assets at OPG. This program ensures security readiness and maximizes response capability to contain, mitigate, and terminate security events while minimizing the adverse impact on plant staff, operations and functions. OPG has a suite of documentation to support the defensive strategy and tactical plans for response. Details regarding the development and maintenance of OPGs defensive strategy such as supporting tactical deployment plans are classified as OPG Confidential - Security Protected or higher.

Additional details about the Nuclear Security program can be found in Section 2.12.

2.10.1.3 Cyber Emergency Preparedness and Response

OPG Cyber Security conducts regular assessments to support OPG Nuclear Security in addressing potential cyber security issues affecting the physical security at Darlington NGS.

Cyber Security related to Information Management is the responsibility of OPG Cyber Security Operations, Architecture and Governance. OPG maintains documentation on Information Technology Emergency Response which includes preparing, detecting and assessing, containing, eradicating and recovering from cyber incidents.

Refer to Section 2.12 for detailed information on the Cyber Security program.

2.10.1.4 Abnormal Waterborne Tritium Emission Response

N-PROC-OP-0038, *Abnormal Waterborne Tritium Emission Response*, provides direction for response to an abnormal waterborne tritium emission from OPG's nuclear sites, and provides guidance for staff to manage the required external notifications in a consistent and effective manner. Specifically, it addresses notifications, default sampling, interfacing with external groups, response network, response facilities, drills and training to support this capability.

Radioactive Liquid Emission Response drills and exercises are conducted annually to demonstrate and assess OPGs ability to respond to simulated Abnormal Waterborne Tritium Emissions, including the effectiveness of response facilities, and the interface with external stakeholders.

On October 20, 2022, Darlington NGS conducted an evaluated drill which included participation by external agencies that receive notification from OPG. The purpose of the drill was to test the ability of Darlington NGS personnel to make initial contact promptly and effectively with internal departments and external agencies, notifying that a liquid emission had occurred, and to prepare personnel for the next stage of response. All objectives of the drill were successfully met, including projected tritium release times, and proper and timely notifications to external agencies. Some minor observations were identified to improve future response, including the creation of a dedicated information board.

2.10.1.5 Radioactive Materials Transportation Emergency Response Plan

The Radioactive Material Transportation (RMT) program, W-PROG-WM-0002, *Radioactive Material Transportation* describes the managed system for RMT at OPG Nuclear. The RMT program ensures safe, compliant, and efficient transportation of radioactive material.

Under this program N-STD-RA-0036, *Radioactive Material Transportation Emergency Response Plan*, identifies the OPG responsibilities and the concepts to enable an effective response to a transportation incident involving an OPG shipment of radioactive material. This plan also identifies the liaison and potential interface with external Emergency Response Organizations (ERO). This plan applies to off-site shipments only. On-site incidents are addressed through the site ERO implementing instructions.

A Darlington NGS Transportation Emergency Response Plan (TERP) table-top drill was conducted on October 20, 2023 (NK38-REP-03490-10162) as an opportunity for qualified personnel to maintain familiarity with their response instructions and understand the collaboration between roles. The drill was conducted to demonstrate the ability to respond to an off-site radioactive waste transportation emergency per Transport Canada regulations. This is covered under OPG's Emergency Response Assistance Plan (ERAP) for the transportation of dangerous goods and is a requirement under federal law.

This drill combined the efforts of qualified personnel from OPG and external agencies including the designated external contractor, Ministry of Environment, Transport Canada, and the Ontario Provincial Police. The use of drone technology will continue to be reviewed to improve response capabilities and personnel safety. There were no significant findings, and all drill objectives were met. Some minor observations were identified to improve future response, including revising response area maps.

2.10.2 Nuclear Emergency Preparedness and Response

2.10.2.1 Emergency Preparedness Program

OPGs Nuclear Emergency Preparedness program is documented in N-PROG-RA-0001, *Consolidated Nuclear Emergency Plan (CNEP).* This plan implements the requirements of REGDOC-2.10.1, *Nuclear Emergency Preparedness and Response, Version 2,* and serves as the basis for the site-specific nuclear emergency preparedness and response arrangements at

OPG's nuclear generating stations. It describes concepts, structures, roles and processes to implement and maintain an effective OPG response in the unlikely event of a nuclear emergency that could endanger onsite staff, the public, or the environment. The objective of the 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 and ensure the health and safety of persons. The CNEP also provides a framework for interaction with external authorities and defines how OPG commitments under the Provincial Nuclear Emergency Response Plan (PNERP) are implemented. OPG acknowledges there is interest from Indigenous Nations and communities in the conduct of the Emergency Preparedness program and is taking steps to facilitate further engagement.

In the unlikely event of a nuclear emergency at Darlington NGS, OPG would perform the appropriate notifications to the Province, CNSC, and local municipalities in accordance with established procedures and requirements under the PNERP. The ERO takes actions to control and mitigate the emergency on-site and minimize off-site effects. Under the PNERP, the Province takes actions to notify and protect the public, including directing protective actions such as sheltering, potassium iodide ingestion, or evacuation. The local municipalities support the implementation of Provincial directions. OPG and a range of other organizations are integrated to ensure effective emergency measures are in place (Figure 30).

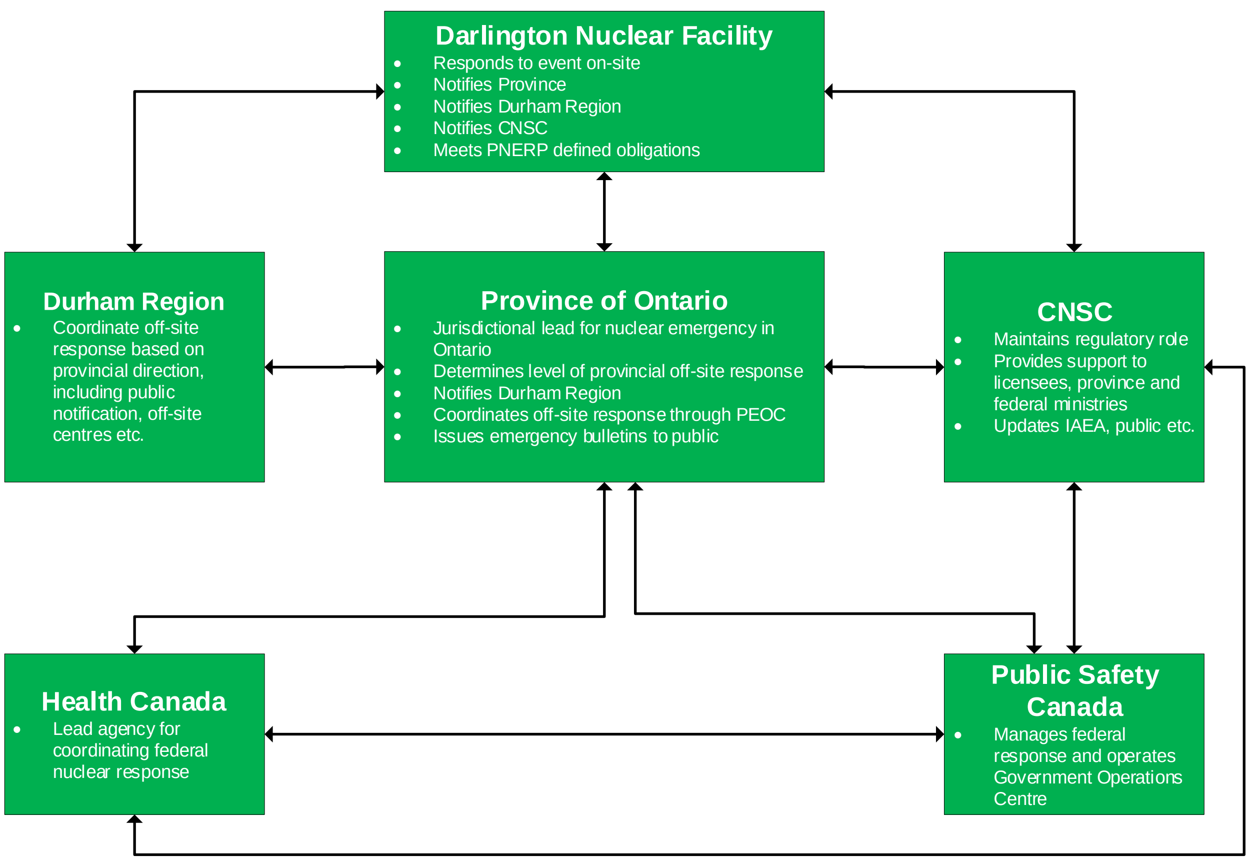


Figure 30: Emergency Response Agency Interactions

As per the PNERP and CNEP, a reportable event is:

1. An event affecting the reactor facility which would be of concern to the off-site authorities responsible for public safety.
2. Provincial and municipal duty staff should respond as per routine monitoring.

The PNERP, last revised in 2017, is undergoing a revision by Emergency Management Ontario (EMO) to align with international best practices. The review and update of the PNERP began in 2021 and is ongoing. OPG will review and provide comments on the final draft PNERP during the public consultation period. The Province will conduct a public consultation process with the objective of obtaining a Cabinet approved PNERP in 2024. OPG has reviewed and provided comments during the initial review period and will enhance its emergency plans to align with any PNERP requirements once issued. Once the revision is complete, EMO will revise the Darlington NGS Implementing Plan and OPG will enhance its emergency plans to align with any PNERP requirements once issued. OPG will also revise the CNEP as required to ensure continued alignment with PNERP requirements.

2.10.2.2 Nuclear Emergency Drills and Exercises at OPG

To ensure the capability to respond effectively to a nuclear emergency is sustained, OPG frequently conducts emergency preparedness drills and exercises which help to test and validate Darlington NGS emergency plans and procedures and provide the ERO with the opportunity to maintain performance in their roles.

Station-based radiological and nuclear emergencies are developed under the directive of N-PROC-RA-0045, *OPG Nuclear Emergency Response Organization Drills and Exercises*. They are intended to meet the requirements of N-PROG-RA-0001, *Consolidated Nuclear Emergency Plan,* and regulatory requirements established by the CNSC under REGDOC-2.10.1, *Nuclear Emergency Preparedness and Response, Version 2.*

Darlington NGS drills and exercises serve the following purposes:

b) Develop and maintain the skills of the ERO.

c) Test the effectiveness of emergency plans and procedures, facilities, equipment, and training, and.

d) Demonstrate the adequacy of plans and preparedness to respond to events ranging from minor to severe accidents.

In February 2022, OPG executed “Exercise Unified Command” at Darlington NGS to test and demonstrate the effective integration of OPG emergency response plans with off-site agencies. The exercise included the participation of over 30 organizations and government agencies including the Province of Ontario, the Regional Municipality of Durham, the City of Toronto and the CNSC. The scope of the exercise included: accident assessment and response to both design basis and beyond design basis conditions, initial event categorization and notifications, event information communication, field radiation monitoring, dose predictions, public protective action decision making and communications, consultation around radioactive release decisions, public communications, and media interactions. Exercise Unified Command 2022 was successful in achieving the overall objective of testing the preparedness of OPG, and the interoperability with government agencies and local communities to respond to a severe event. Full scale interoperability exercises are conducted every 3-years at Darlington.

In September 2023, OPG executed another full-scale nuclear emergency response exercise at Pickering NGS. This exercise and scenario were designed to test emergency plan arrangements less commonly demonstrated including recovery operations. From this exercise, following lesson learned will be applied to Darlington NGS:

- Strategies to enhance drill realism, ensuring participants derive maximum benefit from the exercise.
- Enhancements to methodology for designing extended duration exercise scenarios and managing the associated complexities.
- Enhancements in guidance to staff during event recovery phase.
- Improvements in processes, equipment, and training identified during this exercise are already being implemented to better support our responders.

2.10.2.3 Equipment Important to Emergency Response

Equipment Important to Emergency Response (EITER) includes procedures and processes which identify the Systems, Structures, and Components (SSCs), as well as essential tools and equipment necessary to implement the CNEP. EITER procedures ensure maintenance is prioritized and contingency actions are taken when EITER designated equipment is taken out of service or becomes unavailable. EITER ensures OPG has the capability to implement the emergency plan through the readiness and availability of the EITER equipment, facilities, or through enacting compensatory measures or use of designated alternate facilities where the primary means may be unavailable. EITER requirements are integrated into the work management process for planned maintenance activities.

In 2020 OPG received recognition from WANO with an Industry Strength rating for the EITER program resulting from innovative practices for tracking, managing, and maintaining this equipment. Enterprise Emergency Management works closely with station staff to ensure EITER unavailability is reduced and equipment is restored quickly to service. In response to a self-assessment in 2020, a fleet-wide cross-functional Emergency Mitigating Equipment Excellence Team was established, driving improvements to EITER procedures, processes, training, accountabilities and clarified roles and responsibilities related to the management of this equipment.

EITER Improvements

A revision to the tracking system for EITER will provide automation and an improved visual representation of EITER performance. In addition, improved guidance documentation will guide the users to calculate EITER performance.

2.10.2.4 Potassium Iodide (KI) Pills

Ingestion of Potassium Iodide (KI) is one protective action that may be directed by Provincial authorities in the unlikely event of a nuclear emergency. OPG continues to provide the Regional Municipality of Durham with the necessary resources and support to pre-distribute KI in the 10km Detailed Planning Zone (DPZ), to meet the requirements of REGDOC-2.10.1, *Nuclear Emergency Preparedness and Response, Version 2, and the Provincial Nuclear Emergency Response Plan (PNERP).* The KI pill inventory for the pre-distribution program is maintained separately from the emergency inventory that is maintained by the Province of Ontario. KI tablets pre-distributed within the DPZ are available at schools, childcare centres, health care facilities and municipal services. Pre-distribution ensures that KI is available quickly for residents and businesses within 10 km of Darlington NGS. OPG also provides the ability for qualifying population outside the DPZ to request KI through an online portal. In the unlikely event of a nuclear emergency, additional supplies of KI are available at Reception Centres, Emergency Workers Centres and for the Ingestion Planning Zone (IPZ).

The Prepare to Be Safe website (preparetobesafe.ca) serves as a platform for KI pill Frequently Asked Questions (FAQs) and provides a means for businesses and residents within 50 km of Darlington NGS to request KI pills. Website information is translated into the most common languages spoken within 10 km (based on census data). New households and businesses in the 10 km DPZ are identified monthly by Canada Post and sent KI pills with supporting information included. Media campaigns are conducted three times per year to raise awareness of KI availability, focused on the public residing within the 10 km DPZ but extending into the IPZ, through various media (e.g., news releases, print advertisements, social media, and digital display boards). Durham Region has produced videos to raise general awareness about KI, one of which focused on the availability of KI within the 50 km IPZ.

OPG is committed to building long-term mutually beneficial working relationships and information sharing with other utilities, as well as organizations responsible for public health and emergency management coordination proximate to our operations. OPG continues to participate and support the CNSC-led Potassium Iodide Working Group (KIWG). Any recommendations and lessons learned from this working group will be adopted for Darlington NGS. OPG continues to monitor the changes in the updated regulatory requirements and PNERP, and OPG will maintain compliance. OPG continues to offer support to the KIWG on all matters as needed, including engagement and outreach with Indigenous Nations and communities.

2.10.2.5 Emergency Management Indigenous Nations and Communities and Public Engagement

OPG Emergency Management staff participate in various annual public engagement opportunities where nuclear emergency planning, preparedness and response are discussed. A variety of platforms are used to engage and inform the public, including in-person events (and public information centres), printed products (newsletters, fact sheets), website information, and various traditional and social media strategies. OPG communicates with our local residents as well as the public beyond our local communities through a number of these communication products and forums. Presentations are made every year to each to Darlington's Community Advisory Council and the Durham Nuclear Health Committee including overviews of Ontario's nuclear emergency response framework, OPG emergency preparedness structure, and key program updates as well as addressing various points of interest and questions.

OPG has also responded to requests from Indigenous Nations and communities for information and engagement with respect to emergency management. In May 2023, Emergency Management was invited to participate in a Métis Nation of Ontario community open house where various emergency preparedness, transportation and waste topics were discussed with attendees. OPG has been invited to attend this event again in June 2024 and looks forward to the opportunity to directly engage with the Métis Nation of Ontario. During OPGs 2023 open house at the Darlington Energy Complex (DEC), emergency management information was also made available to participants.

OPG understands that there is interest from Indigenous Nations and communities for further engagement on our Emergency Management programs. OPG is committed to taking steps to better understand the interests, identify opportunities and facilitate increased engagement with Indigenous Nations and communities through OPG's Emergency Management program.

2.10.2.6 External Hazard Assessment

Risk assessments of external hazards are addressed in OPG's *Risk and Reliability Program*, N-PROG-RA-0016 which is consistent with OPG Nuclear Safety Policy, Nuclear Management System and best practices in the industry. Probabilistic Safety Assessments are used to assess the magnitude and frequency of radiological risks to the public from accidents due to the operation of nuclear reactors. OPG's Darlington NGS Probabilistic Safety Assessment Report summarizes an overview of hazard screening method and the external hazard screening assessment.

External hazards are defined as hazards that are initiated outside the OPG exclusion zone or are hazards that are outside the plant's direct control. These hazards could be in the form of natural hazards (e.g., ice-storms, flood, etc.) or man-made hazards (e.g., a chlorine leak from a rail-car derailment, aircraft crash, etc.).

Initiating events for emergency preparedness planning can be non-nuclear and may result from situations and conditions external to the plant site. Potential events are screened based on frequency and consequence. OPGs designed emergency response capability and infrastructure is sufficiently flexible to be used for a broad range of events and disasters both within and beyond the design basis. For beyond design basis situations, the response infrastructure has the capability to draw upon additional external support resources to support OPGs response as needed.

2.10.2.7 Land Use

OPG Real Estate and Services personnel monitor land use policies and activities in proximity to OPG nuclear facilities. Enterprise Emergency Management (EEM) personnel support this activity, when required, to ensure planned activities have no adverse impact on the implementation of nuclear emergency plans.

The following is a list of Regional or Municipal Emergency Services within the 10-km area around Darlington NGS (Table 17):

Table 17: Regional or Municipal Emergency Services

Fire Emergency Stations	6
Regional Police Station	1 (plus one administrative police department)
Hospitals	1 Lakeridge Health Bowmanville Hospital

The following is a list of Transportation systems within 10-km around Darlington NGS (Table 18):

Table 18: Transportation Systems

Major Highways	401, 407, 418
Railway lines	Canadian National, south of Highway 401 and bisects the site Canadian Pacific, north of Highway 401
Naval Ports	Port of Oshawa East Pier

2.10.2.8 Remote Evaluation

OPG EEM has put a large focus on developing and sustaining a culture of innovation, resulting in several impactful initiatives being implemented successfully through annual Excellence Plans. To promote and sustain ERO performance through the pandemic, EEM implemented a remote drill evaluation solution to facilitate the continued execution of ERO drills in-person, at a time when the majority of industry had moved to conducting tabletop style drills. This solution has been recognized as an industry leading initiative and has been benchmarked externally through the WANO as well as several individual nuclear utilities.

OPG is committed to continuous improvement. EEM staff apply lessons learned from drills and exercises, self-assessments and our corrective action program and drive improvements to EP plans, procedures, equipment and ERO training.

2.10.2.9 Emergency Response Organization Performance

As part of an emergency preparedness excellence initiative, a new ERO performance process and tool were implemented in 2023 to provide an accurate picture of overall ERO performance. OPG also introduced additional opportunities for key members of the Darlington NGS ERO to demonstrate their skills and performance in executing Provincial emergency notification requirements in the simulator. As a result, performance has broadly improved across the ERO. In addition, OPG has qualified additional Darlington NGS ERO members for additional capacity beyond program requirements. These changes improve how ERO performance is measured, tracked, and reported to provide data-driven insights into performance strengths and areas requiring improvement. This ongoing ERO performance focus continues to be effective, and lessons learned are applied to other areas requiring improvement as needed.

2.10.2.10 Self-Assessments

Formalized self-assessments and industry benchmarking of Emergency Preparedness program elements are conducted annually to identify program improvement opportunities. Notably, in 2021 a self-assessment was conducted on the virtual activation and operation of the Crisis Management Communications Centre (CMCC). As a result, OPG revised its processes and procedures to include an option to activate the CMCC virtually. In 2023, a self-assessment review was conducted to assess the response of ERO members to the duty change process to validate that ERO turnover expectations are being met. Although the results were very positive, Enterprise Emergency Management implemented corrective actions and improvements to further reinforce its commitment to maintain a high level of emergency preparedness and response.

2.10.2.11 Station Performance Indictors

Emergency response performance indicators are monitored closely and reported quarterly to OPG leadership and the CNSC under REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants*. These indicators are as follows:

- Radiological Emergencies Performance Index;
- ERO drill participation index;
- Emergency Response Resource Completion Index.

2.10.2.12 Radiological Emergencies Performance Index

This indicator monitors timely and accurate licensee performance in drills and exercises when presented with opportunities for categorization of emergencies, notification of offsite authorities, and providing information to local authorities to allow for timely development of protective action recommendations. It is the ratio, in percent, of timely and accurate performance of those actions to total opportunities. In 2021, as part of an emergency preparedness excellence initiative, OPG introduced additional opportunities for key members of the ERO to demonstrate their skills and proficiency in executing Provincial emergency notification requirements in the main control room simulator. As a result, the number of opportunities that is measured has increased dramatically as the result of an excellence initiative.

2.10.2.13Emergency Response Organization Drill Participation Index

The ERO drill participation index indicates what percentage of qualified ERO members have participated in drills, exercises, crew practices, practical evaluations, or actual events on a quarterly basis. This metric varies based on any relevant opportunities available in that quarter. It should be noted that OPG's requalification period is on an 18-month cycle, not 12 months.

2.10.2.14 Public Address System

The Darlington NGS Public Address (PA) system provides immediate notification and messaging to staff working on site of important information, including emergency conditions and associated actions. This includes emergency tones and verbal messaging indicating different types of emergencies which direct staff to take required actions. This system is aging and in 2023 experienced a notable degradation in system performance, including a reduction in coverage across the station to approximately 90% of full coverage.

OPG has undertaken a multi-phased project to assess and replace this system by bringing it into alignment with modern standards to improve the system maintainability, reliability, and performance. This project is expected to be in service by December 2026 with phase 1 implementation in 2025.

To recover the system's performance until the new system is in place, a team was formed, and a bridging strategy was implemented which resulted in the system being restored to 100% coverage within the station. A number of actions were taken to increase safety for all staff on site during this period, including posting of signage and a range of communications indicating system status, development of a text messaging application and implementation of pre-deployed and portable handheld radios which relay the PA system signal.

To provide confidence that the system continues to remain fully functional and to ensure that any issues are quickly identified and resolved, regular system testing is performed, and additional actions were taken to provide greater oversight of this system, including development of a system status dashboard and implementation of annual system health reporting.

2.10.2.15 Public Alerting

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

- Sirens: Mounted on poles, sirens emit a single tone alarm that can be heard outdoors. These sirens are located within 3 km of the Darlington NGS site.
- Telephone Dialing System: An automated telephone dialing system will deliver a recorded emergency message through landline home and business phone numbers within 10 km of the Darlington NGS site.
- Radio, Television, Social Media: Local radio and television stations, and social media, will broadcast information on public health, safety, and welfare. Instructions on what to do in the event of a nuclear emergency will be provided.
- Alert Ready: Canada's National Public Alerting System provides public alerts through radio, television, and on LTE connected and compatible wireless devices (i.e., cellular phones).

OPG provides resources and support to the Regional Municipality of Durham who owns, operates, and routinely tests the public alerting system including sounding the sirens each fall and spring.

Alert Ready officially launched in March 2015; at which time it distributed alerts solely through broadcasters. In April 2018, wireless providers were also required to implement the system and started distributing alerts via smartphones.

2.10.2.16 Evacuation Time Estimate

OPG provides updates to the Darlington Evacuation Time Estimates (ETE) every 5-years as new census data becomes available. An update to the Darlington ETE study using 2021 census data was issued in May 2023.

An industry-accepted methodology is used to complete this work. The ETE study takes into consideration the time required to evacuate the emergency planning zones defined in PNERP, as well as evacuations of schools, hospitals, and other residential institutions. This work is completed with support from the Province, local municipalities, police, and transit organizations. The results are made available to all relevant agencies. The study provides off-site emergency planners with projections on how long it may take for various sectors and emergency planning zones to evacuate if required, as defined in the PNERP. Variables such as time of day, day of week, road restrictions, special event assemblies and weather are assessed as to how those factors may impact the evacuation duration. The 2023 study resulted in increased time estimates compared to the previous 2018 Darlington ETE study. This is primarily a result of population increase, traffic pattern changes and updated planning assumptions.

2.10.2.17 Off-Site Support

Agreements

In May 2022, OPG and EMO endorsed a new 5-year agreement to support EMO in the planning, maintenance, and execution of the PNERP. This new agreement supports the Province who provide staff with expertise in nuclear and radiological science, hazard identification and risk assessment, emergency planning, drills, and exercises, maintenance of 24/7/365 nuclear emergency response capability, and nuclear education and emergency preparedness materials.

A 10-year Nuclear Emergency Mutual Aid Agreement between Canada's four major nuclear operators, (OPG, Bruce Power, Canadian Nuclear Laboratories and New Brunswick Power) was renewed in December 2022 which outlines emergency support that may be provided, and the processes involved in the unlikely event that a nuclear operator suffers a major emergency and requires mutual aid assistance.

Reception Centre and Emergency Worker Centre Support

OPG provides Monitoring and Decontamination Unit capability at Emergency Worker Centres and Reception Centres. Enterprise Emergency Management maintains equipment inventories at these designated offsite locations with the support of the local facility staff. OPG is continuously working with community partners and external stakeholders to improve off-site support.

Reception Centre exercises were conducted at Durham College Reception Centre in Oshawa in June 2018 and at Delpark Homes Centre in Oshawa in September 2019. More recently, in February 2022 an exercise was conducted at Orono Arena as an Emergency Workers Centre. During these three exercises, the OPG Monitoring and Decontamination Unit was activated and processed members of the public or emergency workers and their vehicles, and participation of community partners was present. Lessons learned from these exercises have been incorporated into OPGs and Durham Region processes and procedures.

In an effort to improve familiarization of local nuclear emergency planning and operations at Emergency Workers Centres and Reception Centres, OPG continues to collaborate with its off-site partners to conduct off-site centre drill and exercises and drive improvements to emergency plans and operations.

2.10.3 Fire Emergency Preparedness and Response

2.10.3.1 Fire Protection Program

OPG's comprehensive Fire Protection program consists of two elements: the Fire Protection programs group which provides oversight for regulatory compliance, and the Fire Protection Operations group (Emergency Response Team) which provides fire emergency response at Darlington NGS. Together, the overall Fire Protection program ensures that licensed activities do not result in unreasonable risk to the health and safety of persons and the environment due to fire.

OPG's Fire Protection program and its elements are outlined in N-PROG-RA-0012, *Fire Protection.* OPG's Fire Protection Program has been developed based on the requirements of CSA N293-12 (R2017), *Fire Protection for Nuclear Power Plants,* with the goals of:

- Minimizing the risk of radiological releases to the public as a result of a fire.
- Protecting station occupants from death or injury as a result of a fire.
- Minimizing economic loss resulting from damage to structure, equipment, and inventories as a result of a fire.
- Minimizing the impact of radioactive or hazardous material on the environment as a result of a fire.

To meet these four goals, the Fire Protection programs group establishes processes to ensure that all reasonable measures are taken to prevent fires, and to promptly detect and suppress any fires that may occur at the plant. These include but are not limited to:

- Combustible Material Safety Permits (CMSPs) and Ignition Source Permits (ISPs) to reduce the likelihood and severity of fire through the minimization and control of transient combustible materials and hot works.
- Impairment Manual for Fire Protection Systems to address impairments of fire protection and life safety systems and identify recommended compensatory measures to provide reasonable assurance that the affected impaired area will be unlikely impacted as result of a fire.
- Oversight of the inspection, testing, and maintenance of fire protection systems to ensure they operate as designed during the life of the systems.

Furthermore, the Fire Protection Programs group owns, maintains, and updates the station's Annual Plant Condition Inspection (APCI) Report, Fire Hazard Assessment (FHA) Report, Fire Safe Shutdown Assessment (FSSA) Report, and the Code Compliance Review (CRR) Report, to demonstrate regulatory compliance to the requirements of CSA N293 as stipulated in the PROL for Darlington NGS.

The latest 2023 APCI for Darlington NGS was completed by an independent, qualified third-party vendor. The vendor reported that there was sufficient evidence to conclude that OPG Fire Protection Program was being followed and effectively maintained to ensure compliance with the applicable requirements of CSA N293-12 (R2017), National Fire Code of Canada (NFCC), and National Building Code of Canada (NBCC).

A CCR was conducted in 2023 to verify the as-built conditions of the station complies with the applicable requirements of CSA N293-12 (R2017) and its referenced NFCC and NBCC.

Darlington NGS's Fire Protection Assessments, which consist of the FHA and Fire Safety Shutdown Assessment were completed in 2021 and submitted to the CNSC by the end of 2021 in compliance with the Darlington NGS PROL. In general, the 2021 FPA concluded that Darlington NGS is provided with effective design, construction, fire protection features and operational controls to mitigate the fire hazards present and maintain the fire, life and nuclear safety goals defined in CSA N293.

OPG Fire Protection programs is exploring the possibility of developing and implementing software(s) that could potentially enhance administrative oversight and control for major elements administered by the Fire Protection programs group, such as CMSPs, ISPs, and impairments. An expected feature of the software(s) is the automatic identification of fire-related impairments in an area where a CMSP or ISP is being requested. If implemented, the software(s) has the potential to assist the CMSP/ISP reviewer in understanding the aggregate fire risk in the area as part of the review and approval process, ensuring fire protection goals are not compromised.

2.10.3.2 Refurbishment

For the refurbishment project, N-PROG-RA-0012, *Fire Protection* is being followed. During refurbishment, OPG will:

- Prepare fire protection strategies.
- Perform FHA and FSSA for the islanding areas and refurbishment units.

- Act as Controlling Authority and fire protection subject matter expert for CMSPs.
- Act as ISPs issuer.
- Provide sufficient resources to response to first aid, firefighting, rescue and hazmat incidents in refurbishment units and operating units.

2.10.3.3 Emergency Response Team

OPG maintains an on-site, 24/7 Emergency Response Team (ERT) for manual fire suppression operations at the Darlington NGS site. The Darlington NGS ERT is currently a team consisting of full time and temporary Emergency Response Maintainers (ERMs) and light duty staff. At its disposal are: one incident command vehicle, two fire pumpers, one rescue, light and air apparatus, two response vehicles, five pickup trucks, one response cart for rapid deployment within the station, and four fire carts equipped with pump, aqueous firefighting foam supplies, and dry chemical extinguishers. The Darlington NGS ERT maintains a five-crew shift schedule to provide 24/7 fire protection coverage for the station, with day-support for related fire protection activities such as fire inspection rounds, fire watch, CMSP and ISP inspections. Individual ERMs of the ERT hold the same basic qualifications as professional firefighters at a municipal fire department, and the ERT as a group, and the ERMs as individuals also meet the requirements of internationally recognized NFPA 600, *Standard on Facility Fire Brigades, and* NFPA 1081, *Standard for Facility Fire Brigade Member Professional Qualifications* respectively.

A Memorandum of Understanding (MOU) is established between OPG and the Municipality of Clarington Emergency and Fire Services Department (CEFSD), to provide mutual aid agreements between OPG and Clarington. As part of this MOU, Clarington will respond to all fire emergencies at the Darlington NGS site and provides assistance as needed.

The Darlington NGS ERT participates in multiple annual drills ranging from site drills, contaminated casualty and hospitalization drill, Emergency Mitigating Equipment (EME) deployment drill, to live fire drills at the Wesleyville Fire and Rescue Academy to demonstrate ERT's training and technical capabilities at potential events. The latest drills in 2023 were deemed a success, and demonstrated the Darlington NGS ERT's ability to respond to realistic scenarios that may occur at the Darlington NGS site.

OPG's Wesleyville facility provides on-site training to both Darlington NGS and Pickering NGS ERT, including fire response, medical response, and other specialized training such as hazardous materials response and high-angle rescue. Unique features of the Wesleyville facility are the live-fire burn tower, power plant mock-ups, and industrial settings to conduct the high-angle rescue in realistic operational heights and configurations.

Wesleyville has also supplemented traditional emergency response training by facilitating aerial drone courses for OPG Emergency Services, municipal fire, police and transit. Additionally, local municipal fire departments and career colleges access Wesleyville in support of their internal recruit and incumbent training programs. Through joint training and inter-operability drills at Wesleyville, OPG strengthens relationships and collaboration between OPG and these off-site partners.

As part of its regular equipment upgrade initiative, Darlington NGS ERT recently acquired new Self-Contained Breathing Apparatus (SCBA) Air-Pak X3 for firefighting. The purchase of new SCBA will ensure that the ERMs are provided with new and up-to-date tools for their firefighting needs. The new Air-Pak X3s are also the same equipment used by Clarington Emergency and Fire Services Department, which allows for compatibility, interchangeability and flexibility during a joint Darlington NGS ERT and CEFSD response.

In the past four years, Darlington NGS ERT has been incorporating aerial drones from the OPG Security and Emergency Services (SES) Aerial Support Unit into its training. The aerial drones are used during training to film fire training evolutions and exercises for enhanced evaluation and feedback, as well as reconnaissance and surveillance tools in a variety of scenarios to minimize fire and radiation exposures to firefighters at the scene.

The OPG Aerial Support Unit (ASU) has been working with local fire and police for cross training at our fire academy, supporting public safety events in the surrounding towns. The ASU has been working with agencies from all over north America to establish a collaboration of efforts to start a program called Drones for First Responders (DFR). This will give all first responders a live view from the drone before the responders arrive on scene. The ASU has also been working with security and our regulator for anti-drone and detection technology. The ASU has been on standby and gone on several mutual aid calls for search and rescue and public safety related responses from Peterbourough Police, Port Hope Fire and Police, Clarington Fire and Durham Regional Police. The ASU has also been working with Ontario Tech. University to help the drone industry develop in the nuclear environment. The ASU has also just been training on how to operate and incorporate the Boston Dynamic robot dog “SPOT” into our program. This quadruped robot can mitigate risk for the fire fighters and assist in dangerous and time-consuming responses such as hazmat and confined space calls.

In recognition of the growing use of lithium-ion battery-powered vehicles, including the potential use of lithium-ion battery powered industrial trucks within the station, and the unique fire challenges they represent, Darlington NGS ERT has acquired an Electric Vehicle (EV) fire blanket as part of its fire response tools.

In February of 2022, Darlington NGS ERT participated in Exercise Unified Command, a tri-annual large-scale emergency and preparedness response exercise involving all three levels of government, utilities, and other stakeholders. The exercise was to assess the preparedness of OPG and other stakeholders to respond to a nuclear event at Darlington NGS. The exercise demonstrated the ability of Darlington NGS ERT, OPG, and our partners to respond effectively to a large-scale nuclear emergency at the Darlington NGS site.

A third-party evaluation was conducted of an OPG Industrial Fire Brigade Turbine Generator Fire Drill at Darlington NGS. Observations made during the On-Site Fire Drill showed that the exercise met all objectives incorporated into the fire scenario.

Section 2.11

Waste Management

2.11 Waste Management

The objective of the Darlington NGS Waste Management program is to ensure that adequate provisions are in place to limit the generation of radioactive and conventional waste and if created, control/manage its handling, storage, and disposal. This is done in an effort to ensure the safety of workers and the public; and continuously improve environmental performance in support of OPG's Environmental Policy.

There are two waste management programs that manage the elements of this SCA:

- OPG-PROG-0005, *Environment Health and Safety Managed Systems*; and,
- W-PROG-WM-0001, *Nuclear Waste Management.*

Both programs ensure that nuclear safety is a priority such that plant personnel, the public and the environment are protected and the impacts of plant operation to the public, workers, and the environment will be as low as reasonably achievable.

The *Environment Health and Safety Managed Systems* program, OPG-PROG-0005, describes how OPG's Environmental Management System (EMS) meets the requirements of the ISO 14001, *Environmental Management Systems* standard, including waste management activities. Standard OPG-STD-0156, *Management of Waste and Other Environmentally Regulated Materials*, is part of the EMS program and describes OPG's processes and procedures to address regulatory requirements with respect to waste management. OPG is subject to federal and provincial waste management regulations which include general waste management practices, transportation of dangerous goods, Polychlorinated Biphenyl (PCB) management, Ozone Depleting Substance (ODS) management, and CNSC requirements for nuclear facilities. The radiological waste content of OPG-STD-0156 is limited to low and intermediate level radioactive waste only.

The *Nuclear Waste Management* Program, W-PROG-WM-0001, is a mature and effective program applicable to all of OPG Nuclear. The objective of this program is to ensure adequate provisions are in place to limit the production of radioactive waste and to control its handling, storage, and disposal. Activities are performed in accordance with licensing basis standards and governing documents that prescribe controls and responsibilities to ensure the activities are carried out in a safe and effective manner by qualified personnel.

The program for the transportation of waste material is W-PROG-WM-0002, *Radioactive Material Transportation*, which addresses the radioactive material transportation shipments. This program ensures safe, compliant and efficient transportation of radioactive material from the site to its interim storage facility.

Waste management programs audits and self-assessments are conducted in accordance with OPG's Management System and internal governance requirements, to confirm that compliance obligations are addressed to identify opportunities for continual improvement.

The OPG documents in the table below require written notification of change per Darlington NGS Licence Conditions Handbook, LCH-PR-13.03/2025-R005:

Table 19: SCA 11 – Waste Management

Document	Title
OPG-PROG-0005	Environment Health and Safety Managed Systems
OPG-STD-0156	Management of Waste and Other Environmentally Regulated Materials
N-PROC-RA-0017	Segregation and Handling of Radioactive Wastes
W-PROG-WM-0003	Decommissioning Program
NK38-PLAN-00960-10001	Preliminary Decommissioning Plan - Darlington Nuclear Generating Station
NK38-PLAN-09701-10293	Operations & Maintenance Plan – Retube Waste Processing Building
NK38-REP-09701-10344	RWPB Safety Analysis Summary Report
NK38-REP-09701-10326	Darlington Retube Waste Processing Building – Safety Assessment
NK38-CORR-09701-0597849	RWPB Worker Dose During Normal Operation and Under Accident Conditions
NK38-REP-09701-10338	Fire Hazard Assessment of the DNGS Retube Waste Processing Building (RWPB)

2.11.1 Waste Management Practices

Waste is generated due to day-to-day operations of the plant. Station employees have three streams for waste disposal:

1. Bring waste to a collection area, where solid waste can be disposed as Active Waste, Likely Clean Waste, or Active Metal Waste.
2. Prepare the waste separately for drop-off to the Chemical Waste Collection Centre, commonly known as “Waste Handling”, according to storage and packaging requirements; and,
3. Contact Waste Handling for assistance in containing, securing, or picking-up large, heavy, or hazardous material.

Procedure N-PROC-RA-0017, *Segregation and Handling of Radioactive Waste*, provides direction to workers on the segregation and handling of potentially radioactive solid and liquid waste resulting from operation and maintenance activities.

Waste streams are handled and processed to ensure the safety of employees, the public, and the environment, while applying best practices to reduce and effectively segregate the generated waste.

After segregation and processing by Waste Handling, the generated waste paths can be classified as follows:

- Solid radioactive waste, which is shipped to a licenced waste management facility for incineration or long-term storage (compactable and non-processible).
- Radioactive oil, which is shipped to a licenced waste management facility for incineration.

- Radioactive liquid chemicals, which are either solidified on site and shipped to be stored at a licenced waste management facility or are shipped to be incinerated at a licenced waste management facility.
- Inactive solid conventional waste, which is shipped to public landfill or recycled.
- Inactive chemicals/liquid industrial waste, which is shipped to hazardous waste receiving company for incineration or disposal in hazardous landfill.
- PCBs, which are shipped to a licensed waste facility for incineration.

2.11.1.1 Interim Storage of Radioactive Waste

After radioactive waste has been processed at Darlington NGS, OPG's Nuclear Sustainability Services division manages it on an interim basis. Procedure W-PROC-WM-0025, *Waste Acceptance Criteria for Low and Intermediate Level Radioactive Waste,* defines the acceptance criteria for Low Level Waste (LLW) and Intermediate Level Waste (ILW) at the Western Waste Management Facility (WWMF), where Darlington NGS Low and Intermediate Level waste (L&ILW) is further volume reduced and stored on an interim basis. The LLW in storage buildings at WWMF is also further reduced at Western Clean-Energy Sorting and Recycling, where waste is sorted and segregated to reduce the LLW volume and optimize the use of waste storage space. Western Clean-Energy Sorting and Recycling is a CNSC-licensed facility located in Tiverton ON, operated by Energy Solutions.

Additionally, ILW from the reactor core components (i.e. pressure tubes, end fittings) associated with the Darlington refurbishment is stored, on an interim basis, at the Retube Waste Storage Building (RWSB) onsite. W-STD-WM-0002, *Waste Acceptance Criteria for Darlington Retube Waste Storage Building,* defines the waste that is stored under the Darlington Waste Management Facility (DWMF) licence WFOL-W4-355.00/2033.

High Level waste (HLW) consists of used reactor fuel. After at least 10-years of storage in the Irradiated Fuel Bay (IFB), used fuel is loaded into Dry Storage Containers (DSCs), transferred to DWMF, processed and stored under the facility waste management licence. W-PROC-WM-0082, *Eastern Waste Acceptance Criteria for Used Fuel Dry Storage Containers*, defines the criteria for the acceptance of a DSC which are stored at DWMF on an interim basis.

2.11.1.2 Long Term Disposal of Radioactive Waste

OPG remains committed to the safe and permanent disposal of nuclear waste.

The Nuclear Waste Management Organization (NWMO), in accordance with the federal Nuclear Waste Act (2002), is responsible for implementing Canada's plan for the safe, long-term management of used nuclear fuel. Under the NWMO's plan, a deep geological repository for used fuel is expected to be in-service in the mid-2040s.

Additionally, under the Federal Government's Integrated Strategy for Radioactive Waste (ISRW), the NWMO is also responsible for the long-term disposal of ILW. As per the ISRW, ILW is to be disposed in a deep geological repository with an expected in-service date by 2050.

Waste generators are responsible for LLW. OPG is planning a province-wide Learning Phase to seek a willing host for a LLW disposal facility, starting in 2024 with Indigenous Nations and communities followed by engagement with municipalities. As per the ISRW, LLW is to be disposed of in near surface disposal facilities with an expected in-service date by 2050.

As OPG's waste strategy for permanent disposal continues to evolve over the licence term. OPG will continue to engage with stakeholders and seek amendments to the associated licences as required.

2.11.2 Waste Characterization

The solid and liquid waste generated at Darlington NGS is characterized as either radioactive waste or inactive (non-radioactive) waste. The radioactive waste is further characterized as LLW, ILW, or HLW, while inactive (non-radioactive) waste is further characterized as conventional solid waste or hazardous chemical waste. For discussion of gaseous wastes (i.e. emissions) refer to Section 2.9.3.

LLW is radioactive waste that has a dose rate less than 10 mSv/h at 30 cm. To further segregate and reduce active waste volumes, OPG separates the LLW waste into three categories: incinerable, compactable, and non-processible LLW.

ILW is radioactive waste that has a dose rate of greater than or equal to 10 mSv/h at 30 cm. ILW largely consists of resins, filters and used reactor core components.

HLW is used nuclear fuel that has been withdrawn from a nuclear reactor following irradiation.

Procedure W-PROC-WM-0096, *Nuclear Waste Characterization*, documents the L&ILW characterization in alignment with international best practices and defines the requirements for preparing a waste characterization plan. L&ILW operations involves the safe handling, movement, processing, storage and monitoring of L&ILW.

2.11.2.1 Radioactive Solid Waste

Figure 31 shows the volume of station and refurbishment radioactive waste produced annually since 2015. In the past six years, refurbishment activities have contributed to approximately 66% of the total L&ILW generated at Darlington NGS (refurbishment waste was not tracked separately from station radioactive waste in 2016 and 2017). When refurbishment activities are completed in 2026, the volume of L&ILW generated annually is expected to be closer to pre-refurbishment averages.

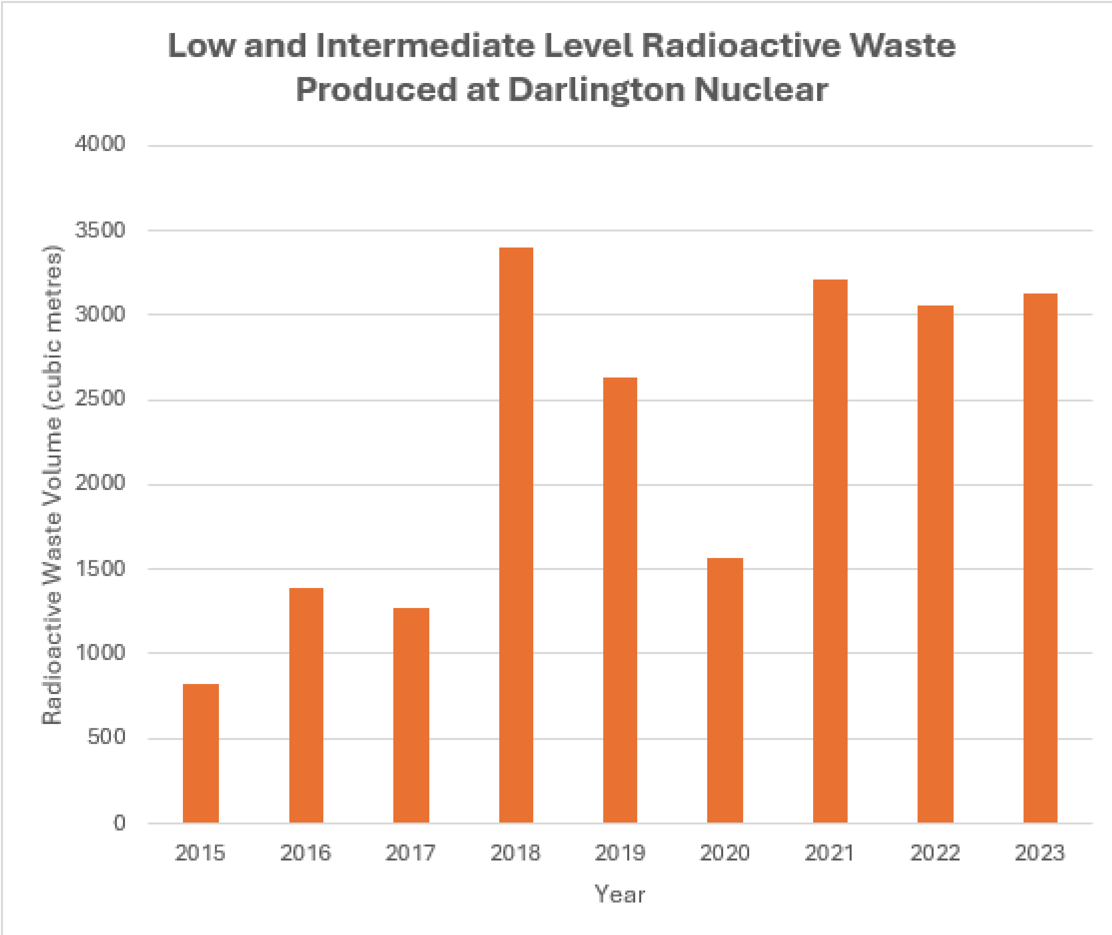


Figure 31: Low and Intermediate Level Radioactive Waste

2.11.2.2 High Level Waste

Approximately, 22,000 fuel bundles are transferred from the Darlington NGS IFB into DSCs each year and safely stored at DWMF. At the end of 2023, just over 900 DCSs are in storage at two storage buildings at the DWMF. The DWMF is licensed separately by the CNSC and considers the future needs of the Darlington NGS station. In 2023, construction of Storage Structure 3 (SS3) commenced and is planned to be in-service in 2025. A fourth storage structure is planned with an in-service date of approximately 2031.

2.11.2.3 Conventional Solid Waste

"Likely Clean" solid waste within the Unzoned Areas and Zone 1 is confirmed not to be contaminated. Any materials that can be recycled are segregated for that purpose. Solid waste is taken to designated waste collection stations.

For "Likely Clean" solid waste materials created in Zones 2 or 3, Unconditional/Conditional Transfer Permits are completed as required in preparation for shipment off-site. Materials that have the potential to be recycled are segregated for that purpose. Waste deemed to be active, trefoil symbols, trefoil tags, and any items with references to radioactivity are placed into the active waste stream regardless of the item's actual activity.

The conventional waste generated is confirmed to be free of contamination and is processed to a waste transfer station and then into a landfill or to a recycler. Conventional solid waste is also volume-reduced to minimize its environmental impact. Recyclable material collected and processed at Darlington NGS includes wood, cans, cardboard, paper, paper towels, plastic, asphalt, concrete, compost, metal, and glass.

2.11.2.4 Hazardous Chemical Waste

Hazardous waste generated at Darlington NGS includes chemicals and liquids such as cleaning agents, grease, oil, waste fuels, acids, batteries, and PCBs. The liquid and chemical wastes are generated from operations, maintenance, and outage activities. The volume of chemical drums on site is tracked and reported monthly with associated targets to ensure that the backlog is maintained at a low manageable level and that the waste is disposed as required by Ontario Regulation 347 requirements.

Oil and chemical waste handling is described in the document D-INS-79000-10001-R007, *Waste Disposal Guidelines for Oil and Chemical Wastes at Darlington*.

2.11.3 Waste Minimization

Darlington NGS has implemented initiatives to minimize and properly segregate waste. Waste minimization is a shared responsibility amongst all Darlington NGS employees. It consists of spreading awareness to all waste generators on the proper handling and segregation of waste, and implementing proper guidelines, instructions, and procedures. Waste minimization and segregation is part of work planning processes. Waste generators are to follow the concept of "Reduce, Reuse, Recycle".

Darlington NGS's waste minimization goals are two-fold: to minimize the volume of waste generated overall and to reduce the quantity of radioactive waste which is generated. The main initiatives that contribute to radioactive waste minimization are:

- Washable personal protective equipment: personal protective equipment worn inside the station is collected, washed and decontaminated by a licensed contractor for re-use.
- The "Likely Clean" program: segregates waste generated inside the Protected Area. "Likely Clean" waste cans are placed next to "Active Waste" cans and waste generated in Zone 3 areas that is believed to be uncontaminated is placed in the Likely Clean receptacles. Likely Clean waste is surveyed and, if free of contamination, is processed as conventional waste.
- "Active Metal" bins: the addition of these bins allows for the segregation of active metal (non processible waste) from other radioactive waste (incinerable and compactible). When active metal waste is mixed with incinerable and compactible waste the entire volume of waste is categorized as non-processible waste. Therefore, the segregation of active metal waste helps reduce non-processible radioactive waste.
- Low level waste with tritium levels less than 100 Maximum Permissible Concentration in air (MPCa) is sent to the tritium off gas room as part of the waste handling process. After off-gassing, the waste is treated as lower tritium activity waste.

OPG calculates the LLW diversion metrics on a monthly basis. A total of 6161 m^3 of LLW was diverted in 2023, with washable PPEs being the biggest contributor at 3136 m^3.

Radioactive waste is collected from designated areas throughout the station. Waste handlers separate the solid waste into conventional, radioactive, and hazardous waste streams. A new storing and segregating area was implemented in 2024, which helps reduce the LLW that is sent for disposal. Designated waste handlers process the waste to prepare and stage for shipment and/or final disposal. To reduce radioactive waste, plastic, wood and cardboard packing is removed from items entering the station, thus reducing the risk of packaging becoming contaminated LLW.

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

OPG has volume reduced reactor components from the Darlington NGS refurbishment and stored them in the RWSB. The RWSB went into service in 2017, via the DWMF waste licence. This waste consists of pressure tubes, end fittings, annulus spacers, calandria tubes and calandria tube inserts, all of which are ILW. It is stored in an inner container, referred to as the Retube Waste Container and an outer container, referred to as the Darlington Storage Overpack and will be stored until a permanent deep geological repository disposal facility becomes operational with the NWMO.

2.11.4 Decommissioning Plans

The purpose of the Decommissioning program, W-PROG-WM-0003, is to define the key program elements, objectives, roles and responsibilities and to ensure that, when retiring a licensed nuclear facility permanently from service and rendering it to a predetermined end-state condition, actions are taken in the interest of health, safety, environment, security, quality and economics. The program objective is to describe the requirements and processes to safely and cost effectively decommission OPG owned nuclear facilities and provide assurance that decommissioning work will be performed in accordance with the applicable regulatory requirements and Codes and Standards.

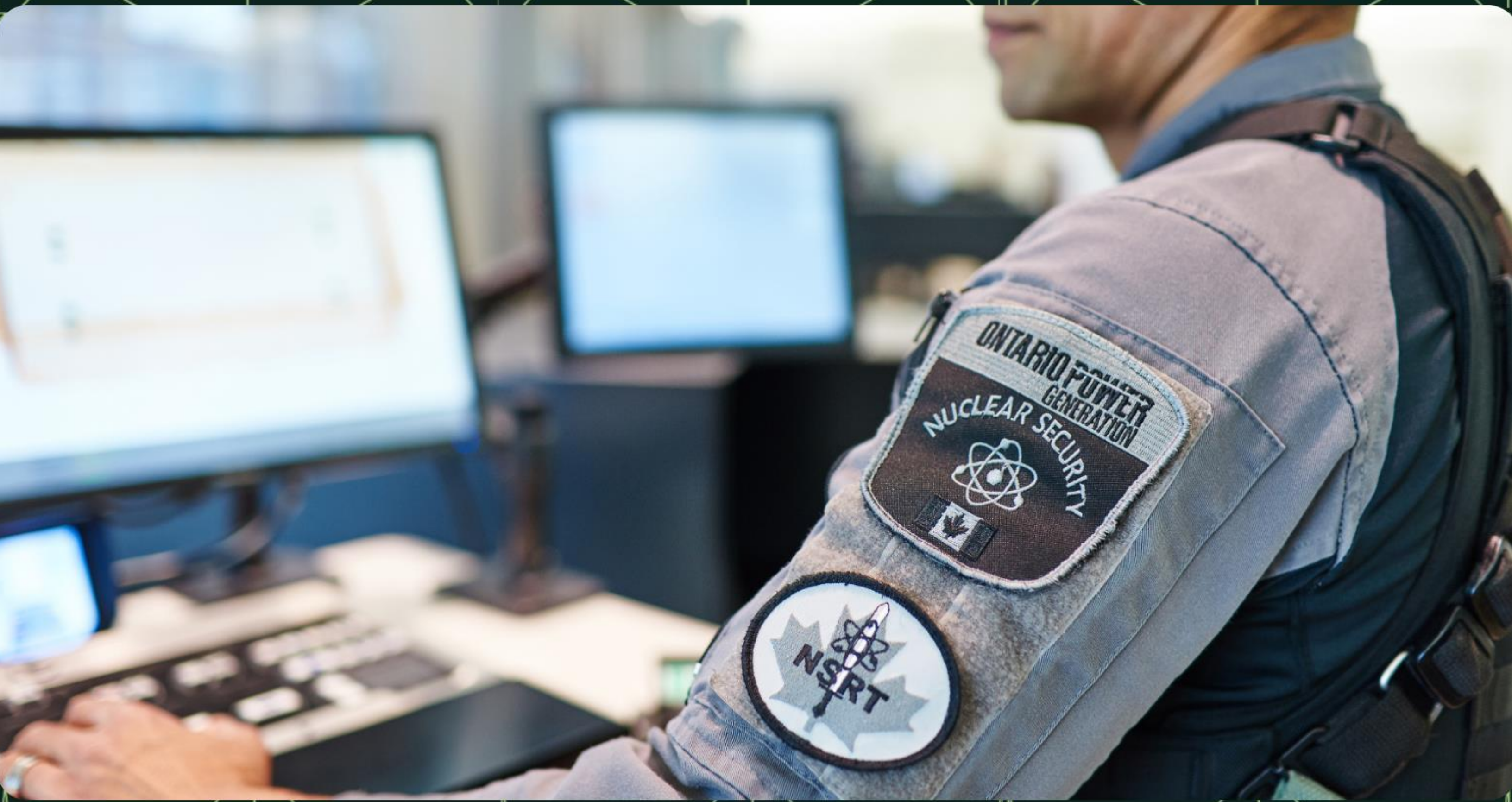
Planning for the eventual decommissioning of Darlington NGS is an ongoing process, taking place throughout each stage of the lifecycle. The current Preliminary Decommissioning Plan (PDP), NK38-PLAN-00960-10001 R003, *Darlington Nuclear Site Preliminary Decommissioning Plan*, was prepared in accordance with the requirements of the CSA standard N294-19, *Decommissioning of facilities containing nuclear substances*, and CNSC Regulatory Guides G-219, *Decommissioning Planning for Licensed Activities*, and G-206, *Financial Guarantee for the Decommissioning of Licensed Activities*, per the Darlington NGS licence and LCH. The PDP is updated and submitted as part of the Financial Guarantee submission every 5-years or when required by the Commission.

The PDP describes the activities that will be required to decommission Darlington NGS and restore the site for other OPG uses. It is also referred to as the Darlington Site PDP as it addresses the interfaces of the Darlington NGS with the DWMF. Details of the DWMF decommissioning are provided in the DWMF PDP. The Darlington NGS Site PDP demonstrates that decommissioning is feasible with existing technologies and it provides the schedule as well as the basis for estimating the cost of decommissioning.

OPG is planning to update the Darlington NGS Site PDP in support of the 2028 to 2032 Financial Guarantee submission. This revision of the PDP will meet the requirements of CNSC regulatory documents REGDOC-2.11.2, *Decommissioning*, and REGDOC-3.3.1, *Financial Guarantees for Decommissioning of Nuclear Facilities and Termination of Licenced Activities*, and CSA standard N294-19 as well as any relevant domestic and international experience and best practices from the industry obtained in the previous 5-years will be incorporated into this revision.

Section 2.12

Security



2.12 Security

The objective of the Nuclear Security program at Darlington NGS is to ensure the safe and secure operation of the Nuclear Generating Station by supporting the protection of nuclear assets at OPG Nuclear in accordance with the legislative requirements of the Corporation, OPG-POL-0032, *Safe Operations Policy* and N-POL-0001, *Nuclear Safety and Security Policy*.

Through the use of equipment, personnel and procedures described in the fleetwide program governing document N-PROG-RA-0011, *Nuclear Security* program. OPG Nuclear Security ensures tactical readiness and maximizes response capability to prevent, contain, mitigate and terminate security events while minimizing the adverse impact on plant staff, operations and functions.

The Security and Emergency Services (SES) organization within OPG has accountably and responsibility for the effective management of security risk based on OPG risk tolerance, the Design Basis Threat (DBT) and required compliance with CNSC regulations and regulatory documents. The Nuclear Security program shall meet the expectations of N-CHAR-AS-0002, *Nuclear Management System*, by establishing, implementing, maintaining and improving a nuclear security management system with a focus on OPG high security sites that encompasses all licensing activities. This includes but not limited to Security Threat Identification and Risk Assessments, performed annually to identify credible threats to a specific site or facility. OPG is required to take any credible threats identified in a Threat Risk Assessment (TRA) into account in the design of the physical protection system. Requirements of this program include the following areas:

- Identify, assess, and understand security risk to staff and the public by conducting security TRAs and consider recommendations on an ongoing basis.
- Consider security risk during normal and abnormal operations and to potential emergency conditions.
- Anticipate potential risks with security strategies. Consider security threats faced by OPG, as a basis for establishing and continuing to improve the security management system.
- Maintain a proactive program which identifies key OPG assets and business interest.

The security program is based on credible risks and vulnerabilities, and as such, and in accordance with the Nuclear Security Regulations, has identified vital areas at Darlington NGS and implemented physical protection measures, including access control, and measures designed to delay unauthorized access taking into account the DBT and any other credible threat identified by the TRA. The OPG Nuclear Security Operations at Darlington NGS has continued to ensure uncompromised safety and security of employees, the public and the environment. The need to improve security performance is recognized and OPG is ensuring Security is held to the same high standards and intrusive oversight as all other organizations at OPG that impact nuclear safety. The OPG Nuclear Security organization operates under the leadership of the Vice-President, Security and Emergency Services, to ensure operational and regulatory requirements are continually met.

OPG Nuclear Security has progressed towards a more proactive approach to identifying program improvements that is evident in the implementation of a Security Excellence Plan that has established a Security Excellence Meeting (SEM) with the pillars of Our People, Our

Performance and Our Future. The Excellence Meeting process is a strategic model that has been proven to drive continuous improvement at the OPG station level.

OPG's Security program has moved from a Tier 3 level program to a Tier 1 level program with OPG's managed system. As such, a comprehensive and enhanced oversight body has been established, including a fleetwide functional peer team, which reviews performance and trends regularly. Security performance and results are reviewed and challenged at the Nuclear Executive Committee (NEC) on a regular frequency to continually drive performance. The process includes the use of N-PROC-RA-0023, *Fleetview Program Health and Performance Reporting*. In support of OPG's safety culture, Security continues to work toward improved performance in all elements of the Security program through a critical lens using effective and established managed processes, in addition to new initiatives.

OPG maintains open communication with the CNSC in forums such as the quarterly Security Director's meeting and the Nuclear Security Advisor Group (NuSAG) which includes security representatives from all Nuclear High Security Sites in Canada. The group is focused on ensuring nuclear security programs in Canada continue to meet future requirements, through the sharing of operating experience and the promotion of best security practices. OPG Security has also formed a Compliance Audit and Governance group, dedicated to unbiased, risk-based assessments of the Security Program. Through these internal self-assessments, OPG is able to monitor performance and trend worker behavior indicators, gather Key Performance Indicators (KPI) data for analysis and proactively identify latent organizational or process-based gaps more effectively.

In accordance with the Nuclear Security Regulations, OPG has identified the vital areas at Darlington NGS and has implemented physical protection measures, including access control, and measures designed to delay unauthorized access taking into account the DBT and any other credible threat identified by the TRA.

In accordance with the Nuclear Security Regulations, OPG Nuclear Security conducts a large-scale security exercise through a Performance Testing Program (PTP) audit at Darlington NGS every 2-years. The exercise tests and evaluates the integrated response capabilities of the Nuclear Security armed and unarmed elements against adversaries equipped within the DBT. This exercise is highly dynamic and realistic, incorporating laser systems to enhance realism. The CNSC observes and audits these exercises and may identify areas for improvement. OPG Security conducts a detailed after-action audit of the results, which has been provided to the CNSC. The combination of the internal audit and observations made by the CNSC are used in the development of the training objectives for each subsequent year. Darlington NGS conducted an exercise on March 9, 2023. OPG Nuclear Security has been operating with an onsite armed response force since January 18, 2010 and maintains a program in place to provide ongoing training for Armed Nuclear Security Officers (ANSO) (also referred to as the Nuclear Response Force) and unarmed Nuclear Security Officers (NSO).

The Security Training organization structure has realigned to report into the Nuclear Training Organization, which enables the incorporation of lessons learned and best practices from across OPG's departments and will support overall alignment. In accordance with the Nuclear Security Regulations and the Security Program, Security drills are regularly conducted to evaluate security physical protection systems including tactical deployment plans under realistic conditions to ensure regulatory compliance as well as to identify security improvements. OPG Security also maintains an ongoing Memorandum of Understanding (MOU) with the Durham Region Police Service (DRPS) for offsite tactical response support. OPG Security will continue to operate at a high standard and meet the CNSC licensing requirements throughout the life of the Darlington NGS.

The OPG documents in the table below require written notification of change per Darlington NGS Licence Conditions Handbook, LCH-PR-13.03/2025-R005:

Table 20: SCA 12 – Security

Document	Title
8300-REP-61400-10003	Darlington Nuclear Generating Station Security Report
8300-PLAN-61400-10012	Darlington Nuclear Security Tactical Plan
N-PROG-RA-0011	Nuclear Security
TRAN-PLAN-03450-10000[1]	Transport Security Plan
NK38-REP-08160.3-00001	Threat and Risk Assessment
N-PROC-RA-0135	Cyber Security
N-STI-08161-10017	Cyber Essential Asset Identification and Classification
N-INS-08161-10011	Cyber Security Controls for Cyber Essential Assets
OPG-PROG-0042	Cyber Security

Notes:
1. OPG recommends TRAN-PLAN-03450-10000, *Transport Security Plan* be removed from the Darlington NGS LCH as the plan is no longer applicable as it was associated with transport licence TL-S-12861-07.01/2022 which is expired and will not be renewed.

2.12.1 Facilities and Equipment

The OPG Security Program ensures the possession, deployment and operation of required facilities and equipment at Darlington NGS comply with the Nuclear Security Regulations, and REGDOC-2.12.1, *High-Security Facilities, Volume II: Criteria for Nuclear Security Systems.*

The Darlington NGS Site Security Report describes in detail the physical security measures and systems and the security organization in place to ensure security of Darlington NGS employees, the public and the environment in accordance with the regulatory requirements. Changes to security systems are documented in the Site Security Report, as well as the Quarterly Security Report per REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants,* and are required to be submitted to the CNSC.

Personnel

Entry to the protected area at Darlington NGS requires all personnel to be searched for weapons and explosive substances at the Main Security Building (MSB), Auxiliary Security Building (ASB), or Refurbishment Project Office (RPO) in accordance with the Nuclear Security Regulations. The Darlington NGS search facilities are equipped with dedicated equipment for conducting security searches that meet REGDOC-2.12.1 Volume II requirements. Once personnel have passed the security search screening process, they are then required to use their proximity card and biometric hand scanners to activate the revolving door to enter the Protected Area.

Vehicles

All vehicles entering the protected area are searched for weapons, explosive substances and unauthorized persons in accordance with the Nuclear Security Regulations as well as contraband and prohibited items. All vehicles, upon entrance and exit from the Protected Area are surveyed for Category I and II nuclear material using the Vehicle Radiation Monitor. Darlington NGS has physical protection measures against forced land vehicle penetration of the protected area. The measures are compliant with REGDOC-2.12.1 Volume II.

Powerhouse Doors

All exterior doors of the Darlington NGS powerhouse are hardened against forced entry, and the doors are equipped with a robust lock system to prevent unauthorized access to the powerhouse. The doors are checked daily by Nuclear Security Officers (NSOs) to ensure they are operating as designed.

Material Security

Searches are conducted on all packages and equipment entering the protected area for weapons, explosive substances and unauthorized persons in accordance with the Nuclear Security Regulations, as well as contraband and prohibited items.

Sealed sources and nuclear fuel are protected, stored and managed in compliance with REGDOC 2.12.3, *Security of Nuclear Substances: Sealed Sources and Category I, II and III Nuclear Material, Version 2.1* (Reference 2.12-1) and in accordance with the Nuclear Security Regulations. Sealed source security measures includes access control, detection of unauthorized access, locking hardware and key control, physical barriers, alarm response protocol, and inspection, maintenance and testing of security-related equipment. Recurring familiarization training has been implemented and conducted with all Nuclear Security Officer staff at Darlington NGS.

Physical Protection Systems

In accordance with REGDOC-2.12.1 Volume II, the Darlington NGS protected area is surrounded by a security fence equipped with devices intended to detect any attempt at unauthorized intrusion into the protected area, and to detect any tampering or component failures that could cause the system to malfunction. A delay system is built into the security fence that includes razor wire. The system is monitored at all times by NSOs in the Central Alarm Station (CAS). Alarms within the protected area are responded to by armed NSOs.

OPG employes Defence in Depth approach to the physical security protection system which is designed to deter, prevent, detect, assess, delay and respond. The various protection measures include but are not limited to:

- Perimeter/site security zone fencing and detection;
- Vehicle denial barriers;
- X-ray units;
- Radiation material detection equipment;
- Explosive detection equipment;
- Central Alarm Station monitoring;
- Lighting;
- Cameras.

On-site and off-site communication

In accordance with the Nuclear Security Regulations, OPG Nuclear Security has a primary communications system which is interoperable with Durham Regional Police Service (DRPS). the primary offsite responder. Redundant secondary communication systems are available to ensure lines of communication to the field and beyond can be established.

There are a number of initiatives underway to enhance security systems at Darlington NGS including hardware updates, upgrades to the CAS, and integration of the Entry Control System.

2.12.2 Response Arrangements

In accordance with the Nuclear Security Regulations, OPG has a written arrangement with the DRPS to provide off-site armed response force support to the Darlington NGS. The DRPS provides response capability for Darlington NGS in the event of identified security incidents.

OPG Nuclear Security has a tactical response plan for Darlington NGS that sets out clear expectations on how to maintain the security of the site and to ensure an effective response to security events including the unauthorized removal of nuclear or radioactive material or to the sabotage of nuclear facilities, as required by the Nuclear Security Regulations and REGDOC-2.12.1, *High Security Facilities, Volume I: Nuclear Response Force, Version 2*. The tactical plan implements the primary objective of Nuclear Security to make an effective intervention taking into account the CNSC DBT and any other credible threat identified by the TRA to the protected area. DRPS provide support to this tactical plan.

2.12.3 Security Practices

The OPG Nuclear Security organization has accountabilities and responsibilities for the delivery of security services to effectively manage security risks based on OPG risk tolerance levels, the DBT and required assurance of compliance with CNSC regulations.

Frontline Darlington NGS Security personnel consist of two roles, NSOs and ANSOs. NSOs perform all security functions for Darlington NGS primarily personnel, bulk material and vehicle searching, surveillance and patrolling, while ANSOs provide on-site armed support capable of dealing with situations outlined in the DBT in addition to core NSO duties. A defensive strategy is followed along with a tactical plan as required by the Nuclear Security Regulations and REGDOC-2.12.1 Volume I.

The OPG Security clearance process ensures personnel requiring access to OPG business units, locations, or access to OPG Confidential, OPG Confidential Exclusive or Security Protected information, do not pose a risk to the facilities, its employees, or company assets. Persons, including OPG employees and contractors, who require unescorted access to the Darlington NGS protected area must comply with the applicable requirements of Nuclear Security Regulations. Under OPG-PROC-0119, *Clearance Process,* and OPG-GUID-61400-0001, *Guide to Security Clearance*, each person requiring unescorted access must complete a Nuclear Site Access Security Clearance Form and be approved through the clearance process. These processes are in compliance with REGDOC-2.12.2, *Site Access Security Clearance*. A proximity card is given to each approved applicant, and the proximity card and biometric scans permit entry to and exit from the protected area, as per the Nuclear Security Regulations. Upon exit from the protected area, in accordance with the Nuclear Security Regulations, all personnel and vehicles are scanned for Category I or II nuclear substances.

Prescribed information is controlled and released only on a ‘need to know’ basis to those who possess the appropriate security clearance.

The trait of Vigilance was added to OPG’s Nuclear Safety and Security Culture traits. OPG maintains vigilance as part of its defense-in-depth security strategy through requirements such as OPG’s Supervisory Awareness Program, Continuous Behavioral Observation Program (CBOP). The program ensures all supervisors have the skill and knowledge to recognize behaviors that might constitute a risk to health and safety of employees, the plant and the general public.

2.12.4 Drills and Exercises

The OPG Security Program ensures the Nuclear Security Response Force conducts effective interventions, based on the DBT and any other credible threats identified through threat and risk assessments within the protected area. The objective is to prevent sabotage of the nuclear facilities or the sabotage and theft of Category I, II, or III nuclear materials.

To achieve this objective, the Nuclear Response Force is equipped with gear prescribed by REGDOC-2.12.2 Volume I, which includes tactical equipment, both lethal and less lethal options, and tactical personal protection equipment. A yearly maintenance program is in place to ensure firearms are maintained and armored to manufacturer specifications.

NSOs and ANSOs are required to qualify in specific training program elements and must requalify within established requalification periods as per REGDOC-2.2.4, *Fitness for Duty, Volume III: Nuclear Security Officer Medical, Physical, and Psychological Fitness*, and REGDOC-2.12.1, Volume I. N-TQD-603-00001, *Nuclear Security Training and Qualification Description,* establishes the training requirements for NSOs and ANSOs, including initial and subsequent requalification training requirements. OPG Security employs OPG’s Training Information Management System (TIMS) to ensure the tracking and completion of required qualifications. The position of a Nuclear Security Training Coordinator is specifically used to implement and manage programs that support and adhere to nuclear security regulatory requirements, ensuring that employees meet qualifications and are recertified as necessary. The responsibilities of this position include ensuring the acquisition of essential documentation, as well as the required medical, physical, and psychological certifications for individuals before they can be authorized to act as nuclear security officers. Additionally, it involves safeguarding the requalification requirements for officers are continuously met.

The purpose of the training is to ensure officers are proficient at performing duties described in Nuclear Security Regulations and for armed officers REGDOC-2.12.1, Volume I. Examples of duties include, but are not limited to:

- Employing tactical strategies and movement.
- Managing larger scale high risk security incidents utilizing Incident Command response model.
- Search and control of persons, vehicles and shipments.
- Utilizing search equipment in the course of duties.
- Conducting patrols and responding to alarms.

OPG deploys a Security Training Team consisting of Tactical Trainers and Training Technicians who are responsible for developing and utilizing various training methods aimed at enhancing the competence and confidence of Security Officers. These methods include, but are not limited to:

- Dynamic physical drills for individual officers.
- Officers working in pairs and small teams.
- Demonstrations of skills.
- Equipment usage.
- Procedural adherence.
- Tabletop exercises, written exams, and the prescribed qualification testing procedures as per REGDOC-2.12.1 Volume I.

Additionally, Security Supervisors utilize on-crew trainers to ensure proficiency in specific aspects of officer's duties as well as conducting monthly drills and crew practice sessions to evaluate proficiency. These activities are reported, assessed and archived and are used to inform security training objectives.

2.12.5 Cyber Security

OPG has established an enterprise-wide cyber security program, which is outlined in OPG-PROG-0042, *Cyber Security*, to establish and maintain processes, procedures and controls to ensure OPG meets or exceeds regulatory requirements for cyber security, specifically CSA N290.7-14, Cyber Security for Nuclear Power Plants and Small Reactor Facilities standard. Moreover, OPG has implemented a Nuclear Cyber Security procedure, N-PROC-RA-0135, *Cyber Security* which identifies systems that are Cyber Essential Assets (CEA) and the requirements to protect them from internal and external cyber threats, up to and including the design basis threat. This program is under the purview of OPG's Nuclear Cyber Security section, which operates under the Corporate & Technology Services organization.

The cyber security program objectives address the following elements:

- Defensive strategy and security architecture: N-STI-08161-10001, *Defensive Cyber Security Architecture Standard* specifies the requirements for establishing a Defensive Cyber Security Architecture (DCSA) that is specifically tailored to the needs of OPG Nuclear Facilities including Darlington NGS. DCSA focuses on the arrangement of zones to establish defence-in-depth, and also specifies the requirements for boundary protection, secure communications and interconnections between zones, and common security control requirements that provide for protection across the facility.
- Policies and procedures: OPG-POL-0035, *Cyber Security Policy* requires OPG to establish and maintain a management system that reduces cyber risk, protects critical information and operational technology assets in accordance with internationally recognized cyber security standards while at a minimum maintaining compliance to regulatory and legal requirements. The policy supports the respective program, nuclear specific procedure and lower-level documents tailored to address specific clauses of CSA N290.7-14.
- Asset identification and classification: N-PROC-RA-0135 defines instructions for the identification of Cyber Assets and Cyber Essential Assets per the definitions defined by

CSA N290.7-14. Further, these assets are classified and prioritized using a graded approach for applicable cyber security controls commensurate to their significance and susceptibility.

- Roles and responsibilities: Roles and responsibilities for staff to meet program, process and lower-level document expectations are well defined under N-PROC-RA-0135.
- Security Controls: N-PROC-RA-0135 makes use of a graded approach to establish the necessary cyber security controls to protect Cyber Essential Assets.
- Awareness and Training: Qualifications and trainings are documented in training plan, N-PLAN-08161-00008, *Training Plan*. System Owners confirm that all cyber security activities performed on systems that they are responsible for are completed by competent individuals with the necessary qualifications.
- Cyber Asset Configuration Management and Life Cycle Approach: Applicable change control processes are listed under N-PROC-RA-0135 to ensure Cyber Essential Asset configuration management and life cycle management follows CSA N290.7-14.
- Coordination with other programs: Nuclear Cyber Security process, N-PROC-RA-0135 receives its authority from the enterprise-wide OPG-PROG-0042, *Cyber Security* program. Furthermore, N-PROC-RA-0135 is compliant with CSA N286-12, Management System Requirements for Nuclear Facilities, and interfaces with other nuclear processes to provide the necessary elements of a comprehensive cyber security program in OPG Nuclear.
- Incident response, reporting and recovery plan: N-PLAN-08161-00010, *Nuclear Cyber Security Incident Response Plan* provides guidance to cyber security incidents that potentially impact Nuclear Operational Technology digital assets supporting OPG Nuclear facilities.
- Program review and maintenance: OPG's Nuclear Cyber Security process emphasizes program review through monthly program performance updates, annual fleetview reports, continuous improvement through annual self-assessments, operating experience lessons, corrective actions, and updates to relevant CSA standards and CNSC regulations and REGDOCs. Furthermore, the process integrates lessons learned from cyber security incidents, audits, as well as supplemental drills/exercises.

Section 2.13

Safeguards & Non-Proliferation

2.13 Safeguards and Non-proliferation

Safeguards and Non-Proliferation refers to an international system of monitoring and verifying nuclear material and specified nuclear activities, administered in Canada by the CNSC and verified by the IAEA, to deter the diversion of nuclear material from legitimate peaceful activities. This system facilitates the IAEA to evaluate compliance with its obligations pursuant to its international safeguards agreements.

Canada has entered into a Safeguards Agreement and an Additional Protocol (hereafter referred to as "safeguards agreements") with the IAEA pursuant to its obligations under the *Treaty on the Non-Proliferation of Nuclear Weapons* (INFCIRC/140). The international *Treaty on the Non-Proliferation of Nuclear Weapons* is the cornerstone of Canada's efforts to promote its objectives of international disarmament, non-proliferation, and the peaceful use of nuclear energy. More specifically, Canada maintains obligations under the following Canada-IAEA safeguards agreements:

- *Agreement Between the Government of Canada and the International Atomic Energy Agency for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons* INFCIRC/164; and,
- *Protocol Additional to the Agreement Between Canada and the International Atomic Energy Agency for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons INFCIRC/164/Add.1.*

For Nuclear Power Plants in Canada, the non-proliferation program is limited to the tracking and reporting of foreign obligations and origins of nuclear material. The Additional Protocol contains further requirements for the provision of information and access, including the obligation to allow access to some locations on 24 hours' notice, and the obligation to provide information on and access to certain nuclear manufacturers and researchers, neither of which need involve nuclear material.

OPG is in compliance with these requirements to facilitate Canadian compliance with Canada's Safeguards agreements with the IAEA, and with OPG's obligations established in the *General Nuclear Safety and Control Regulations*.

Darlington NGS has an effective Safeguards and Non-Proliferation program that that ensures compliance with Canada's international safeguards obligations arising from the Canada/International Atomic Energy Agency safeguards agreements as well as other measures arising from the Treaty on the Non-Proliferation of Nuclear Weapons. This program consists of, in the following hierarchy:

- OPG's N-PROG-RA-0015, *Safeguards and Nuclear Material Accountancy* program is designed to establish, maintain, and verify compliance with Safeguards and Nuclear Material Accountancy requirements, ensuring all necessary measures are taken to facilitate Canada's compliance with international safeguards agreements and any other measures arising from the Treaty on the Non-Proliferation of Nuclear Weapons.
- N-STD-RA-0024, *Safeguards and Nuclear Material Accountancy Implementation* provides further direction to ensure OPG complies with its licence conditions, the Nuclear Safety and Control Act, the General Nuclear Safety and Control Regulations, and any other related regulations in support of Canada's safeguards and nuclear material accountancy agreements.

- N-PROC-RA-0136, *OPG Safeguards and Nuclear Material Accountancy Requirements* then captures specific requirements for the establishment and maintenance of the Safeguards program at OPG Nuclear; this procedure closely follows and where possible, exceeds the CNSC regulatory document, REGDOC-2.13.1, *Safeguards and Nuclear Material Accountancy.*

OPG's Safeguards and Nuclear Material Accountancy program is implemented in a manner to:

- Prevent damage, theft, loss, sabotage, or diversion of nuclear material.
- Timely detection of and reporting of damage, theft, loss, sabotage, or diversion of nuclear material.
- Establish and maintain a system(s) of accounting for nuclear material.
- Generate and submit nuclear material accountancy reports.
- Interface with IAEA personnel and support requests for information or site access.
- Provide operational and design information to support an integrate Safeguards approach appropriate for the facility.
- Facilitate the implementation, maintenance, and operation of Safeguards equipment and surveillance without undue interference.

These agreements, regulations, programs, standards, and procedures collectively provide a comprehensive system designed to fulfill the Safeguards and Non-Proliferation objective, as outlined in the safeguards agreements, 'the timely detection of diversion of significant quantities of nuclear material from peaceful nuclear activities to the manufacture of nuclear weapons or of other nuclear explosive devices or for purposes unknown, and deterrence of such diversion by the risk of early detection.'

Throughout the current Darlington NGS licence, the OPG Safeguards program was successful in meeting all international Safeguards and Non-Proliferation agreements.

Since 2016, Darlington NGS received satisfactory results from all inspections performed by the IAEA (results can either be satisfactory or unsatisfactory), indicating that Darlington NGS has successfully met the Safeguards requirements. Darlington NGS provided satisfactory support to the IAEA including nuclear material accountancy and control, access and assistance to the IAEA, operational and design information, support for Safeguards equipment, and containment and surveillance. In addition, the Darlington NGS safeguards program is internally evaluated each year through self-assessments to ensure the continued health of the program, including the program remains in compliance with regulatory requirements and a satisfactory working level structure is in place to ensure success in meeting OPG obligations.

The OPG documents in the table below require written notification of change per Darlington NGS Licence Conditions Handbook, LCH-PR-13.03/2025-R005:

Table 21: SCA 13 – Safeguards and Non-proliferation

Document	Title
N-PROG-RA-0015	Nuclear Safeguards
N-STD-RA-0024	Nuclear Safeguards Implementation
N-PROC-RA-0136	OPG Safeguards and Nuclear Material Accountancy Requirements

2.13.1 Nuclear Material Accountancy and Control

Nuclear material accountancy involves activities which establish and report the quantities of nuclear material present within defined areas, as well as the changes in those quantities within defined time periods. This includes nuclear material measurement, record keeping, preparation and submission of accounting reports, and verification of accounting information.

All units of nuclear material have a unique identifier which is tracked and accounted for. For all non-exempted nuclear material, Darlington NGS has Material Balance Areas (MBAs), where inventory of nuclear material can be categorized and tracked, and key measurement points (KMPs) within those MBAs, where inventory of nuclear material can be measured. Any movements from one MBA to another are promptly reported to the CNSC and IAEA. Nuclear material movements within the same MBA are also tracked internally to ensure precise status. Inventory changes are input into Nuclear Material Accountancy software by staff qualified to move nuclear material. This software supports tracking and report generation. Reports of inventory status are submitted to the CNSC and IAEA as required by the licence conditions, which currently refer to REGDOC-2.13.1 and include:

- Inventory Change Documents;
- General Ledger;
- List of Inventory Items;
- Physical-KMP Inventory Summary;
- Obligated Material Inventory Summary;
- Reconciliation Statements.

To support accounting and reporting, additional information is provided by OPG to the CNSC and ultimately to the IAEA, including operational information, plant design information, and site procedures. Providing current operational data and upcoming plans allows CNSC and IAEA to compare and validate observations from installed measurement equipment to the inventory data provided. Transparency with plant design information and site processes prevent potential gaps in measurement points and methods.

Darlington NGS utilizes an electronic system to help track deadlines associated with CNSC/IAEA Safeguards requirements to ensure submissions are made on time in accordance with REGDOC-2.13.1. This system also supports historical traceability by documenting when submissions were made, in addition to record keeping of submitted files.

In accordance with N-PROG-RA-0015, *Safeguards and Nuclear Material Accountancy*, Darlington NGS shall disclose to the CNSC, the IAEA, or an IAEA inspector, any records required to be kept or any reports required to be made under a safeguards agreement. In accordance with the General Nuclear Safety and Control Regulations, Section 31, OPG shall file a report with the CNSC within 21 days of becoming aware of any inaccuracy or incompleteness in a record to be kept under the Act.

All communications with the CNSC and IAEA which contain sensitive information, such as nuclear material accounting, is performed using only secure means. To ensure timely communication and report submissions, procedures are kept in alignment with REGDOC-2.13.1 requirements and relevant staff are trained on these procedures to be aware of reporting requirements and timelines. Between 2015 and 2023 an average nearing 100

Safeguards Nuclear Material Accountancy submissions per year were submitted to the CNSC and IAEA.

2.13.2 Access and Assistance to the IAEA

The IAEA may require access to a given site for a variety of purposes pursuant to the Canada-IAEA safeguards agreements. Darlington NGS will grant prompt access to all locations within the licence to the IAEA and CNSC inspector(s), or to person(s) acting on behalf of the IAEA/CNSC, where such access is required to carry out an activity pursuant to a safeguards agreement. Site procedures are written to allow access for inspection at all operating hours. Initial access to areas for inspection will be attained within two hours of the IAEA arriving onsite provided it is safe to do so.

Typically, an OPG Single Point of Contact (SPOC) is assigned for all informal communications with IAEA/CSNC for Safeguards activities. A contact list including the SPOCs information is maintained and shared with the IAEA/CNSC to facilitate communication. The SPOC is trained in station processes related to Safeguards to help ensure effective and timely support. In the case where the OPG SPOC is unavailable, such as on night shifts, procedures are in place for staff on shift to make the same appropriate arrangements for the inspector(s) access during all station operating hours.

In granting access, Darlington NGS will provide:

- Health and safety services.
- Escorts for conventional and radiological safety.
- Technical or equipment assistance as required.
- Physical access equipment such as:
  - Ladders;
  - Scaffolding;
  - Lifting devices supplied as necessary.

Assigned Darlington NGS personnel will guide the IAEA and CNSC to ensure compliance with site procedures for the duration of the site access. Where necessary to ensure safe access, required training will be arranged as soon as practical.

IAEA and CNSC inspectors regularly perform site visits to review the status of monitoring equipment, accessible nuclear material inventory, submitted records, station design, procedures, and worker practices. Site visits are also required to perform maintenance of IAEA surveillance equipment, for example successfully completed IAEA replacement of Core Discharge Monitors with significant support from OPG. These inspections and maintenance prevent gaps in nuclear material safeguarding provisions.

Existing procedures have been in place for some time and have been reviewed against the safeguards agreements and Canadian regulations to ensure compliance; they have also been tested through many years of use at Darlington NGS site. During site visits, there are opportunities to share concerns and potential improvements to existing processes to make the OPG safeguards program, access and assistance more effective.

Similarly, Darlington NGS staff support trilateral meetings between OPG, CNSC and IAEA as forums to discuss the integrated Safeguards approach, process improvements, emerging trends, etc. With a culture of continuous improvement, site procedures are updated with any lessons learned. Should regulatory requirements be revised, thorough gap analysis is performed to identify any areas for improvement within existing site procedures. Site procedures are then promptly updated to maintain alignment, and where possible exceed, the latest regulatory requirements in force.

2.13.3 Operational and Design Information

The purpose of providing accurate and timely operational and design information to the CNSC and IAEA is to ensure adequate measures are in place to Safeguard nuclear material and ensure compliance with the non-proliferation Safeguards agreements. Operational and design information is used to ensure an appropriate, integrated approach for the site specifics is in place. It is also useful in understanding and validating observations from installed measurement equipment and provided nuclear material accounting reports. An appropriate site-specific safeguards approach is critical to assure that measures – such as nuclear material reporting, safeguards equipment and surveillance, and in person inspections – are sufficient to the timely detection of diversion of significant quantities of nuclear material from peaceful nuclear activities.

Darlington NGS utilizes an electronic system to help track deadlines associated with CNSC and IAEA Safeguards requirements to ensure submissions are made on time. This system also supports historical traceability by documenting when submissions were made, in addition to record keeping of submitted files. It also enables oversight to closeout ensuring sufficient rigour and due process.

There are three primary reports provided by Darlington NGS to the CNSC and IAEA to capture relevant design and operational information required by REGDOC-2.13.1. The reports are Design Information Questionnaire (DIQ), Operational Program, and Additional Protocol.

The Design Information Questionnaire (DIQ) is an IAEA form which Darlington NGS completes with all applicable information, including:

a) The identification of the facility, stating its general character, purpose, nominal capacity and geographic location, and the name and address to be used for routine business purposes.

b) A description of the general arrangement of the facility, including site and building maps as needed, with reference to the form, location and flow of nuclear material and to the general layout of important items of equipment which are used to handle, produce or process nuclear material.

c) A description of features of the facility relating to nuclear material accountancy, containment and surveillance.

d) A description of the existing and proposed procedures at the facility for nuclear material accountancy and control.

e) Health and safety procedures that the IAEA shall observe and with which the inspectors shall comply at the facility.

Through Darlington NGS's internal routine electronic tracking (typically yearly), the DIQ is reviewed for any changes; any identified changes are included in a revision to the DIQ and it is resubmitted to the CNSC and IAEA. In addition, the Darlington NGS safeguards specialist maintains awareness of potential site developments that may necessitate updates and resubmission of the DIQ at any time. The OPG *Engineering Change Control* program, N-PROG-MP-0001, also requires design changes to be reviewed for potential impact to Safeguards in the early planning phase (for additional information on OPG's engineering change control program see Sections 2.1.5 and 2.5.1). Expected impacts are addressed collaboratively with CNSC and IAEA to maintain an adequate safeguards program. More specifically, design changes flagged for potential impacts to Safeguards are discussed with the Darlington NGS safeguards specialist and reported to the CNSC and IAEA for alignment prior to implementation. Direct communications from the design change team allows for detailed and applicable information to be gathered for accurate reporting; moreover, OPGs design change process requires rigorous documentation to capture all details that would be needed for Safeguards; relevant information as confirmed through documentation and discussion with the design change team, IAEA and CNSC (where applicable) is then included in the DIQ update.

To further ensure the accuracy of the submitted DIQ and the site-specific safeguards measures, the IAEA also performs routine Design Information Verifications (DIVs). During a DIV, the IAEA performs in person inspections of the provided DIQ information to verify it is accurate and sufficient to make decisions on the safeguard measures. The IAEA inspects various areas of the facility and asks many questions to confirm that there are no potential gaps in the safeguards approach or the DIQ. Much like any other IAEA inspection, there are opportunities for feedback and lessons learned, whereby the DIQ can be updated and resubmitted to ensure the highest standards are applied. The DIV is an important aspect of the DIQ.

The Operational Program is a CNSC form which Darlington NGS completes with all applicable information, including, but not limited to:

a) Any anticipated shutdown periods during the upcoming calendar year.
b) Information on expected transfers of nuclear material in the next calendar year.
c) Updates on current or upcoming projects of relevance to safeguards, such as the construction or decommissioning of a building, the commencement of projects involving nuclear material, changes to the types of nuclear material being possessed, etc.

The Operational Program is submitted annually as per REGDOC-2.13.1. Typically, quarterly updates are also provided to deliver confirmation of no change, or identify any changes.

Much like the DIQ preparation, the Darlington NGS safeguards specialist maintains awareness of site operating plans that may necessitate revision and resubmission of the Operational Program at any time. The Darlington NGS safeguards specialist gathers the required information from site contacts most applicable to the information; this ensures accurate information is provided from the source.

The Additional Protocol is an annual report which includes, but is not limited to:

a) Current drawings of the site, a general description of each building on the site, including its use and, if not apparent from that description, its contents.
b) General plans for the succeeding 10-year period relevant to the development of the nuclear fuel cycle (including planned nuclear fuel cycle-related research and

development activities) when approved by the appropriate authorities in Canada.

The information provided in the Additional Protocol assists the CNSC and IAEA in reviewing the site Safeguards approach, looking for gaps, or future areas of increased concern, to address.

In addition to the above three reports, Darlington NGS maintains communication with the CNSC and IAEA Safeguards divisions. Operational activities that could not be foreseen, such as sudden power loss, that may affect Safeguards are promptly reported to the CNSC and IAEA. Furthermore, OPG supports industry peer team meetings, benchmarking of other nuclear generating stations, and routine trilateral meetings with the IAEA and CNSC to discuss the Safeguards program; these are excellent environments to learn from each other and identify areas for improvement in the overall safeguards program.

OPG strives to be transparent with the CNSC and IAEA to ensure alignment and facilitate the objectives of the Safeguards and Non-Proliferation agreements.

2.13.4 Safeguards Equipment, Containment, and Surveillance

There are several IAEA Safeguards equipment installed at Darlington NGS to allow remote monitoring of necessary nuclear material movements within the station; for instance, cameras and radiation monitors which are strategically placed at critical transfer locations. Darlington NGS supports this equipment by providing the required services and operating safeguards equipment as specified by the IAEA; such services include power supplies, lighting, internet connections, etc. The installed equipment provides the IAEA with continuous detailed data of nuclear material movements. The IAEA use the information to compare against Darlington NGS's nuclear material accountancy reports to ensure all nuclear material movements are accounted for and used for legitimate purposes in accordance with the non-proliferation treaty.

IAEA equipment is labelled and sealed to deter interference, damage, or tampering. Site procedures and staff training clearly detail that tampering or disruption of IAEA surveillance equipment must be immediately reported to the CNSC. Tampering or disruption may take many forms including: physical damage, broken IAEA seal, power supply interruption longer than credited backup supply, reduction of lighting in areas of IAEA cameras, shielding of IAEA radiation measurement devices, high ambient temperature, etc. Where possible, duel switchable power supplies are provided for increased reliability and online maintenance.

Additional critical support parameters, such as the minimum required ambient lighting for IAEA cameras or a specified range of ambient temperature for IAEA computers, have requirements captured in site procedures and training, reinforce expectations to perform all due diligence to satisfy these bounds.

The IAEA conducts remote monitoring to ensure functionality of surveillance equipment, as well as in-person inspections to verify no tampering has occurred. OPG personnel also perform periodic inspections to confirm no visible tampering of IAEA equipment.

Darlington NGS shall not make changes to any aspect of a facility, facility operation, equipment or procedures that would affect implementation of safeguards measures except with prior approval of the CNSC, or a person authorized by the CNSC.

From 2012 to 2023 there were a total of five events reportable to the CNSC related to Safeguards Equipment, Containment and Surveillance. In each case, immediate action was taken to resolve the condition. Where practical, reoccurrence control actions were implemented following the event.

Besides the reported events, there were no observations of adverse equipment support identified by the IAEA. Such observations can be made by IAEA remote monitoring of equipment, site inspections and maintenance. Visual inspections of accessible Darlington NGS IAEA equipment were performed at least once per year since 2017 by both OPG and IAEA. In all cases no visible signs of equipment/seal damage or tampering was found.

In the spirit of continuous improvement, annual Safeguards self-assessments have been completed by OPG since 2016. The self-assessments identified minor areas for improvement and created actions to address them to keep standards high. In all instances, the self-assessment concluded that the Darlington NGS Safeguards program was healthy, which is expected to continue.

2.13.5 Import and Export

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

Section 2.14

Packaging & Transport

2.14 Packaging and Transport

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

The program document, W-PROG-WM-0002, *Radioactive Material Transportation* (RMT), establishes the program and necessary controls for safe, regulatory compliant and efficient transportation of radioactive material at OPG. The RMT program establishes procedures for the handling, packaging, shipment, and receipt of radioactive materials. The program also addresses emergency response to transportation accidents. OPG's response in the event of a transportation accident involving radioactive material is documented in N-STD-RA-0036, *Radioactive Material Transportation Emergency Response Plan*.

The OPG documents in the table below require written notification of change per Darlington NGS Licence Conditions Handbook, LCH-PR-13.03/2025-R005:

Table 22: SCA 14 – Packaging and Transport

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

2.14.1 Package Design and Maintenance

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

Each OPG radioactive materials transportation packaging (with the exception of one-time use packagings) is subject to an annual maintenance outage. Packaging maintenance is performed in a dedicated facility - the Transportation Package Maintenance Building at the Nuclear Sustainability Services (NSS) - Western Waste Management Facility.

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

Modifications to OPG's existing radioactive materials transportation packagings are a rare occurrence due to the maturity of the designs. Although several of OPG's packagings are greater than 15-years old, all packagings have been maintained in good condition without any reduction in safety or operability.

An improved version of the OPG Trillium Transportation Package, designated as Trillium TP-03, will be added to the OPG fleet in 2025 to increase the fleet's capacity to transport spent ion exchange resins and intermediate level waste from the Darlington, Pickering, and Bruce Power stations. The design of the Trillium TP-03 was developed in accordance with OPG's *Design Management* (N-PROG-MP-0009) and *Engineering Change Control* (N-PROG-MP-0001) programs.

OPG plans to update its Type B package safety analysis reports, the associated CNSC design approval certificates, and lower category regulatory compliance reports to demonstrate compliance with the International Atomic Energy Agency *Regulations for Safe Transport of Radioactive Material, 2018 Edition* by 2027.

2.14.2 Packaging and Transport Program

The objective of the RMT program is to ensure that shipments of radioactive material for which OPG is the consignor are prepared and offered for transport in a manner that is compliant with the *Transportation of Dangerous Goods Regulations* (TDG) and the PTNSR. The RMT program also establishes the necessary
controls for safe and compliant transportation and handling aspects of radioactive material within OPG's control where OPG is the consignee or when OPG Class 7 carriers are used. This is done to ensure the safety of workers, the public, and the environment.

The RMT program is owned by the Low & Intermediate Level Waste Operations and RMT department within the NSS division of OPG. The overall structure of the program is defined in W-PROG-WM-0002. As per this document, it is the responsibility of the station organization *"to ensure that radioactive shipments are characterized, classified, packed, shipped, and received in accordance with approved procedures and applicable regulations."* To ensure regulatory compliance, NSS issues and maintains a set of procedures and instructions that provide information on the correct means of handling, loading, and offering of radioactive material for shipment, including W-PROG-WM-0002, W-PROC-WM-0033, *Radioactive Shipments* and W-PROC-WM-0040, *Type A and Less Package Receiving, Handling and Shipping*.

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

There have been hundreds of radioactive material shipments to and from the Darlington NGS site during the current licensing period and none have been involved in any accidents or any other dangerous occurrences.

2.14.3 Registration for Use

Users of Type B packages must register with the CNSC and acknowledge that they have the necessary instructions to properly prepare the package for shipment. The objective of the user registration process is to ensure that OPG applies for and obtains confirmation from the CNSC that OPG has been registered as a user for the package of certified design. OPG's process for registration for use of packages of certified design is specified in W-PROC-WM-0006, *Radioactive Materials Transportation Records*.

Currently OPG is a registered user for 11 different package designs. These packages include OPG's intermediate level waste and tritiated heavy water transportation packages, and packages from external agencies and companies for used fuel samples, Cobalt-60, and Molybdenum-99. OPG has never used a package of a certified design without being a registered user.

3.0 Facility-Specific Information

This section highlights the facility-specific information associated with Darlington NGS Power Reactor Operating Licence (PROL) 13.03/2025.

3.1 Tritium Removal Facility

The Tritium Removal Facility (TRF) and Heavy Water Management Building (HWMB) reduces the tritium content of heavy water inventories for Darlington NGS and all Ontario CANDU reactors. This is accomplished through distillation, ion exchange and particulate filtration as well as extraction and immobilization of the tritium isotope for storage in a secure vault. The reduction of tritium reduces the radiation dose to OPG personnel and minimizes the tritium emissions to the environment. The facility also maintains isotopic purity requirements for heavy water at Darlington NGS. Maintaining isotopic purity of heavy water helps with the fission process by slowing down neutrons and therefore optimizing fuel burn-up.

The OPG documents in the table below require written notification of change per Darlington NGS Licence Conditions Handbook, LCH-PR-13.03/2025-R005:

Table 23: Tritium Removal Facility

Document	Title
NK38-OPP-03600	Darlington Nuclear Operating Policies and Principles
D-INS-39000-10003	TRF Planned Outage Management
N-PROG-AS-0008	Heavy Water Management Plan

Since 2015, the TRF has removed approximately 157.5 million Curies (5.81e+18 Bq) of tritium. During the current licence term, several initiatives were completed to improve and ensure continued detritiation capability:

- The HWMB (West Annex) was commissioned and placed into service, increasing OPG's heavy water storage capacity by 1900 Mgs. The addition of this facility allows for flexibility with refurbishment, Pickering end of commercial operation/refurbishment activities as well as support for Bruce Power's Major Component Replacement activities.
- Wet scrubbers were placed into service. The function of a wet scrubber is to remove tritiated water vapour from an air stream. Key indicators of success include:
    - The HWMB wet scrubber reduced the tritium emission during the Unit 1 moderator drain by 95% compared to the previous Unit 3 drain without the scrubber.
    - The recombiner wet scrubber reduced the tritium emission by 80% during the 2023 TRF outage during warm up activities of the high tritium distillation and low tritium distillation columns.
- The cryogenic refrigeration compressor conditioning monitoring system was put into service. This will allow time between cryogenic refrigeration system-only outages being extended from 10,000 hours to 15,420 hours. The main purpose of the cryogenic refrigeration system is to provide refrigeration to maintain the distillation processes.

- A helium-3 tool was commissioned and placed into service. This allows the harvesting of stored immobilized tritium containers for helium-3 which is an inert decay product of tritium. In addition to eliminating tritium as a waste by product, helium-3 is anticipated to be a valuable input to the fusion industry and has uses, today, in Magnetic Resonance Imaging, super-cooling systems that support quantum computing, and border security to detect radioactive materials. OPG produces one third of the global supply.
- In 2021, the detritiation factor returned to the design value as a result of the use of deep evacuations to remove impurities in the cryogenic refrigeration system. As a result, the TRF is able to process an increased volume of water.
- The 2023 TRF outage was executed event free and ahead of schedule using lessons learned from the 2021 outage.
- The health of the heavy water program allowed a timely response to an Industry peer's unit transient and support their return to service. OPG coordinated and supplied a total of ~78 Mg of D2O in drums within a 2-week window.

The TRF team is developing and supporting plans for Pickering Units 1 & 4 end of commercial operation and Units 5-8 refurbishment.

A decision to extend the TRF operation through 2060 has been made to align with Darlington NGS operations. Reliability improvements and life extension activities will be incorporated into each planned TRF outage.

A major component replacement project team has been established and initial scopes of each proposed refurbishment outage from 2026 onward have been developed. The six refurbishment outages will begin in 2026 to 2038 with an estimated duration of 6 to 10 months each. These outages will address equipment reliability, redundancy and maintainability. Planned improvements include:

- Hydrogen compressor replacement.
- Cryogenic refrigeration system turbine oil skid system replacement.
- Low pressure service water line replacement.
- Fisher bellows valve replacements (~76 valves).
- Auxiliary system improvements (i.e. drain and purge, tritium immobilization).
- TRF simulator – the current simulator is task based and not all scenarios contain the cryogenic physics required to allow for live plant manipulation. A $1.5M investment is being made into the simulator to improve physics and allow for improved initial and continuing training as well as a more realistic means of practicing first of a kind evolutions.

3.2 Refurbishment

The Darlington NGS refurbishment project is a multi-year, multi-phase, project that is enabling Darlington NGS to continue safe and reliable operation through 2055. The project includes the replacement of life-limiting critical components, the completion of upgrades to meet regulatory requirements, and the rehabilitation of components in Darlington NGS's four units.

The OPG documents in the table below require written notification of change per Darlington NGS Licence Conditions Handbook, LCH-PR-13.03/2025-R005:

Table 24: Refurbishment

Document	Title
NK38-NR-PLAN-09701-10001, Sheet: 0003	Darlington Refurbishment Return to Service Program Management Plan
NK38-INS-09701-10006	Nuclear Refurbishment Unit Readiness for Service
N-PROC-MP-0090	Engineering Change Control Process

Progress to date (Figure 32):

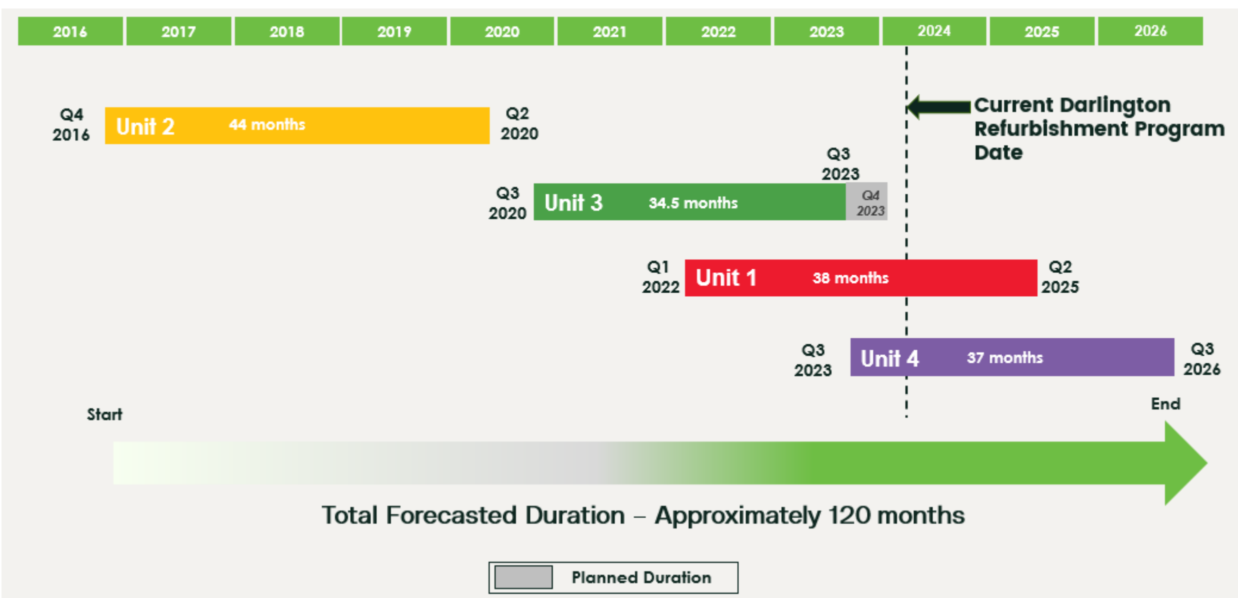


Figure 32: Refurbishment Progress

Two of the four units have been refurbished and returned to service:

- Unit 2 was successfully returned to service on June 4, 2020. Completion of this first unit represented a significant achievement for the project and provided considerable experience and lessons learned for the subsequent units.
- Unit 3 was successfully returned to service on July 17, 2023. Overall, Unit 3 was completed with marked performance improvements and efficiencies versus Unit 2 with a 56% reduction in Medically Treated Injuries, 36% reduction in Collective Radiation Exposure and 43% reduction in quality events. Other highlights are included in Figure 33:

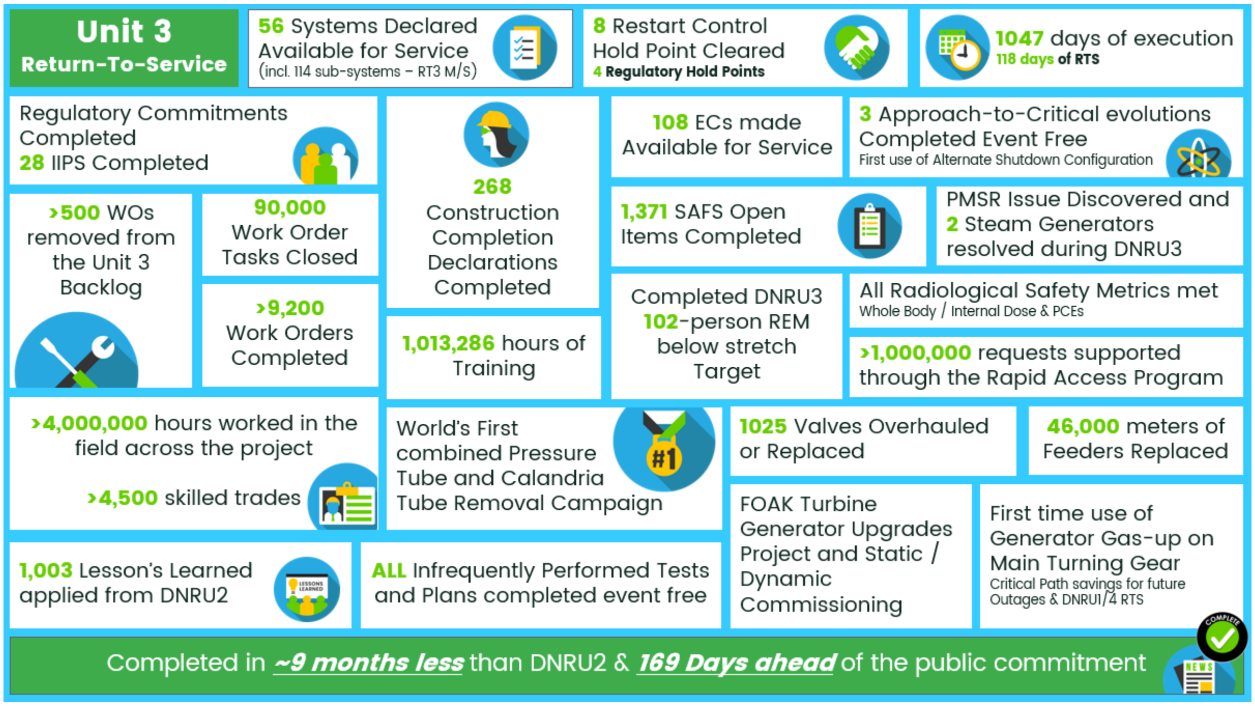


Figure 33: Unit 3 Return-To-Service

- Unit 1 refurbishment activities are progressing, currently in the final segment, which involves loading fuel, tieing the unit back to station containment and final unit start-up and reactor physics testing. This final segment is progressing as planned, with fuel load targeting completion in Q2 2024. Overall, Unit 1 is on track to be returned to service in Q2 of 2025.
  - Restart Control Hold Point (RCHP) 1 of 8 was completed on December 20, 2023, and was shortly followed by the refill of the Moderator System in late December 2023.
  - The second RCHP was completed on April 29, 2024. This also marks the completion of Regulatory Hold Point (RHP) 1 of 4, a significant milestone in the return to service process.

- Unit 4 refurbishment commenced on July 19, 2023, shortly after the return to service of Unit 3, and is the last of four units undergoing refurbishment at Darlington NGS. Refurbishment activities are progressing on schedule, safely and successfully with completion of the defueling of the reactor in September 2023. The unit is progressing through the disassembly segment (2nd segment), forecasting completion in Q3 2024, and the overall schedule is on track to be returned to service in Q3 of 2026.

3.2.1 Major Projects and Improvements

While the primary focus of refurbishment is the replacement of the reactor core components, there has also been a considerable number of initiatives and improvements completed to ensure Darlington NGS's continued safe operation. These improvements are outlined in the Integrated Implementation Plan (IIP) and focus on enhancing the station's safety and reliability.

The IIP presents the scope and schedule for the implementation of actions resulting from environmental assessments, integrated safety reviews, addressing code gaps, component condition assessments, and integrated aging management programs. Overall, 541 of 622 of the IIP refurbishment and continuing operation commitments have been completed up to Q1 2024.

Key station improvements that have been implemented includes (but not limited to):

- Fuel channels, feeders, calandria tubes, and end fitting replacements: the full scope of this project includes replacement of fuel channel and calandria tube assemblies, feeders, feeder cabinet insulation, and instrumentation tubing associated with the feeders. Design improvements have also been incorporated to the feeder material and bend fabrication as the original design exhibited susceptibility to Flow Accelerated Corrosion, a known degradation mechanism.
- Auxiliary Shutdown Cooling (ASDC): installation of two completely diverse auxiliary shutdown cooling pumps per unit. These pumps serve as backup to the main shutdown cooling pumps to protect against common cause failures. The two ASDC pumps and their support services are independent, diverse, and physically separated from the main SDC pumps.
- Replacement of the Shutdown System (SDS) trip computers: the current SDS trip computers relied on older technology that was becoming increasingly difficult to maintain, and spare parts availability was limited. The new computers retain much of the existing software and the core functionality of the current system, including trip setpoints and trip timing but also improves human-user interface and human factors considerations.
- Replacement of In-core Flux Detectors: the Reactor Regulating System (RRS) in combination with the Liquid Zone Control is required to monitor and control the bulk and spatial neutron flux power distribution. This project has involved the replacement of aged Flux Detectors for SDS1, SDS2 and RRS in each unit based on performance indicators to ensure flux tilt is within limits.
- Implementation of a Containment Filtered Venting System (CFVS): this system provides controlled and filtered emergency venting of the containment to prevent over-pressurization and ensure containment integrity. The CFVS minimizes releases to the environment, reduces the content of flammable gases, and filters out radioisotopes with high removal efficiencies.
- Shield Tank Overpressure Protection modification: this modification enhances the relief capacity of the shield tank surrounding each unit's calandria vessel limiting containment over-pressurization.
- Enhancements to the Powerhouse Steam Venting System (PSVS): these enhancements include duplication of the programmable controller logic of the current PSVS to improve reliability and protect plant systems following a steam line break. These modifications are aimed at reducing plant risk and improving operational flexibility.
- Installation of a third Emergency Power Generator (EPG3): this generator is designed to withstand a seismic event greater than the Design Basis Earthquake and increases emergency power reliability when one EPG is not available.
- Implementation of alternate and independent water supply to the Primary Heat Transport (PHT) system: this is achieved through the installation of Emergency Mitigating

Equipment and a permanent line from the Emergency Service Water to the PHT system to act as an emergency heat sink.

- The replacement of the Primary Heat Transport Liquid Relief Valves: this modification addresses valve opening and closing times to eliminate water hammer effects while maintaining overpressure protection requirements.
- Upgrades to the Turbine and Generator Controls: the work scope includes replacement of analogue Steam Turbine Electronic Controls system, with a dual or triplicated redundant digital control system and provisions of generator rotor monitoring. Replacement of the entire Turbine Supervisory System and the installation of a full scope maintenance simulator.
- Main Output Transformers (MOTs) and Unit Service Transformers (USTs) Replacements: the original MOTs and USTs had been in service for over 25-years and OPG has been completing proactive replacements due to obsolescence of spare parts and aging. In conjunction with these replacements, the original deluge systems is being replaced with improved designs to meet new fire protection requirements. The new deluge system includes replacement of legacy piping and supports and extending sprinkler coverage.

These projects have been undertaken to enhance the reliability and safety of Darlington NGS, ensuring its continued safe operation.

3.2.2 Conventional Safety Performance

Safety is a top priority for OPG. OPG has one of the lowest injury rates in the Canadian electricity sector. In order to maintain this excellent safety performance, OPG continues to set challenging targets for its day-to-day operations. At the end of Q1 2024, the Program reported a Total Recordable Injury Frequency (TRIF) of 0.21 against its internal target of 0.40, reflecting three medically treated injuries in Q1 2024.

OPG sets very challenging targets for all aspects of its operations and the Program. This expectation has resulted in a Program safety performance that is significantly better than the overall construction industry average as illustrated in Table 25, below. As of Q1 2024, the Program is approaching over 53 million hours worked with one Lost Time Injury, which occurred in May 2019. OPG employs a variety of leading indicators to ensure that issues are addressed before incidents occur. OPG's practice of proactively tracking events/safety incidents where no injuries occur, but where there is potential for harm, is one example of a leading indicator. OPG carefully logs and reviews each of these incidents and implements corrective actions to reduce the likelihood of future incidents. Additionally, a Quality of Safety Practices (QSP) metric was implemented in 2023 as a monitoring metric to assess safety practices in real time. The QSP metric score is calculated by using Observation and Coaching (O&C) data related to high-energy hazards based on the percentage that meet or exceed expectations compared to all high-energy hazard O&Cs. In addition, the Safe Work Planning Assessment (SWPA) is being piloted to assess the quality of direct controls implemented to address high-energy hazards within safe work plans. The implementation of the SWPA is expected by the first quarter of 2024.

Table 25: Conventional Safety Performance (includes OPG and Vendor)

Historical Actuals										IHSA[2]
Measure	**OPG Target**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**Ontario Construction Industry 2023**
TRIF[1] (Total Recordable Injury Frequency)	0.40	0.64	0.49	0.39	0.52	0.35	0.25	0.29	0.19	4.24
Lost Time Injuries	0	0	0	0	1	0	0	0	0	N/A

Notes:

1. TRIF is the average number of fatalities, Lost Time Injuries, medical treatment injuries and restricted work injuries per 200,000 hours worked.
2. Infrastructure Health & Safety Association (IHSA) rating is the most current safety rating for the Ontario Construction Industry (current as of 2023 year-end).

3.2.3 Radiological Safety Performance

OPG's Radiological Protection (RP) program continues to meet regulatory requirements and industry standards. All workers are in compliance within regulatory dose limits and OPG's more stringent internal targets. OPG's dose performance is industry leading. This performance is a result of OPG's robust nuclear safety culture and OPG's *As Low as Reasonably Achievable* (ALARA) radiological safety principles. Lessons learned on Unit 2 and Unit 3 have been incorporated into training and enhanced radiological safety measures on Unit 1 and Unit 4. The Program's ALARA committee continues to monitor and challenge RP performance to ensure ALARA principles result in lower doses to workers.

Table 26 provides a summary of the radiological safety performance and includes both OPG and vendor employees. The statistics are specific to Refurbishment only. Due to the nature of the work, such as reactor component replacements, a higher person-mSv dose is expected compared to the Station statistics. The actual dose remains lower than the forecasted targeted dose, representing a lower radiological exposure.

Table 26: Radiological Safety Performance

	2021 Year End		**2022 Year End**		**2023 Year End**	
	Actual	**Target**	**Actual**	**Target**	**Actual**	**Target**
Unit 3 Collective Radiation Exposure (person-mSv)	10280	13790	3370	6330	550	950
Unit 1 Collective Radiation Exposure (person-mSv)	N/A	N/A	7220	9840	4751	5000
Unit 4 Collective Radiation Exposure (person-mSv)	N/A	N/A	N/A	N/A	4269	4750

3.2.4 Quality Performance

Refurbishment of the Darlington NGS units involves many thousands of removal and installation activities, which are required to be executed with a high degree of precision. Many of the installation activities involve precision fit tasks and highly technical welding. The quality management program is used to identify issues during refurbishment execution by focused surveillance of vendor performed work.

Incorporation of lessons learned has improved industrial and radiological safety, tooling, schedule management, organizational alignment, enhanced safety and Foreign Material Exclusion planning and oversight. A culture of continuous improvement has resulted in the collection and implementation of lessons learned and continues to drive performance in Unit 1 and Unit 4 return to service. The most significant improvement elements from Unit 3 include Operational Transfer Plans, and Refurb Outage Control Centre Change Management.

3.2.5 Collaboration

In 2015, long-term agreements were made to revitalize Ontario's nuclear feet at both OPG and Bruce Power to ensure the Province has the reliable baseload power it needs. Throughout these projects, our focus on collaboration has led to the sharing of lessons learned, innovations, resources, and tooling and equipment, resulting in more efficient and successful projects for both companies (Figure 34).

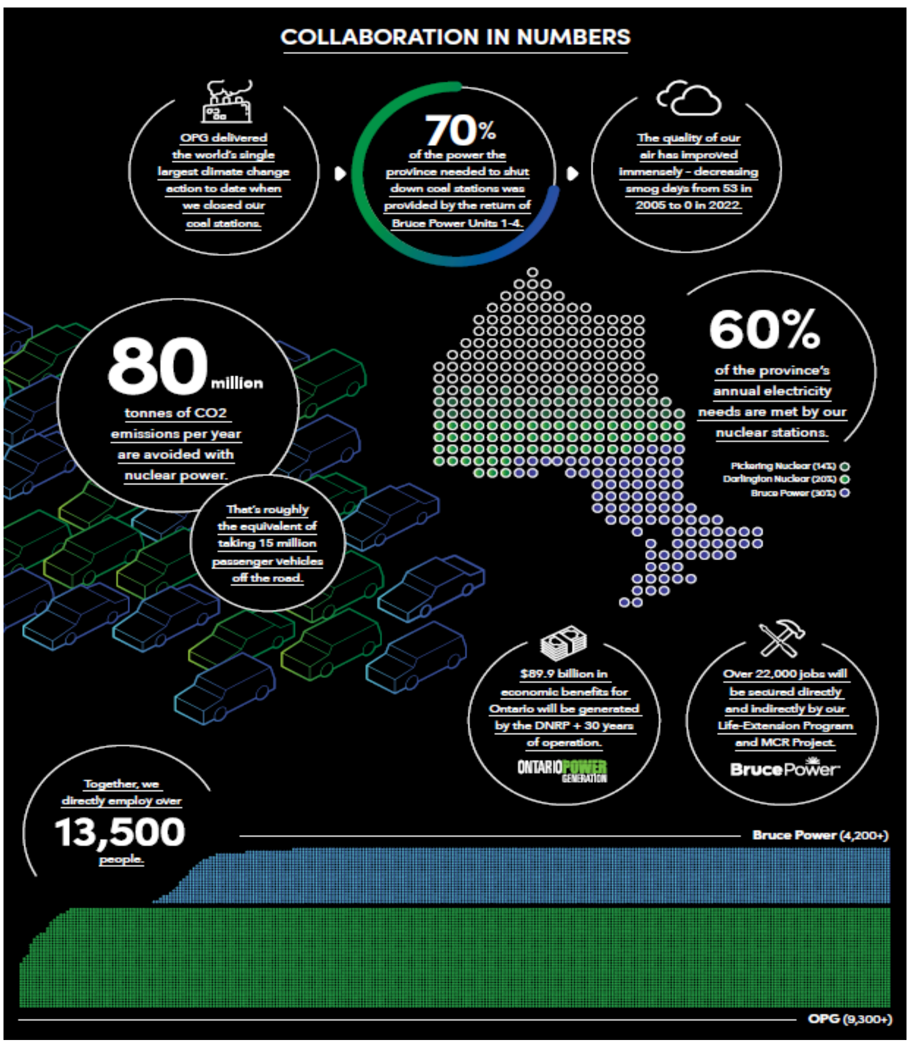


Figure 34: Collaboration in Numbers

3.2.6 Recognition

The refurbishment project continues to garner significant external attention. Numerous requests for visits and/or tours of Darlington NGS and the Retube and Feeder Replacement Mock-up and Training Facility at the Darlington Energy Complex, as well as invitations to speak/present on a wide range of project-related topics.

The following organizations visited Darlington NGS for primary benchmarking purposes to gain insight into improvement opportunities:

- CNCAN Romania;
  - Focus on best practices, return to service protocols, Lessons Learned/Enterprise Business Extensions and Cable Surveillance Program Human Performance.
- Emirates Nuclear Energy Corporation;
  - Focus on overall Refurbishment structure and execution.
- EDF Energy;
  - Focus on overall Refurbishment structure and execution.
- KHNP Korea Nuclear Research Institute;
  - Focus on development and deployment, operations and maintenance, Operator training, commissioning and regulatory support.

3.2.7 Next Steps – Return-to-Service

Return-to-Service Protocol

Return-to-Service (RTS) involves returning the reactor and associated nuclear and non-nuclear systems to commercial operation. Darlington NGS must demonstrate that all regulatory requirements have been met and that the associated work has been completed to the satisfaction of the CNSC through an RTS protocol which establishes the administrative process to be used to clear the following four RHPs:

- RHP 1: Prior to fuel load;
- RHP 2: Prior to Guarantee Shutdown State removal;
- RHP 3: Prior to exceeding 1% full power; and,
- RHP 4: Prior to exceeding 35% full power.

Each of these hold points require regulatory verification to confirm operational readiness of the plant safety systems to satisfy regulatory requirements for staged progress through the commissioning phases up to full power operation. A completion assurance document is the deliverable presented to the CNSC when seeking approval to release an RHP. It provides evidence of the completion of commitments required to support the release of the hold point.

The RTS Program Management Plan, NK38-NR-PLAN-09701-10001, Sheet: 0003, *Darlington Refurbishment Return to Service Program Management Plan* describes the processes, procedures, and organization that will be used during the Darlington NGS Refurbishment Project to manage the modification and restart activities. This plan identifies eight internal

Restart Control Hold Points (RCHPs) that will be the focus of the run-up activities leading up to full power and unit availability for commercial operation.

Unit 1 RTS

Completion of 51 Systems Available for Service (SAFS) declarations will support RTS and the removal of each of the eight RCHPs milestones, including four RHPs. In 2023, 14 SAFS were completed in support of clearing the first RCHP and to permit the refilling of the Moderator System. The refill of the Moderator System was completed in Q4 2023. Upon the completion of eight SAFS in Q1 2024, the second RCHP was achieved in April 2024, followed by the first Regulatory Hold Point. This marks a significant milestone as the RTS activities progress in 2024.

Unit 4 RTS

Completion of 51 SAFS declarations is planned and will support RTS and the removal of each of the eight RCHPs, including four RHPs. The refurbishment of Unit 4 began on July 19, 2023, and RTS activities are scheduled to begin in 2025.

3.3 Periodic Safety Review (PSR)

The Darlington Periodic Safety Review (D-PSR) was completed in accordance with Licence Condition 3.4 of Darlington NGS PROL 13.03/2025. The D-PSR is a subsequent review which builds on previous OPG Integrated Safety Review (ISR)/PSR work such as: (1) the Pickering PSR2 (programmatic components applicable to Darlington NGS) and (2) the Darlington NGS ISR, performed in support of refurbishment and life extension. The D-PSR was conducted in accordance with the D-PSR Basis Document, NK38-REP-03680-11844, *DNGS Periodic Safety Review Basis Document*, and the requirements of CNSC regulatory document REGDOC-2.3.3, *Periodic Safety Reviews*. The planning basis for the D-PSR covers the period of operation of Darlington NGS units from November 2025 to November 2035.

As per REGDOC-2.3.3, the D-PSR was conducted in four phases:

1. Preparation of the D-PSR Basis document.
2. Conduct of safety factor reviews and identification of gaps and strengths.
3. Analysis of the gaps and identification of potential safety enhancements for Darlington NGS in the global assessment process; and,
4. Preparation of a plan for the implementation of safety enhancements.

The OPG documents in the table below require written notification of change per Darlington NGS Licence Conditions Handbook, LCH-PR-13.03/2025-R005:

Table 27: Integrated Implementation Plan

Document	Title
N-INS-03680-10001[1]	Darlington NGS Integrated Implementation Plan (IIP) Change Control and Closeout Process

Notes:
1. N-INS-03680-10001 has been superseded by N-PROC-MA-0109, *Periodic Safety Review (PSR)*.

3.3.1 D-PSR Basis Document

The first phase of the D-PSR process was the development of the D-PSR basis document, NK38-REP-03680-11844, for acceptance by the CNSC. The D-PSR Basis Document defined the approach for completing the D-PSR, specifically the:

- Proposed operating strategy of the facility.
- Scope and methodology, including conduct of safety factor reviews and identification of compliances and gaps.
- Process for categorizing, prioritizing, tracking and resolving gaps arising from the Safety Factor reviews.
- Conduct of the global assessment.
- Methodology for developing the Integrated Implementation Plan (IIP).
- Applicable current versions of Laws, Regulations, Codes and Standards (LRCSs).
- Major milestones, including the freeze date for document revisions; and,
- Project management and quality management processes to be followed.

3.3.2 Safety Factor Reviews

The second phase of the D-PSR process was the completion of safety factor reviews. Safety factor reviews cover all aspects important to the safety of an operating nuclear power plant. In accordance with REGDOC-2.3.3, there were 15 Safety Factors used in the D-PSR review, as shown in Table 28 below:

Table 28: Safety Factors

<table>
<tr><th>Subject Area</th><th colspan="2">Safety Factor</th></tr>
<tr><td rowspan="4">The Plant</td><td>SF1</td><td>Plant Design</td></tr>
<tr><td>SF2</td><td>Actual Condition of Structures, Systems and Components Important to Safety</td></tr>
<tr><td>SF3</td><td>Equipment Qualification (Environmental and Seismic)</td></tr>
<tr><td>SF4</td><td>Aging</td></tr>
<tr><td rowspan="3">Safety Analysis</td><td>SF5</td><td>Deterministic Safety Analysis</td></tr>
<tr><td>SF6</td><td>Probabilistic Safety Analysis</td></tr>
<tr><td>SF7</td><td>Hazards Analysis</td></tr>
<tr><td rowspan="2">Performance and Feedback from Operating Experience</td><td>SF8</td><td>Safety Performance</td></tr>
<tr><td>SF9</td><td>Use of Experience from other NPPs and Research Findings</td></tr>
<tr><td rowspan="2">Management</td><td>SF10</td><td>Organization, the Management System and Safety Culture</td></tr>
<tr><td>SF11</td><td>Procedures</td></tr>
</table>

Subject Area	Safety Factor	
	SF12	Human Factors
	SF13	Emergency Planning
Environment	SF14	Radiological Impact on the Environment
Radiation Protection	SF15	Radiation Protection

The results of the safety factor reviews were documented in 15 safety factor reports which address the review tasks derived from REGDOC-2.3.3 and document the results of the assessments of Darlington NGS with respect to applicable modern LRCSs and OPG program effectiveness reviews. The safety factor reports were submitted to the CNSC for review and included the:

- Scope of the review.
- Applicable elements of the D-PSR assessment basis (review tasks and applicable LRCSs).
- Review methodology.
- Assessment of compliance with review tasks.
- Effectiveness review of OPG programs supporting compliance assessments.
- Review findings (compliances, strengths, gaps and improvement opportunities).
- Impacts on other safety factor reviews (interdependencies); and,
- Overall assessment of the safety factor.

3.3.3 Global Assessment

The third phase was the global assessment which provided an overall evaluation of the safety of the plant and assessed the acceptability of Darlington NGS for continued operation over the period of the D-PSR.

The global assessment process consists of the following elements:

a) *Identification and consolidation of Gaps and Strengths from the Safety Factor Reports:* The strengths and gaps from the 15 safety factor reports and CNSC findings were consolidated and grouped by topic area to support the global assessment.

b) *Development of Global Issues:* Gaps of a common nature were consolidated into global issues to facilitate the assessment of safety impact and to identify and assess practical and effective resolutions. The global issues were tabularized, tracking sources of the issues, to facilitate further review and assessment.

c) *Assessment of the interfaces between various Safety Factors and aggregate impact of Global Issues:* The aggregate impact of the global issues was assessed and the interaction between the issues was identified. New global issues were also identified as part of this consolidation review, where applicable.

d) *Prioritization of Global Issues and Gaps:* D-PSR global issues and associated gaps were prioritized with respect to their importance to nuclear safety to determine the safety significance level associated with each global issue. This supported the resolution evaluation method and the outcome of the resolution process. This methodology is consistent with OPG prioritization processes used in previous ISRs, PSRs and industry practice. The safety significance level considered deterministic and probabilistic safety analysis impact, as appropriate. Probability levels selected for delineation between categories were based on significance, as applied in previous ISRs and PSRs. These values account for overall safety impact and align, where appropriate, with requirements and limits in relevant safety standards. The relationship between safety significance level and impact on nuclear safety is shown in Table 29 below:

Table 29: Safety Significance Level and Impact on Nuclear Safety

Safety Significance Level	Impact on Nuclear Safety
1	High
2	Medium
3	Low
4	Very Low

e) *Development of Resolutions/Dispositions of Global Issues and Gaps:* Resolution options were developed and assessed using risk informed decision-making techniques. The development of the resolution utilized the following strategy:

- Defence-in-depth elements were considered during the assessment of potential dispositions;
- Overall safety significance guided the resolution process when developing resolutions;
- For global issue resolution, the process was as follows:
    - Evaluate the global issue to understand safety basis and intent of the requirement;
    - Consider possible options for resolution/mitigation. Consider safety significance and defence-in-depth elements;
    - Evaluate options with respect to effectiveness, cost, schedule, practicality. For potential plant modifications, this required an evaluation of the safety impact, both deterministic and probabilistic. If it was not practicable to fully resolve a global issue, other mitigation options were considered for enhancements.
    - Evaluate the practicality of a proposed resolution in terms of cost, resources, schedule, and relation to the overall safety impact;
    - Propose recommended resolution/mitigation;
    - Document the decision-making process.
- Items of high or medium impact on nuclear safety (safety significance Levels 1 and 2) required a more in-depth analysis to clearly establish the issue and potential impact, and to develop the proposed recommended resolution/mitigation.
- Items of very low impact on nuclear safety (safety significance Level 4) were generally deemed acceptable deviations, and while these items were not tracked

beyond the global assessment, they were shared with the accountable organizations for consideration as potential enhancement initiatives for future work program planning purposes. A similar treatment was applied for items of low impact on nuclear safety (safety significance Level 3) for which a practicable solution was not readily evident.

- Proposed resolutions were categorized as i) programmatic (changes to procedures and programs), ii) engineering (plant modifications or maintenance), or iii) analytical (e.g., safety or hazard analysis), to facilitate binning of potential work. In some cases, the proposed resolutions entailed work from more than one of these categories.
- In some cases, the development of resolutions/dispositions to the global issues was part of an OPG or industry initiative currently underway or planned. The resolution and development of options required more detailed analysis and assessment, extending beyond the timelines for submission of D-PSR. In these instances, the status of the initiative and plans were included in the disposition. The work was included in the global assessment to facilitate continued tracking.
- Where a global issue/gap was closed, due to work done in the interim or for other reasons, the rationale was documented, and the global issue/gap was set to resolved and closed.

f) *Assessment of Defence-in-Depth and aggregate impact of Acceptable Deviations:* After evaluating a range of resolutions for global issues, and determining a recommended resolution, the impact on defence-in-depth, considering both deterministic and probabilistic elements, was evaluated to assess the aggregate impact on overall safety. This overall assessment was an important element in supporting the enhancement plans and the planned operational strategy over the period of the D-PSR. For each of the five levels of defence listed below, the defence-in-depth Assessment considered the overall plant as well as the identified strengths, acceptable deviations, and the proposed resolutions to the global issues listed in the global assessment.

Level 1: Prevention of abnormal operation and failures;

Level 2: Control of abnormal operation and detection of failures;

Level 3: Control of accidents within the design basis;

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

Level 5: Mitigation of radiological consequences of significant releases of radioactive materials.

g) *Ranking Global Issues:* All global issue resolution statements were ranked from 1 through 35, in accordance with overall safety significance. The ranking considered factors such as the priority previously determined (i.e., safety significance level), the contribution to defence-in-depth, the source of the issue and the degree of non-compliance with the D-PSR assessment basis.

h) *Expert Panel and OPG Senior Management review of proposed Resolution Statements:* The results of the global assessment were reviewed by a panel of industry experts independent of the global assessment team. The enhancements identified in the D-PSR Global Assessment Report (GAR), with their priority and safety basis, were then presented to OPG Senior Management for approval. This review ensured alignment with the proposed resolutions, their basis and context, and is the means to obtain concurrence that the proposed enhancements are practicable and effective. This also allowed the senior management team to consider potential realignment of overall priorities based on the insights from the D-PSR.

i) *Assessment of overall acceptability of operation of the plant over the period considered in D-PSR:* As a final step in the assessment process, the team assessed the overall acceptability of operation of the plant over the period considered in D-PSR. This entailed a review of the results of the safety factor reviews, a consideration of enhancements planned (both newly identified in D-PSR and from other station plans) and a consideration of plant performance and initiatives underway.

j) *Preparation of the Global Assessment Report:* Preparation of the GAR was conducted to summarize the assessments and document the global assessment.

The results of the global assessment are documented in the D-PSR GAR, NK38-REP-03680-11938, *Darlington NGS Periodic Safety Review (D-PSR): Global Assessment Report*, which was submitted to the CNSC for review. The GAR presents the results, assesses the overall defence-in-depth of the plant, and documents the conclusions, corrective actions, and enhancements to be considered. It includes a ranked list of the global issues with identified actions, with rationale for the ranking using an established decision support methodology. Residual global issues and acceptable deviations are noted in the GAR, summarizing the assessed aggregate impact on safe operations. However, these items are not tracked further beyond the GAR or carried forward into the Integrated Implementation Plan (IIP). The GAR includes a statement of OPG's assessment of the overall acceptability of operation of the plant. Reviews and approval of the report were conducted as required under the OPG management system.

3.3.4 Integrated Implementation Plan

The fourth and final phase was the preparation of the IIP, which involved transforming the proposed resolution statements resulting from the global assessment into Resolution Actions with supporting IIP Actions. The IIP Actions described in NK38-REP-03680-11940, *Darlington NGS Periodic Safety Review (D-PSR): Integrated Implementation Plan,* include initiatives derived from the safety factor reviews and the GAR and existing initiatives that were integral to the overall assessment. The initiatives summarized in the IIP were mapped to the CNSC Safety and Control Areas as per REGDOC-2.3.3.

The IIP includes a schedule that is established to manage the completion of the resolution actions, and the supporting IIP Actions, with baseline target completion dates, progress reporting requirements, and plan risk management for the period of the D-PSR. The IIP includes a tabularized listing of the safety enhancement initiatives, their assigned owners, and their planned implementation date. The IIP was accepted by the CNSC in March 2024 (Reference 3.3-1).

A structured oversight organization is in place to assign accountability for the overall IIP and IIP Action ownership, and to ensure that the IIP phase is resourced to mitigate risks and enable program success. An action tracking and management system is in place for OPG and Regulatory Oversight to ensure actions are completed per the baseline schedule. The reporting, completion, change management, and close-out of the resolution and IIP actions are managed through the PSR process per N-PROC-MA-0109, *Periodic Safety Review (PSR)*.

3.3.5 D-PSR Results

Through the safety factor review process, 99 D-PSR gaps identified from various sources (e.g., safety factor reports and expert panel review) were integrated into the global assessment. These gaps were consolidated and grouped based on topical similarities into 23 global issues. This consolidation facilitated the analysis of interfaces between Safety Factors and the aggregate impact of global issues. Each global issue was prioritized with respect to nuclear safety and assigned a corresponding Safety Significance Level.

Following prioritization, proposed resolution plans were developed for each global issues that identified resolutions to address the associated gaps. Proposed resolution plans were then ranked to determine activities that will be the most effective in enhancing safety of the plant.

Resolution plans proposed for several global issues are already in progress, and many of the global issues Resolution Plan actions reflect existing work programs and plans at the station. In particular, for the global issues of highest safety significance (e.g., Fitness for Service Assessments to cover the operating period), OPG is already actively working on addressing the global issues for the operating period to the end of 2035. None of the global issues identified an immediate safety concern that requires additional planned or urgent action to be taken outside of the D-PSR process.

A summary of the significance of the 23 global issues is outlined below:

- One global issue related to the replacement of the heat transport system liquid relief valves was assessed to have a high impact on nuclear safety and was therefore assigned Safety Significance Level 1. OPG was already fully aware of the need to complete the replacement of these valves and there are open actions associated with the D-ISR IIP, NK38-REP-03680-10185, *Darlington NGS Integrated Implementation Plan*, to track the replacement of these valves to completion.
- One global issue related to Aging Management was assessed to have a medium impact on nuclear safety and was therefore assigned Safety Significance Level 2. The Resolution Plan for this global issue leverages existing OPG processes for aging management and the completion of this Resolution Plan will support the continued safe operation of Darlington NGS during the D-PSR timeframe.
- 13 global issues related to specific requirements in modern codes and standards were assessed to have a low impact on nuclear safety and were therefore assigned Safety Significance Level 3. Actions have been identified as part of the applicable Resolution Plan to adopt requirements in modern codes and standards where it is practical to do so in order further align Darlington NGS with modern standards.
- Eight global issues related mostly to OPG governance, specific requirements in modern codes and standards, or administrative gaps were assessed to have a very low impact on nuclear safety and therefore assigned Safety Significance Level 4. Based on their significance, the majority of the gaps associated with these global issues were assessed as acceptable deviations. However, the resolution plans do include actions to address a subset of gaps associated with these global issues, which reflects OPG's focus on continuous improvement.

In addition, as part of the Safety Factor review, 12 Strengths in Darlington NGS design, operations, and performance were identified. The methodology and the list of Strengths were reviewed by an Expert Panel with extensive knowledge of the D-PSR project and the design and operation of Darlington NGS. The Strengths were used in the Defence-in-Depth

Assessment to demonstrate the extent to which the safety requirements of defence-in-depth are fulfilled and to support mitigation of the global issues.

As part of the global assessment, a Defence-in-Depth Assessment was performed which supported extended operation at Darlington NGS by demonstrating the extent to which the safety requirements of defence-in-depth are fulfilled at Darlington NGS. The overall assessment was an important element in supporting the proposed enhancement plans and the planned operational strategy over the period of the D-PSR.

The results of the Defence-in-Depth Assessment were as follows:

- The Defence-in-Depth Assessment confirmed that effective Level 1 barriers are ensured through the original conservative design, supplemented by design improvements implemented since initial operation, comprehensive programs in place to ensure continued fitness for service and operation within the design basis, and ongoing continuous improvements based on national and international OPEX and evolving regulatory requirements. Given the focus and priority placed on addressing new requirements in modern codes and standards and the processes in place to address equipment condition, the first level of defence continues to be strong and effective for Darlington NGS.

- The assessment of Defence-in-Depth Level 2 confirmed that the provisions in place at Darlington NGS are mature and robust. Implementation of measures to ensure compliance with modern requirements for inspections and maintenance, and improvements to the Deterministic and Probabilistic Safety Assessments, further enhance the Level 2 barrier at Darlington NGS.

- The assessment of Defence-in-Depth Level 3 confirmed that effective provisions for the control of accidents within the design basis are provided at Darlington NGS. Operators have indications and alarms, as well as the capability to perform actions from the Main Control Room and Secondary Control Areas, for this purpose. The review confirmed that Darlington NGS has strong Level 3 barriers due to the high quality of the design, supported by a robust set of safety analyses which is further enhanced through the implementation of CNSC REGDOC-2.4.1, *Safety Analysis – Deterministic Safety Analysis*, and best practices from CSA N290.17-17, *Probabilistic Safety Assessment for Nuclear Power Plants*.

- The assessment of Defence-in-Depth Level 4 confirmed that Darlington NGS has additional design features and procedural provisions which are in place and are adequate to address severe accident conditions. Darlington NGS Units 1-4 have complementary design features for Beyond Design Basis Accidents (BDBA). Operating Manuals and Abnormal Incident Manuals include Emergency Mitigating Equipment Guidelines to prevent accident progression. Severe Accident Management Guidelines (SAMG) for mitigating accident progression in the very unlikely event of a BDBA have been implemented. Furthermore, a mature emergency response infrastructure is in place, and the requisite qualified staffing and expertise are maintained. A significant number of improvements have been implemented since initial operation specifically to reinforce Defence-in-Depth Level 4. Nonetheless, OPG as a learning and continuous improvement organization, continues to evaluate industry OPEX, best practices, and recommendations in order to identify opportunities for improving their accident management capabilities.

- The assessment of Defence-in-Depth Level 5 confirmed that extensive plans and procedures are in place at Darlington NGS to ensure capability and readiness to respond to a nuclear emergency, with the support of a coordinated effort from various response organizations. The implementation of SAMG, post-accident monitoring capability, installation of Containment Filtered Venting System, and implementation of OPEX from Fukushima have also significantly improved the existing robust barriers for the Defence-in-Depth Level 5.

The Defence-in-depth assessment concluded that Darlington NGS Units 1-4 design and operation have effective barriers in all levels of Defence-in-Depth and that significant enhancements have been implemented since the plant was put into service.

Proposed resolution plans were developed to address the 23 global issues with consideration of safety benefit and practicability. The proposed resolution plans for each of the 23 global issues consisted of the following Resolution types:

- Resolution Statement: An activity intended to address the global issues. There were 35 resolution plans categorized as Resolution Statements covering 10 global issues (some global issues had more than one Resolution Statement).
- No Further Action: Activities which had already been completed or had actions already underway outside of D-PSR to address the related GI or where information had been found that addressed the global issues have been categorized as requiring No Further Action within the D-PSR. 21 proposed resolution plans were categorized as No Further Action during the global assessment.
- Acceptable Deviation: The global assessment categorized proposed resolutions as acceptable deviations when it was determined that the proposed resolution had Low/Very Low Safety Significance or when practicable resolutions were not readily evident. 13 proposed resolution plans were categorized as acceptable deviations during the global assessment. There were 209 D-ISR Issues classified as acceptable deviations in the previous ISR, of which 143 acceptable deviations were identified as applicable to D-PSR. In addition, 13 D-PSR Gaps were classified as acceptable deviations. In total, 156 acceptable deviations from D-ISR and D-PSR were considered for their aggregate impact on Darlington NGS design and operation in support of the Defence-in-Depth Assessment.
- Cross-Reference: The global assessment categorized proposed resolutions that were covered by another resolution as Cross-Reference. Five proposed resolution plans were categorized as Cross-Reference during the global assessment.

The global assessment process resulted in 10 global issues that have 35 proposed Resolution Statements with a defined activity. The resolution plans associated with the remaining 13 global issues do not have Resolution Statements and fit into one of the other categories defined above. Resolution Actions were developed by senior industry experts, meeting with responsible OPG area experts, to define completion and success criteria. When complete, these Resolution Actions will address the associated Resolution Statement. Actions were independently reviewed and approved by OPG senior leadership, to ensure that actions would satisfy the completion criteria and success criteria, and that implementation timelines would be met by responsible Action Owners. The Resolution Actions, and their supporting IIP Actions, form the scope of the D-PSR IIP, NK38-REP-03680-11940.

Of the 35 Resolution Statements, 25 have been excluded from the D-PSR IIP because they are either already being tracked in the D-ISR IIP, NK38-REP-03680-10185, covered by an existing action, or were completed following the finalization of the D-PSR GAR. The D-PSR IIP provides the rationale for excluding the 25 Resolution Statements. The remaining 10 Resolution Actions, and the supporting 17 IIP Actions, which define the scope of the D-PSR IIP are scheduled with target completion dates ranging from Q4 of 2023 to Q4 of 2028. The status and progress of the Resolution and IIP Actions is reported to the CNSC annually in IIP progress reports. The latest progress report for the D-ISR IIP, NK38-REP-03680-10185, was submitted in February 2024 (Reference 3.3-2).

3.4 Isotope Irradiation Program

Darlington NGS Power Reactors are utilized to support the radioisotope industry in both the medical and food safety fields.

Darlington NGS Power Reactors' reliability, high neutron flux, online fueling and capacity to produce isotopes in high quantities make power reactors an ideal source of neutrons for large scale radioisotope production. The predictable and reliable nature of Darlington NGS Power Reactors enables dependable supply for isotope markets and provides opportunity to expand offerings to new isotope markets.

OPG, and its family of companies, produce isotopes by leveraging reactor neutrons. The reactor cores are analyzed to be safe in this configuration and processes and procedures are in place to ensure safe handling and hand-off of the resultant isotopes to OPG's strategic partners.

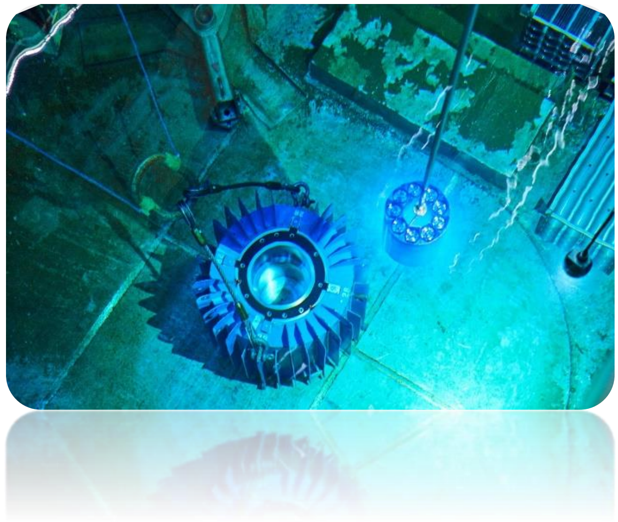
Darlington NGS's support for safe production of isotopes includes the planned production of Cobalt-60 (Co-60), Molybdenum-99 (Mo-99), and Yttrium-90 (Y-90) and there is potential for additional growth in this fast-changing and life-saving field.

Results and Planned Improvements

With scientific advancements in medical and industrial sectors, OPG is investing in innovative technologies to expand isotope production capabilities into valuable resources that benefit our society.

Cobalt-60 (Co-60)

In April 2023, OPG submitted an application to the Commission to amend the Darlington NGS PROL in order to produce Co-60, an isotope used in medical device sterilization and in food production (Reference 3.4-1). About 40% of the world's single-use medical devices, such as syringes, gloves, implants and surgical instruments, are irradiated and sterilized with Co-60. Similar to its use in sterilizing medical devices, Co-60 is useful in sterilization of food products, removing pathogens and parasites. Pending the Commission's decision by summer 2024, Co-60 production is planned to start with the initial harvest expected in 2028.



Molybdenum-99 (Mo-99)

In October 2021, the Darlington NGS PROL was amended to authorize OPG to possess, transfer, process, package, manage and store Mo-99 radioisotope and its associated decay isotopes. As of Q3 2022, OPG completed installation activities during the Unit 2 planned outage following the removal of the two Regulatory Hold Points. In 2024, OPG continues to progress with commissioning activities, with support from its wholly owned subsidiary and its strategic business partner, utilizing the Target Delivery System (TDS) to facilitate production of Mo-99 in Darlington NGS Unit 2. The unique design of the Darlington NGS's CANDU reactors allows for Mo-99 to be harvested from Darlington NGS without interrupting the generation of clean energy. Commercial operation is targeted to commence in Q3 2024 making Darlington NGS the first commercial-scale reactor in North America to produce Mo-99, securing a stable domestic supply of this isotope.

Mo-99 is valuable because its daughter isotope, technetium-99m, is the most widely used radioisotope in the world. It is used in 80% of all nuclear medicine imaging procedures to help diagnose cancer, heart disease and other ailments.

The OPG documents in the table below require written notification of change per Darlington NGS Licence Conditions Handbook, LCH-PR-13.03/2025-R005:

Table 30: Mo-99 Isotope Irradiation Program

Document	Title
NK38-OM-30550	Darlington Operating Manual – Target Delivery System (TDS)
NK38-MMP-30550-13	Target Delivery System Flask Hoisting and Handling Procedure
N-REP-03500-0839983	Integrated Nuclear Safety and Operational Assessment of the Target Delivery System in Darlington

Yttrium-90 (Y-90)

On February 26, 2024, OPG submitted an application to the Commission to amend the Darlington NGS PROL in order to produce the radioisotope Y-90 (References 3.4-2 and 3.4-3). Utilizing the TDS, Y-90 is planned to be harvested from Darlington NGS.

Pending the Commission’s decision, Y-90 production is expected to begin by mid-2025 and the irradiated Y-90 will be sent to the vendor’s facility to package and distribute to more than 30 countries globally for use in minimally invasive, targeted radiation therapy to destroy cancer cells and shrink tumors.

Overall, the reliability of Darlington NGS’s CANDU reactors and expanding the breadth of ways that isotopes can be generated will be a key component to strengthening the radioisotope supply chain for the coming decades.

4.0 Additional Matters of Regulatory Interest

This section addresses the requirements and/or of the following regulations made under the NSCA:

- General Nuclear Safety and Control Regulations, paragraphs 3(1)(l) and (m), and sections 29 to 32;
- Class I Nuclear Facilities Regulations, paragraph 3(j);
- Canadian Nuclear Safety Commission Cost Recovery Fees Regulations;
- CNSC REGDOC-3.2.2, *Aboriginal Engagement*.

4.1 Environmental Assessment

OPG undertook an Environmental Assessment (EA) under the *Canadian Environmental Assessment Act* for the mid-life refurbishment of the four Darlington NGS reactors and continued operation of the plant to approximately 2055, NK38-REP-07730-10002, *Environmental Impact Statement Darlington Nuclear Generation Station Refurbishment and Continued Operation*.

The Environmental Impact Statement (EIS) and its 15 associated Technical Supporting Documents (TSDs) for the EA were submitted to the CNSC in 2011 (Reference 4.1-1). The EA concluded that refurbishment and continued operation of Darlington NGS, taking into account mitigation measures, was not likely to cause significant adverse environmental effects. This conclusion was confirmed in the CNSC's Record of Proceedings, Including Reasons for Decision (Reference 4.1-2).

In 2013, OPG applied for the renewal of Darlington NGS' operating licence, including refurbishment (Reference 4.1-3), and provided an addendum to the original application for renewal in 2015 (Reference 4.1-4), the current licence was granted.

Mitigation and Follow-up Activities

Follow-up and monitoring program activities were identified in the EA to verify that the environmental effects of refurbishment and continued operations are as predicted, and to confirm that the proposed mitigation measures are effective (and thus determine if additional or new mitigation measures are required).

The mitigating measures and follow-up program activities were included in the scope of the Darlington NGS Integrated Implementation Plan (IIP) and are also being tracked through this plan, NK38-REP-03680-10185, *Darlington NGS Integrated Implementation Plan,* (Reference 4.1-5).

With respect to mitigation (in-design and additional mitigation), six of the nine actions have been completed in their entirety and the remaining three are on track for completion. The six completed actions relate to:

- Offsetting for fish impingement and entrainment losses (IIP-EA-001).
- Demonstrating that the implementation of good industry management practices are effective in minimizing air/soil/water quality effects on humans and biota (IIP-EA-002).

- Reducing traffic disruption during peak periods and maintaining safe traffic conditions both on-site and off-site during the Refurbishment phase (IIP-EA-003).
- Monitoring and consulting municipalities on land-use policies and future developments proposed in the vicinity of the Darlington NGS site with focus on sensitive land uses (e.g. hospitals, schools) which may result in incompatible uses and effects on implementation of the emergency plans (IIP-EA-004).
- Protecting and avoiding the potential Van Camp cemetery which has potential archaeological and cultural heritage resource interest (IIP-EA-007); and
- Maintaining emergency response procedures to protect the health and safety of people and the environment in the context of specific Accident & Malfunctions scenarios (IIP-EA-008).

The following three mitigation actions remain open, though certain elements of each have been completed:

- IIP-EA-005 (Socio-Economics) relates to informing neighbours and the public of the refurbishment project and on-going activities of the Darlington NGS operations. This includes annual activities from 2014 to 2025.
- IIP-EA-006 (Socio-Economics) relates to minimizing the disruption of recreation facilities and amenities on the Darlington NGS site, which includes maintaining public access to the Waterfront Trail. This will include undertaking a Recreational User Survey of the Darlington NGS site recreation facilities for two seasons in one year after the restart of all reactors and reviewing the survey results. These activities are anticipated to be completed in 2026.
- IIP-EA-009 (Accidents & Malfunctions) relates to design modifications for various systems. The open item is for the provision of an alternate and independent supply of water to the primary heat transport system. This is anticipated to be completed by 2026 (based on each unit's refurbishment outage restart).

Three of six EA follow-up activities have been completed in their entirety. These relate to:

- Characterizing the conventional chemical (i.e., non-radiological) parameters present in Darlington NGS effluent streams (IIP-EA-010);
- Confirming the effectiveness of mitigation measures to protect stormwater quality in the area subject to refurbishment activities (i.e., Protected Area) (IIP-EA-011); and,
- Confirming the liquefaction potential of foundation materials in the Protected Area is acceptably low (IIP-EA-015).

The following three EA follow-up program activities remain open, though certain elements of each have been completed:

- IIP-EA-012 (Aquatic) relates to confirming the accuracy of the predictions made in the EA concerning changes in lakewater temperatures in the vicinity of the Condenser Cooling Water (CCW) discharge, and their associated possible effects on survival rates for round whitefish embryos. The open activities for this IIP objective are to (1) conduct thermal monitoring after the restart of all reactors (continued operations phase), and (2) report on monitoring data collected during continuous operations and assess the likely effects on the survival of round whitefish embryos. These activities are anticipated to be completed by 2027.

- IIP-EA-013 (Aquatic) relates to impingement and entrainment, including characterizing early life stages of fish and macro invertebrates being entrained and fish impinged by station operations, monitoring at a level capable of detecting fish Species at Risk and aquatic species of conservation concern, and determining the total fish and macro invertebrate losses and associated impact. An entrainment study assessing impacts to fish and macro invertebrates was conducted in 2015 prior to refurbishment with the submitted report reviewed and approved by the CNSC and Fisheries and Oceans Canada (DFO). The open activities for this IIP objective are incorporated into OPG's amended Fisheries Act Authorization (FAA) for Darlington NGS (Reference 4.1-6). The combined IIP and FAA open activities are to prepare a sampling plan for fish impingement and entrainment in 2026, conduct associated 24-month impingement monitoring in 2027 and 2028, and entrainment monitoring in spring 2027- spring 2029, and submit a report to DFO (copied to the CNSC) documenting the findings of each study by March 31, 2030.
- IIP-EA-014 (Accidents & Malfunctions) relates to updating the station Probabilistic Risk Analysis (PRA) to confirm that the assignment of probabilities appropriately represents the Safety Improvement Opportunity (SIO) changes. The anticipated completion date of this action is 2026.

For information on OPG's comprehensive environmental protection programs, including monitoring through existing programs, refer to Section 2.9.3.

4.2 Indigenous Engagement

OPG is directed by a corporate wide Indigenous Relations policy that provides a framework for meaningful engagement with Indigenous Nations and communities and for the support of community programs and initiatives through its Corporate Citizenship Program.

The purpose of the policy is to work with Indigenous Nations and communities proximate to Darlington NGS and those that express interest in our operations at Darlington NGS. Engagement includes dialogue on Darlington NGS-related plans and activities, eliciting feedback and fostering opportunities through partnership and collaboration.

OPG is committed to engaging with Indigenous Nations and communities regarding nuclear operations and future projects. OPG's Indigenous Relations Policy provides a framework for engaging with Indigenous peoples and providing support for community programs and initiatives while respecting Aboriginal and Treaty rights which are recognized and affirmed under s.35 of Constitution Act, 1982. OPG also takes guidance from the CNSC, as outlined in REGDOC-3.2.2, that provides information for licensees on carrying out Indigenous engagement activities.

4.2.1 Power Reactor Operating Licence (PROL) Renewal and Duty to Consult

From OPG's perspective, the continued operation of Darlington NGS does not create any new adverse impacts on Aboriginal and/or Treaty rights held by local Indigenous Nations and communities but does extend the known impacts and the ongoing mitigation efforts. OPG is committed to continue working with Indigenous Nations and communities to inform OPG's understanding of how activities carried out under a renewed PROL may impact Aboriginal and/or Treaty rights and address those impacts, as appropriate.

OPG is committed to meaningful engagement, building awareness of Indigenous perspectives and knowledge, and while the Duty to Consult has not been formally delegated by the Crown, OPG endeavours to meet the standard of meaningful consultation and engagement. Meaningful engagement takes time and investment of resources, and OPG is committed to working with the Indigenous Nations and communities to develop culturally reflective frameworks and respectful protocols that incorporate the unique priorities, and capacity needs of each Nation.

Engagement on Darlington NGS PROL renewal is focused on the Williams Treaties First Nations (WTFN) in whose Treaty and traditional territory Darlington NGS is located, as well as other Indigenous Nations and communities that express an interest. Over the course of OPG's engagement with the WTFN, the perspective that all life is connected has been shared and has helped frame OPG's approach to understanding various plant and animal species – particularly those that are viewed as "invasive species" by the western world. Gleaning Indigenous Knowledge is a privilege that is earned through meaningful relationship building, and it is gradually shared as trust is developed. OPG respects the principles of ownership, control, access, and possession (OCAP)® and works to ensure that any data and information shared with OPG remains under the control of the Indigenous Nation or community that provided it. OPG continues to engage with the rightsholders surrounding Darlington NGS to build an understanding of Indigenous Knowledge, values, and worldviews to better understand how Indigenous perspectives can be incorporated into methodologies and practices. Through these engagements, OPG aims to not only share information on our operations but to develop awareness of the potential impacts on the Aboriginal and Treaty rights of the Indigenous Nations and communities, as well as ways to avoid, mitigate and/or accommodate those impacts, as required.

As was committed to during the License to Construct Hearing #1 in January 2024, OPG will support the development of an Indigenous Knowledge Study (IKS), led by WTFN members Mississaugas of Scugog Island, Curve Lake, Hiawatha and Alderville. The initial focus will be on the Darlington New Nuclear Project area and will extend to Darlington and Pickering NGS, and in time, to WTFN shared and treaty territory. This IKS will also help to inform OPG regarding cumulative effects of nuclear development in the territory as well as a Rights Impact Assessment and an enhanced monitoring program featuring WTFN participation.

OPG has established Framework Agreements with the Curve Lake First Nation, Hiawatha First Nation, the Mississaugas of Scugog Island First Nation, the Six Nations of the Grand River, and as of April 2024, with Alderville First Nation. The framework agreements allow for dedicated time and capacity funding to support ongoing, regular engagement on OPG's nuclear and renewable generation operations. Where a need for capacity support is identified to support project-specific engagement, OPG is open to exploring options.

In addition to the Indigenous Nations and communities noted above, Darlington NGS has provided PROL renewal information and invited the following Indigenous Nations and communities to engage on OPG's licence renewal application and any other engagement opportunities of interest:

- Rama First Nation;
- Beausoleil First Nation;

- Georgina Island First Nation;
- Métis Nation of Ontario Region 8;
- Missisaugas of the Credit First Nation;
- Mohawks of the Bay of Quinte;
- Kawartha Nishnawbe.

4.2.2 Indigenous Community Meetings

OPG engages with the Indigenous Nations and communities with whom there are established Framework Agreements on a regular basis to discuss station operations, environmental reporting, employment/procurement opportunities and other topics viewed as priorities by the communities. For those Nations and communities with whom there are no established agreements, OPG shares information and is open to engaging as requested and as interest and schedules allow.

Darlington NGS PROL specific Indigenous Engagement - August 2023 to February 2024:

- All Indigenous Nations and communities identified were provided with initial information regarding the Darlington NGS PROL Renewal and the offer to have further discussions and engagement was extended in December 2023.
- Introductory Darlington NGS PROL Renewal Presentation and discussion meetings occurred with Curve Lake and Hiawatha First Nation (August 10, 2023) and Mississaugas of Scugog Island First Nation (August 22, 2023).
- In September 2023, representatives from OPG's Darlington relicensing team were invited and spent the day with representatives and Elders from Curve Lake First Nation.
- Update meetings on the Darlington NGS PROL Renewal process were held with Curve Lake First Nation and Hiawatha First Nation on October 24, 2023 and January 23, 2024; and with Mississaugas of Scugog Island First Nation on February 8, 2024.

The information sharing and preliminary engagement that has occurred to date has generated productive discussions about the PROL application, including the early identification of interests and concerns from Indigenous Nations and communities. In consideration of the interests and concerns OPG has heard to date, OPG's immediate next steps include the circulation of the Draft Darlington NGS PROL Relicensing Indigenous Engagement Plan to identify Indigenous Nations and communities. OPG welcomes Indigenous Nations and communities' review and input, so that the approach can be tailored to best fit community needs and interests.

OPG acknowledges that there are multiple ongoing and proposed activities that OPG is requesting Indigenous Nations and communities' engagement on, amongst requests from other proponents and regulators. OPG has also heard the importance of establishing an engagement framework after a licensing decision is made. OPG is steadfast in its commitment to supporting meaningful engagement during and after the licencing application process and will work in collaboration with Indigenous Nations and communities to identify approaches to engagement that is considerate of the engagement context and the interests of each Indigenous Nation and community.

As engagement continues, there will be upcoming opportunities for site visits, workshops and information sessions will be extended, or as interest is expressed by Indigenous Nations and communities.

OPG will endeavor to respond to any questions, concerns or comments from Indigenous Nations and communities, and intends to continue and improve upon its engagement activities supported by existing and future Framework Agreements, as well as the PROL renewal Indigenous Engagement Plan.

4.2.3 Commitment to Reconciliation

OPG is committed to taking concrete and measurable actions to advance reconciliation with Indigenous peoples and to report regularly on the company's activities and progress in achieving established goals.

In the fall of 2021, OPG launched the Reconciliation Action Plan (RAP), which outlined the commitment to advancing reconciliation with Indigenous peoples under the pillars of leadership, relationships, people, economic empowerment, and environmental stewardship. The RAP is a public document that serves as a roadmap to reconciliation and the 2021 edition included 38 specific actions and commitments with clear deliverables and timelines spanning between 2022 and 2031. An annual report was published in the fall of 2022 which noted that the first-year goals were achieved through much work, dedication, and collaboration with communities.

The RAP is being updated and published in Q2 2024 with over 20 new commitments that were developed through internal discussions and input from Indigenous Nations, communities, and businesses. Included in the RAP update, will be a report on our 2023 results, including:

1) 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.
2) 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.
3) 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).
4) In 2022, OPG's Supply Chain mandated criteria for Indigenous content on supplier bids and awards higher scores to businesses that can demonstrate positive Indigenous relations (employment and business partnering).
5) In 2023, OPG created an Indigenous Engagement Vendor Scorecard in collaboration with Mississaugas of Scugog Island and Curve Lake First Nations. This scorecard identifies criteria for vendors to meet in the areas of Indigenous procurement, capacity building, Indigenous employment, and cultural training, with points awarded according to defined performance metrics.
6) The Indigenous Circle is an Employee Resource Group (ERG) that provides an internal network for Indigenous employees of OPG. Established in 1992, the Indigenous Circle promotes awareness about the diversity of Indigenous people both

within OPG and externally through involvement in special events, career fairs, and other programs. Annually in June, the Indigenous Circle hosts National Indigenous Peoples Day celebrations across OPG sites. Between 2021 and 2024, OPG partnered with INDspire's Building Brighter Futures Program on the John Wesley Beaver Memorial Scholarship, resulting in 20 awards of $10,000 each offered to Indigenous post-secondary students across Ontario. OPG also hosts events to commemorate National Day for Truth and Reconciliation and Treaty Week and all staff are invited to participate, learn, and build their awareness of Indigenous culture and how to demonstrate reconciliation.

7) OPG is actively seeking input from the 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.

8) OPG leadership encourages and supports staff to engage with and visit Indigenous Nations and communities to gain firsthand knowledge and develop relationships. For example, throughout the summer of 2023, OPG staff were present at the various pow wows held in various First Nations. Further, in the fall of 2023 OPG staff had the privilege of visiting Curve Lake First Nation and the Petroglyphs Provincial Park to participate in a community tour and deepen their understanding of the local culture and values and OPG staff were invited to attend and participate in two Harvester's Symposiums held by Curve Lake First Nation, where community members were in attendance and information was made available about OPG's nuclear operations.

4.3 Financial Guarantee, Nuclear Liability Insurance and Cost Recovery

Financial Guarantee

The objective of OPG's financial guarantee is to ensure that sufficient funds are estimated, collected, and administered for the management of liabilities associated with operating and decommissioning of all its nuclear facilities. The financial guarantee is prepared for all OPG owned or leased facilities and makes specific financial provisions for the decommissioning of the Darlington NGS. The Darlington NGS preliminary decommissioning plan, NK38-PLAN-00960-10001, *Darlington Site Preliminary Decommissioning Plan* forms the basis for establishing and maintaining an acceptable Financial Guarantee.

In addition to the decommissioning program, OPG's Financial Guarantee also covers financial provisions for the long-term management (storage and eventual disposal) of all operational and decommissioning wastes (Used Fuel, Low Level Waste, and Intermediate Level Waste).

OPG's financial guarantee is prepared and maintained on a 5-year cycle in accordance with the requirements set out in CSA Standard N294, *Decommissioning of facilities containing nuclear substances* and CNSC Regulatory Document, REGDOC 3.3.1, *Financial Guarantees for Decommissioning of Nuclear Facilities and Termination of Licensed Activities*. OPG also provides an annual financial guarantee report to the CNSC detailing the status of the guarantee including the amounts accumulated in segregated funds and the value of the Provincial guarantee (when required). The report compares the amount of the liabilities and the financial resources available to discharge the obligations.

The financial guarantee provisions for Darlington NGS demonstrate that the current level of funding is adequate for decommissioning the station and returning the site to an end state agreed with the Regulators. CNSC access to these funds is provided by the *CNSC Financial Security and Ontario Nuclear Funds Agreement Access Agreement* between the CNSC, OPG and the Province of Ontario, and, as required, the *Provincial Guarantee Agreement* between the CNSC and the Province of Ontario. In December 2022, the Commission accepted OPG's proposed 2023-2027 consolidated financial guarantee as documented in Record of Decision DEC 22-H104 in Reference 4.3-1.

OPG will continue to provide annual Financial Guarantee reports to the CNSC detailing the status of the guarantee, including the amounts accumulated in segregated funds.

Nuclear Liability Insurance

OPG is required, under the Nuclear Liability and Compensation Act (NLCA), to maintain financial security in an amount equal to $ 1 billion for its Darlington NGS in 2024. The following four figures provide certificates of insurance that verifies the financial security OPG has secured as required by the NLCA for 2024.

Marsh

Certificate of Insurance

No.: **2024-4** Dated: **February 29, 2024**

This document supersedes any certificate previously issued under this number

This is to certify that the Policy(ies) of insurance listed below ("Policy" or "Policies") have been issued to the Named Insured identified below for the policy period(s) indicated. This certificate is issued as a matter of information only and confers no rights upon the Certificate Holder named below other than those provided by the Policy(ies).

Notwithstanding any requirement, term, or condition of any contract or any other document with respect to which this certificate may be issued or may pertain, the insurance afforded by the Policy(ies) is subject to all the terms, conditions, and exclusions of such Policy(ies). This certificate does not amend, extend, or alter the coverage afforded by the Policy(ies). Limits shown are intended to address contractual obligations of the Named Insured.

Limits may have been reduced since Policy effective date(s) as a result of a claim or claims.

Certificate Holder:	**Named Insured and Address:**
Canadian Nuclear Safety Commission Headquarters 280 Slater Street P.O.Box 1046 Station B Ottawa, ON K1P 5S9	**Ontario Power Generation Inc. 700 University Avenue, H18-J18 Toronto, ON M5G 1X6**

This certificate is issued regarding:
Darlington Nuclear Generating Station

Type(s) of Insurance	Insurer(s)	Policy Number(s)	Effective/ Expiry Dates	Sums Insured Or Limits of Liability	
NUCLEAR LIABILITY	Nuclear Risk Insurers Limited - Licensed	L18CAN2099/2024	Jan 01, 2024 to Jan 01, 2025	Limit of Liability	CDN 600,000,000 45% of total limit of liability

Notice of cancellation:
The insurer(s) affording coverage under the policies described herein will not notify the certificate holder named herein of the cancellation of such coverage.

Marsh Canada Limited
120 Bremner Boulevard
Suite 800
Toronto, ON M5J 0A8
Telephone: (647)-3543154
Fax: -
[redacted]

Marsh Canada Limited

By: [redacted]

Figure 35: Nuclear Liability Insurance – Marsh – Certificate of Insurance

Marsh

Certificate of Insurance

No.: **2024-5** Dated: **March 01, 2024**

This document supersedes any certificate previously issued under this number

This is to certify that the Policy(ies) of insurance listed below ("Policy" or "Policies") have been issued to the Named Insured identified below for the policy period(s) indicated. This certificate is issued as a matter of information only and confers no rights upon the Certificate Holder named below other than those provided by the Policy(ies).

Notwithstanding any requirement, term, or condition of any contract or any other document with respect to which this certificate may be issued or may pertain, the insurance afforded by the Policy(ies) is subject to all the terms, conditions, and exclusions of such Policy(ies). This certificate does not amend, extend, or alter the coverage afforded by the Policy(ies). Limits shown are intended to address contractual obligations of the Named Insured.

Limits may have been reduced since Policy effective date(s) as a result of a claim or claims.

Certificate Holder:	Named Insured and Address:
Canadian Nuclear Safety Commission Headquarters **280 Slater Street P.O.Box 1046 Station B** **Ottawa, ON K1P 5S9**	**Ontario Power Generation Inc.** **700 University Avenue, H18-J18** **Toronto, ON M5G 1X6**

This certificate is issued regarding:
Darlington Nuclear Generating Station : issued for ELINI (unlicensed carrier)

Type(s) of Insurance	Insurer(s)	Policy Number(s)	Effective/ Expiry Dates	Sums Insured Or Limits of Liability	
NUCLEAR LIABILITY	Euro Liab. Ins for the Nuc. Ind. (ELINI)	24EL/0036	Jan 01, 2024 to Jan 01, 2025	Limit of Liability	CDN 270,000,000

Notice of cancellation:
The insurer(s) affording coverage under the policies described herein will not notify the certificate holder named herein of the cancellation of such coverage.

Marsh Canada Limited
120 Bremner Boulevard
Suite 800
Toronto, ON M5J 0A8
Telephone: (647)-3543154
Fax: -
[redacted]

Marsh Canada Limited

By: [redacted]

Figure 36: Nuclear Liability Insurance – Marsh – Certificate of Insurance

NIAC | NUCLEAR INSURANCE ASSOCIATION OF CANADA

401 Bay Street, Suite 1600, Toronto, ON Canada M5H 2Y4

CERTIFICATE OF INSURANCE

This is to certify to: Canadian Nuclear Safety Commission
280 Slater Street P.O. Box 1046 Station B, Ottawa, ON, K1P 5S9

The policies of insurance as herein described have been issued to the Insured named below and are in force at this date.

Name of Insurer:	**Name and Address of Insured:**
Nuclear Insurance Association of Canada 401 Bay St., Suite 1600 Toronto, ON M5H 2Y4	Ontario Power Generation Inc. and its subsidiaries 700 University Ave., Toronto, ON M5G 1X6

TYPE OF INSURANCE	LIMITS OF LIABILITY	DEDUCTIBLE	POLICY NUMBER	POLICY PERIOD*
Nuclear Energy Liability Policy Operators Form No. 610 (1016) - Darlington Nuclear Generating Station (Power Reactor Class) - Claims Expense Form No. 620 (04/16)	$330,000,000 $33,000,000	Nil	OF105	Jan.1, 2024 to Jan. 1, 2025, 12:01 AM Standard Time at the Location of the Insured

*NIAC Operators Form is continuous until cancelled. Policy Period refers to the current annual continuation certificate in force.

The insurance afforded is subject to the terms, conditions and exclusions of the applicable policy. This Certificate is issued as a matter of information only and confers no rights on the holder and imposes no liability on the Insurer. The Insurer will endeavour to mail to the holder of this Certificate 30 days' written notice of any material change in or cancellation of these policies but assumes no responsibility for failure to do so.

The Nuclear Insurance Association of Canada's collective liability is limited to **55.0000%** of the Limit of Liability of $600,000,000 under Operators Form No. 610 (1016) and $60,000,000 under Claims Expense form No. 620 (04/16).

Issued at: Toronto, Ontario

NUCLEAR INSURANCE ASSOCIATION OF CANADA

[redacted]

Dated: March 1, 2024

Authorized Representative

Figure 37: Nuclear Liability Insurance – NIAC – Certificate of Insurance

Northcourt
Nuclear Risk Specialists
An Optio company

CERTIFICATE OF INSURANCE

This is to certify to: Canadian Nuclear Safety Commission

280 Slater Street P.O. Box 1046 Station B, Ottawa, ON K1P 5S9

Name of Insurer	Name and Address of Insured
NORTHCOURT LIMITED The Bastions Office No. 2, Triq Emvin Cremona, Floriana FRN 1281, Malta	Ontario Power Generation Inc. and its subsidiaries 700 University Ave., Toronto, ON M5G 1X6

Type of Insurance	Nuclear Energy Liability Policy Operator's Form - Darlington Nuclear Generating Station (Power Reactor Class)	Policy No	NCNTPL56
Limit of Liability	CAD 1,000,000,000		
Deductible	Nil		
Policy period	1 January 2024 to 1 January 2025, both days 12:01AM Standard Time at the Location of the Insured		

Operator's Form is continuous until cancelled. Period refers to the current annual continuation certificate in force.

The insurance afforded is subject to the terms, conditions and exclusions of the applicable policy. This Certificate is issued as a matter of information only and confers no rights on the holder and imposes no liability on the Insurer. The Insurer will endeavour to mail to the holder of this Certificate 30 days' written notice of any material change in or cancellation of these policies, but assumes no responsibility for failure to do so.

Northcourt's liability is limited to **13.0000%** of the Limit of Liability (being CAD 130,000,000).

Issued at: London, UK

Dated: 01 March 2024

For and on behalf of Northcourt Limited

Signature [redacted]

Authorised Signatory

Northcourt Limited 1/3/24

UK: 10th Floor, 1 Minster Court, Mincing Lane, London, EC3R 7AA
MALTA: The Bastions Office No. 2, Triq Emvin Cremona, Floriana FRN 1281

Figure 38: Nuclear Liability Insurance – Northcourt – Certificate of Insurance

Cost Recovery

Pursuant to the *Canadian Nuclear Safety Commission Cost Recovery Fees Regulations*, the CNSC prepares a Regulatory Activity Plan for Class I nuclear facilities and calculates an estimated annual fee payable for that fiscal year using the estimated full cost of the plan. OPG pays the CNSC's fees on a quarterly basis.

4.4 Public Information and Disclosure Program

OPG recognizes that members of the public, stakeholder groups, and local communities have an interest in the Darlington NGS operations. This may include operations, licensing activities, health, safety and security of persons, employees and the environment.

OPG believes in open and transparent communication in a timely manner to maintain positive and supportive relationships and confidence of key stakeholders and the public. OPG's *Nuclear Public Information Disclosure and Transparency Protocol*, posted on OPG's website, describes our communication principles and information requirements and reporting.

The following OPG document requires written notification of change per Licence Conditions Handbook, LCH-PR-13.03/2025-R005:

Table 31: Licensee Public Information Program

Document	Title
N-STD-AS-0013	Nuclear Public Information and Disclosure

OPG's Corporate Relations and Communications organization adheres to standard N-STD-AS-0013, *Nuclear Public Information and Disclosure,* as it describes consistent standards and procedures for all public disclosure of both material and non-material information. Public information and disclosure involves the provision to inform, in a timely and transparent manner, accurate information to stakeholders and the public in the vicinity of OPG's nuclear facilities regarding events, activities and operations. The standard is a regulatory requirement developed in accordance with CNSC REGDOC-3.2.1 *Public Information and Disclosure.*

OPG's public information program has been recognized as a strength by national and international utility peers. To ensure continuous improvement, OPG will annually evaluate the effectiveness of N-STD-AS-0013 and implement findings. Strategies include:

- Interviews/focus groups/surveys with key stakeholders, community members, community groups/committees.
- Self-Assessments.
- Reviews of documentation/reports, including media coverage and Salesforce reports.
- Public opinion/opinion leader polling, research polling.
- Consultation with public and key stakeholders on a variety of Corporate Relations strategies including community and key stakeholder programming.

In addition, OPG continues to benchmark current practices amongst other industries.

The public information program proactively provides information to the public and stakeholders on Darlington NGS's operations.

The primary focus area for engagement activities, in addition to the public at large, includes two municipalities proximate to the Darlington NGS site including the host community (Clarington) and adjacent community within 10 km of the project (the City of Oshawa). The 10 km radius is consistent with the Darlington NGS *Detailed Planning Zone* for nuclear emergency planning purposes, an area where residents are most familiar with nuclear plant operations and regularly receive station information and operational updates.

OPG ensures the public and stakeholders with a potential interest in Darlington NGS operations and performance, are provided with relevant information and have the opportunity to share their views and perspectives. Information is communicated in a number of ways based on their interests and preferred means of communication.

Darlington NGS Stakeholders and audiences may include but are not limited to:

- Residents in the vicinity of the Darlington NGS and the public.
- Established community committees such as the Darlington Community Advisory Council and the Durham Nuclear Health Committee.
- Local businesses and business organizations, such as boards of trade and chambers of commerce.
- Private/public community organizations and special interest groups.
- Non-Governmental Organizations.
- Nuclear industry associations/organizations and regulatory bodies.
- Media.
- Federal, provincial, regional, and municipal agencies and officials with a regulatory role or project interest.
- OPG employees and retirees.

4.4.1 Communication Methods

Communication methods are the approaches and activities used to distribute information, and to solicit feedback and input. The methods employed are specific to the issues and matters that arise and include:

Advertisements and Letters: Public notifications are prepared and distributed to announce upcoming hearings and other licensing activities, via a press release (as required), stakeholder letter(s), web communications, the OPG community newsletter (Neighbours) and advertisements in local print media (as required).

Website: The OPG website is updated on a regular basis as new information becomes available. The website serves as a vehicle to provide access to information, as well as a mechanism to receive input from interested persons as an enhancement of the public outreach program.

Toll Free Information Line: The 1-800 toll free line for Darlington NGS continues to be maintained. Messages are checked and responded to on weekdays and any required follow-up is completed in a timely manner.

Media Relations: Ongoing liaison with respect to operations and licensing activities is initiated and maintained by OPG with reporters and news editors for both electronic and print media.

OPG Employee Communication Activities: The employee communication program includes articles written in OPG-wide and Darlington NGS-specific employee media. Staff presentations and information sessions are also held. In addition, an intranet site is maintained to facilitate communication with employees.

Key Stakeholder Briefings: Briefings are conducted to present information and provide an opportunity to have questions and comments addressed. Regular updates are presented to municipal representatives, established community committees including the Darlington and Pickering Community Advisory Committees, Durham Nuclear Health Committee, and other key stakeholders on a frequency commensurate with various activities and milestones. Feedback from these meetings is recorded for response and issues management.

Workshops: Key stakeholders with a high level of interest in operations or other station activities may be invited to participate in workshops that involve meaningful discussions with the opportunity to provide substantive input.

Public Information Sessions: Information sessions (in person or virtual) advertised broadly and open to any participants provide an opportunity to learn more about Darlington NGS and the licensing phases/activities and provide comments and/or have questions answered by members of the OPG team.

Information Centre: Darlington NGS continues to operate an information centre, as referenced below.

Social Media: OPG maintains a presence on social media (Facebook, Twitter, Linked In and Instagram) and shares information through these media.

4.4.2 Station Reporting

OPG regularly and proactively provides information to the public on its facility activities. For operational status changes or unscheduled operations that may cause public concern or media interest, OPG follows the *Public Information and Disclosure Protocol* to notify key community stakeholders in a timely manner as outlined in Section 4.4. The purpose of the protocol is to ensure contacts in the emergency agencies (fire, police, and emergency management) and local government organizations are kept aware and are able to respond accurately if they receive questions from constituents. OPG maintains a duty on-call organization 24 hours a day, seven days a week.

On a quarterly basis, OPG publicly posts performance reports on station operations on OPG's website and shares this document electronically with key stakeholders. Additionally, since 2014, OPG issues a quarterly Environment Report in an easy to read and understandable format.

4.4.3 Welcoming Visitors

Darlington NGS maintains an Information Centre to host public, community groups and students. Visitors can find information on operations, technology, future plans and current issues, and staff are available to have conversations and answer questions. Students are offered curriculum-based educational presentations, introductions to CANDU technology and STEM-based activities.

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

4.4.4 Community Outreach

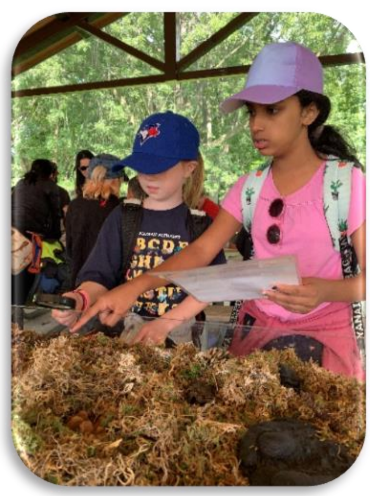
Outreach activities to interested groups and communities may include:

- Station tours, bus tours, presentations, reactor mock-up tours and virtual tours to community groups, key stakeholders, industry partners, students and the general public.

Community Power Expo at Darlington NGS

- Three times a year, OPG publishes a Neighbours Newsletter which is distributed to approximately 250,000 residents and businesses within 10 km of the Darlington and Pickering stations. The newsletter is posted on opg.com and distributed at community events.
- Annually, OPG hosts a Community Power Expo, which is widely advertised with a focus on the nearby community. Staff from OPG and various industry partners are present to answer questions and provide information to participants. In 2023 the annual event hosted more than 3,500 people from across the Durham Region.

Darlington NGS's Corporate Relations team continues to provide quality programs within our host communities. Our annual March Break and Tuesdays on the Trail programs reached thousands of community members throughout the winter and summer months.



4.4.5 Community Committees

OPG works with established local community committees on matters of interest and concerns related to our operations and projects. Updates on the status of licensing activities are provided to the committees.

- The Darlington Community Advisory Council meets regularly to exchange information with community leaders and local residents, who in turn provide advice to senior OPG staff on issues of environmental, economic and public concern.

- OPG has representatives on the Durham Nuclear Health Committee and OPG staff make regular presentations on a variety of environmental, community outreach and operational issues. This committee is chaired by the Durham Region Medical Officer of Health.

OPG meets often with stakeholder groups, elected officials, and municipal representatives, as well as with stakeholder groups that have an interest in nuclear, safety, energy, climate change, and/or environmental issues.

Community Responsibility

As the province's largest electricity generator, OPG had the responsibility to not only keep the lights on for families, hospitals and essential businesses during the COVID-19 pandemic, but also a social responsibility to do everything we could to help meet our communities' most vital health care needs. Throughout the pandemic, OPG provided essential support across the province, including donations of supplies to frontline healthcare workers and food distribution centres, among others.

4.4.6 Environmental Partnerships and Programs

Darlington NGS is committed to biodiversity work on OPG property and on public lands within the host communities. Darlington NGS's biodiversity program continues to provide plantings, pollinator gardens, and numerous other initiatives. Since 2000, OPG has planted more than 8.7 million trees throughout the province, and we continue to help create hundreds of acres of new grasslands and wetlands.

To further enhance local sustainability efforts, OPG has a long-standing partnership with Courtice Secondary School. Within this unique partnership, students work closely with OPG to support regional ecosystems and biodiversity through science-based habitat stewardship. Many projects including pollinator plantings, building of bee hotels, turtle rafts and bird nest boxes have been accomplished over the years.

Since 2011, OPG has been a lead partner in the Bring Back the Salmon program with the Ontario Ministry of Natural Resources, and the Ontario Federation of Anglers and Hunters. OPG's support contributes to all four pillars of the Bring Back the Salmon program but is weighted towards fish production. The program originally began at Pickering NGS, however Darlington NGS began participating in the program in 2019. Since then, each year, the Darlington NGS Information Centre houses a hatchery and partners with a local school as part of the program. In 2023, the five-month hands-on lesson on Atlantic Salmon and the biodiversity of the Lake Ontario watershed, introduced students and teachers to the Atlantic Salmon species, their history in Ontario, and the restoration efforts to bring back a healthy and self-sustaining population to Lake Ontario.

OPG's Nuclear Operations hold a Gold Level Conservation Certification from the Wildlife Habitat Council (WHC). This achievement recognizes the specific efforts of our biodiversity programs, which aim to protect and nurture species and their habitats wherever the company operates. The WHC certifies conservation programs on corporate lands around the world and promotes environmental management through various partnerships and education.

Community Recognition

- United Way Durham, Region McLaughlin Award – 2016;
- Community Care Durham, Corporate Leadership Award – 2016;
- Greater Oshawa Chamber of Commerce, Sustainability Award – 2019;
- Greater Oshawa Chamber of Commerce, Business Excellence Award – 2021;
- Whitby Chamber of Commerce, Business Achievement Award - Excellence in Governance Strategy Award – 2021;
- Whitby Chamber of Commerce, Business Achievement Award (50 + People) – 2021;
- City of Oshawa, Business Excellence Sustainability Award – 2023.

4.4.7 Employee Communications

The OPG Employee Communication division at Darlington NGS works to keep employees informed on station, fleet-wide company, and industry issues in a timely, accurate and consistent manner by working collaboratively with station leadership and staff to develop and implement strategic station-wide communications programs.

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

The Communications team develops annual communications strategies to support Darlington NGS's business plans and vision, major on-site projects, initiatives, and events. They include selected services and materials designed to achieve communication goals. This ensures consistent communications have a positive, long-term impact on workforce alignment and engagement using a reliable two-way information exchange by way of the supervisory chain and meaningful face-to-face communication with direct reports, as well as more informal and formal online information channels. Darlington NGS site communications anchor and reinforce key messages through multiple channels, including but not limited to face-to-face meetings, intranet websites, site-wide emails, in-station TV screens, and videos.

The team leads a number of initiatives throughout the year to measure and gauge the effectiveness of the strategies to promote a process of continual learning and improvement.

External evaluators and review teams continue to recognize the positive contributions of internal communications on the culture at Darlington NGS.

5.0 References

Section 1.0 References	
1.0-1.	OPG letter, B. Duncan to M. Leblanc, "Darlington NGS – Application for Renewal of Darlington Nuclear Generating Station Power Reactor Operating Licence 13.00/2014", December 13, 2013, CD# NK38-CORR-00531-16490.
1.0-2.	OPG letter, B. Duncan to M. Leblanc, "Darlington NGS – Additional Information in Support of Application for Renewal of Darlington's Power Reactor Operating Licence (PROL) 13.01/2015", January 30, 2015, CD# NK38-CORR-00531-17206.
1.0-3.	OPG letter, A. Grace to A. Mathai, "Darlington NGS – Response to CNSC Staff's Request for Implementation Plans or Justification for Identified Documents to be Guidance in the Darlington Licence Conditions Handbook", March 19, 2024, CD# NK38-CORR-00531-25234.
Section 2.2 References	
2.2-1.	OPG letter, S. Gregoris to D. Saumure, "Application to Amend the Darlington and Pickering Nuclear Generating Station Power Reactor Operating Licences, 13.03/2025 and 48.01/2028 Respectively", February 15, 2024, CD# N-CORR-00531-23826.
Section 2.4 References	
2.4-1.	OPG letter, W.M. Elliott to M. Santini and F. Rinfret, "OPG Safety Analysis Improvement and REGDOC-2.4.1 Compliance", July 11, 2014, CD# N-CORR-00531-06620.
2.4-2.	OPG letter, R.C. Morrison to P.A. Webster and T.E. Schaubel, "Progress Report on OPG Safety Report Improvement Activities, Part 3: Accident Analysis, Action Items: Pickering A 2007-4-17, Pickering B 2007-8-13 and Darlington 20071317", January 28, 2009, CD# N-CORR-00531-04435.
2.4-3.	OPG letter, D. Townsend to G. Frappier, "Progress Update on Category 3 CANDU Safety Issues – Implementation of Risk Control Measures", June 18, 2020, CD# N-CORR-00531-20185.
2.4-4.	CNSC letter, G. Rzentkowski to W.M. Elliott, "Re-categorization of CANDU Safety Issue PF12 - Channel Voiding during a Large Loss of Coolant Accident", May 17, 2013, e-Doc# 4137088, CD# N-CORR-00531-06187.
2.4-5.	CNSC letter, A. Viktorov to M.R. Knutson, "Darlington NGS - Application of the Composite Analytical Approach to Darlington Large Break Loss of Coolant Accident Analysis", February 27, 2023, e-Doc # 6979971, CD# N-CORR-00531-23605.
Section 2.5 References	
2.5-1.	CNSC letter, P.A. Webster and M. Santini to W.M. Elliott, "Design Codes and Standards Effective Dates for OPG Nuclear Fleet", June 22, 2012, eDoc# 3947068, CD# N-CORR-00531-05758.
Section 2.9 References	

2.9-1.	Fisheries and Oceans Canada letter, S. Eddy to R. Geofroy, "Amendment of Darlington Nuclear Generation Station 14-HCAA-01267-Notice of Amendment", October 27, 2023, CD# D-CORR-00539.4-00007.
Section 2.12 References	
2.12-1.	OPG letter, A. Grace to A. Mathai, "Darlington NGS – Response to CNSC Staff's Request for Implementation Plans or Justification for Identified Documents to be Guidance in the Darlington Licence Conditions Handbook", March 19, 2024, CD# NK38-CORR-00531-25234.
Section 3.3 References	
3.3-1.	CNSC letter, A. Mathai to A. Grace, "Darlington NGS – Periodic Safety Review (D-PSR) – CNSC Staff Acceptance of the Integrated Implementation Plan (IIP)", March 25, 2024, e-Doc# 7248767, CD# NK38-CORR-00531-25314.
3.3-2.	OPG letter, A. Grace and B. Vulanovic to A. Mathai, "Darlington NGS Refurbishment - Submission of 2023 Annual Integrated Implementation Plan (IIP) Progress Report and Request for Concurrence for the Associated Completion Declaration Forms", February 29, 2024, CD# NK38-CORR-00531-25196.
Section 3.4 References	
3.4-1.	OPG letter, R. Geofroy to D. Saumure, "Darlington NGS – Application for Darlington Nuclear Generating Station Power Reactor Operating Licence 13.03/2025 Amendment for Production of the Cobalt-60 Radioisotope", April 28, 2023, CD# NK38-CORR-00531-23462.
3.4-2.	OPG letter, A. Grace to D. Saumure, "Darlington NGS - Application for Amendment to the Darlington NGS Power Reactor Operating Licence 13.03/2025 for Additional Isotope Production", February 26, 2024, CD# NK38-CORR-00531-25141.
3.4-3.	OPG email, L. Moraru to M. Young, "Darlington NGS – Redacted Application for Amendment to the Darlington NGS Power Reactor Operating Licence 13.03/2025 for Additional Isotope Production", May 14, 2024, CD# NK38-CORR-00531-25215.
Section 4.1 References	
4.1-1.	OPG letter, D. Reiner and B. Duncan to P.A. Webster, "Proposed Refurbishment and Continued Operation of Darlington NGS Environmental Assessment – Submission of Environmental Impact Statement and Technical Support Documents", December 1, 2011, CD# NK38-CORR-00531-15720.
4.1-2.	CNSC letter, L. Levert to D. Reiner, "Record of Proceedings – Environmental Assessment on the Refurbishment and Continued Operation of the Darlington Nuclear Generating Station", March 14, 2013, e-Docs# 4105438, CD# NK38-CORR-00531-16265.
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4.1-4.	OPG letter, B. Duncan to M. Leblanc, “Darlington NGS - Additional Information in Support of Application for Renewal of Darlington's Power Reactor Operating Licence (PROL) 13.01/2015”, January 30, 2015, CD# NK38-CORR-00531-17206.
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4.1-6.	Fisheries and Oceans Canada letter, S. Eddy to R. Geofroy, “Amendment of Darlington Nuclear Generation Station 14-HCAA-01267-Notice of Amendment”, October 27, 2023, CD# D-CORR-00539.4-00007.
Section 4.3 References	
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Appendix A: Commonly Used Acronyms

Acronym	Word
AAs	Adjuster Assemblies
ABFP	Auxiliary Boiler Feed Pump
ACU	Air Cooling Unit
ADL	Administrative Dose Limits
AIA	Authorized Inspection Agency
AIMs	Abnormal Incident Manuals
AIR	Accident Injury Rate
AL	Action Level
ALARA	As Low as Reasonably Achievable
AMP	Aging Management Plan
ANDE	Advanced Non-Destructive Evaluation
ANO	Authorized Nuclear Operator
ANSO	Armed Nuclear Security Officers
AOO	Anticipated Operational Occurrences
APCI	Annual Plant Condition Inspection
ARRR	Annual Risk and Reliability Report
ASB	Auxiliary Security Building
ASDC	Auxiliary Shutdown Cooling
ASR	Accident Severity Rate
ASTGMS	Automated Source Term Gamma Monitoring System
ASU	Aerial Support Unit
ASW	Auxiliary Service Water
BDBA	Beyond Design Basis Accident
BDBE	Beyond Design Basis Earthquake
CA	Condition Assessment
CANDU	CANada Deuterium Uranium
CAS	Central Alarm Station
CBOP	Continuous Behavioral Observation Program
CC	Corrective Critical
CC/CN	Corrective Critical and Non-Critical
CCW	Condenser Cooling Water
CEA	Cyber Essential Assets
CEFSD	Clarington Emergency and Fire Services Department
CEO	Chief Executive Officer
CFAM	Corporate Functional Area Manager
CFSI	Counterfeit, Fraudulent and Suspect Items
CFVS	Containment Filtered Venting System
CIGAR	Channel Inspection and Gauging Apparatus for Reactors
CIS	Components Important to Safety
CMCC	Crisis Management Communications Centre
CMSP	Combustible Material Safety Permits
CN	Corrective Non-Critical
CNEP	Consolidated Nuclear Emergency Plan
CNO	Chief Nuclear Officer
CNR	Canadian National Railway

Acronym	Word
CNSC	Canadian Nuclear Safety Commission
CO	Closed Out
CofA	Certificate of Authorization
COG	CANDU Owners Group
CPI	Chemistry Performance Index
CRC	Corporate Relations and Communications
CRE	Collective Radiation Exposure
CRO	Control Room Operator
CRR	Code Compliance Review
CRS	Cryogenic Refrigeration System
CRSS	Control Room Shift Supervisor
CSA	Canadian Standards Association
CSCA	Common Secondary Control Area
CSIs	CANDU Safety Issues
CSP	Critical Safety Parameter
CT	Calandria Tube
CT-LISS	Calandria Tube-Liquid Injection Shutdown System
CW	Circulating Water
D4F	Darlington for the Future
DBA	Design Basis Accident
DBE	Design Basis Earthquake
DBT	Design Basis Threat
DC	Deficient Critical
DC/DN	Deficient Critical and Non-Critical
DCC	Digital Control Computers
DCSA	Defensive Cyber Security Architecture
DEC	Darlington Energy Complex
DFO	Department of Fisheries and Oceans
DFR	Drones for First Responders
DIQ	Design Information Questionnaire
D-ISR	Darlington Integrated Safety Review
DLA	Dynamic Learning Activity
DMS	Dose Management System
DN	Deficient Non-Critical
DPRS	Durham Region Police Service
D-PSR	Darlington PSR
DPZ	Detailed Planning Zone
DRL	Derived Release Limit
DSA	Deterministic Safety Analysis
DWMF	Darlington Waste Management Facility
DWP	Demineralized Water Plant
EBP	Electronic Based Procedures
ECA	Environmental Compliance Approvals
ECC	Engineering Change Control
ECI	Emergency Coolant Injection
ECL	Exposure Control Levels
ECO	End of Commercial Operation
ED&I	Equity, Diversity, and Inclusion

Acronym	Word
EEM	Enterprise Emergency Management
EFADS	Emergency Filtered Air Discharge System
EFDR	Event Free Day Reset
EHC	Electrohydraulic Converter
EITER	Equipment Important to Emergency Response
EM	Emergency Management
EME	Emergency Mitigating Equipment
EMEGs	Emergency Mitigating Equipment Guidelines
EMO	Emergency Management Ontario
EMP	Environmental Monitoring Program
EMS	Environmental Management System
EOC	Emergency Operations Centre
EOP	Emergency Operating Procedure
EPC	Engineer, Procure, Construct (Section 2.1.5)
EPC	Enterprise Project Contractors (Sections 2.5.5.1 and 2.8.2.4)
EPD	Electronic Personal Dosimeter
EPG	Emergency Power Generator
EPR	Environmental Protection Reviews
EPRI	Electric Power Research Institute
EPS	Emergency Power Supply
EQ	Environmental Qualification
EQA	Environmental Qualification Assessment
EQP	Equipment Performance Index
ER	Equipment Reliability
ERA	Environmental Risk Assessment
ERAP	Emergency Response Assistance Plan
ERI	Equipment Reliability Index
ERM	Emergency Response Maintainers
ERO	Emergency Response Organization
ERT	Emergency Response Team
ESA	Emergency Shift Assistant
ESC	End Shield Cooling
ESL	Equipment Status Log
ESM	Equipment Status Monitoring
ESP	Environmental Stewardship Pickering
ESW	Emergency Service Water
ETE	Evacuation Time Estimates
EV	Electric Vehicle
FAA	Fisheries Act Authorization
FAAGM	Fixed Area Alarming Gamma Meter
FAATM	Fixed Area Alarming Tritium Monitors
FAQ	Frequently Asked Questions
FFAA	Fuelling Facility Auxiliary Area
FH ER	Fuel Handling Equipment Reliability
FHA	Fire Hazard Assessment
FINCH	Fully Instrumented Nominal Channel Power
FMD	Fuelling Machine Duct
FSSA	Fire Safe Shutdown Assessment

Acronym	Word
GFP	Gaseous Fission Product
GHS	Globally Harmonized System of Classification and Labelling of Chemicals
GIE	Global Innovation Effectiveness
GOSP	Governance, Oversight, Support and Perform
GSS	Guaranteed Shutdown State
GVO	Generator Voltage Output
GWPP	Groundwater Protection Program
HFE	Human Factors Engineering
HLW	High Level Waste
HoW	Hours of Work
HP	High Pressure
HPM	Health Physics Manager
HSMS	Health and Safety Management System
HTS	Heat Transport System
HTS-AMS	Heat Transport System Aging Management Strategy
HVAC	heating, Ventilation and Air Conditioning
HWMB	Heavy Water Management Building
I/O	Input/Output
IAEA	International Atomic Energy Agency
IAM	Integrated Aging Management
ICFDs	In-Core Flux Detectors
IESO	Independent Electricity System Operator
IFBs	Irradiated Fuel Bays
IHSA	Infrastructure Health & Safety Association
IIP	Integrated Implementation Plan
ILW	Intermediate Level Waste
INPO	Institute of Nuclear Power Operations
ION	Indigenous Opportunities Network
IPB	Isolated Phase Bus
IPZ	Ingestion Planning Zone
IRIS	Industry Reporting and Information System
IRS	Internal Responsibility System
ISAR	Industrial Safety Accident Rate
ISO	International Standards Association
ISP	Ignition Source Permits
ISRW	Integrated Strategy for Radioactive Waste
IST	Industry Standard Toolset
IUCs	Instrument Uncertainty Calculations
IWST	Injection Water Storage Tank
JHSC	Joint Health and Safety Committee
JIT	Just-in-Time
KI	Potassium Iodide
KIWG	Potassium Iodide Working Group
KPI	Key Performance Indicators
L&ILW	Low and Intermediate Level Waste
LBLOCA	Large Break Loss of Coolant Accident
LCH	Licence Conditions Handbook

Acronym	Word
LCMP	Life Cycle Management Plan
LLW	Low Level Waste
LOCA	Loss of Coolant Accident
LP	Low Pressure
LPSW	Low Pressure Service Water
LRF	Large Release Frequency
LWPRB	Local Work Protection Review Board
LZC	Liquid Zone Control
M&D	Monitoring & Diagnostics
MBA	Material Balance Areas
MBFP	Main Boiler Feed Pump
MCCP	Minimum Complement Coordinator Program
MCQ	Multiple Choice Question
MCR	Main Control Room
MDE	Margin Design Earthquake
MIV	Mispositioning Index Value
MOT	Main Output Transformer
MOU	Memorandum of Understanding
MPO	Main Power Output
MSB	Main Security Building
MSLB	Main Steam Line Break
MVC	Main Vacuum Chamber
NBCC	National Building Code of Canada
NEC	Nuclear Executive Committee
NFCC	National Fire Code of Canada
NGS	Nuclear Generating Station
NLCA	Nuclear Liability and Compensation Act
NPCS	Negative Pressure Containment System
NPP	Nuclear Power Plant
NSA	Nuclear Safety Analysis
NSCA	Nuclear Safety and Control Act
NSO	Nuclear Security Officers
NSRB	Nuclear Safety and Review Board
NSS	Nuclear Sustainability Services
NSSCMP	Nuclear Safety and Security Culture Monitoring Panel
NuSAG	Nuclear Security Advisor Group
NWMO	Nuclear Waste Management Organization
O&C	Observation and Coaching
ODS	Ozone-depleting Substances
OHSA	Occupational Health and Safety Act
OPEX	Operating Experience
OPG	Ontario Power Generation Inc.
OSL	Operator Shift Log
OSRs	Operational Safety Requirements
P&IC	Pressure and Inventory Control
PA	Public Address
PAWCS	Post Accident Water Cooling System
PB	Pressure Boundary

Acronym	Word
PCB	Polychlorinated Biphenyl
PdM	Predictive Maintenance
PDP	Preliminary Decommissioning Plan
PDS	Plant Damage States
PEOC	Provincial Emergency Operations Centre
PFU	Predicted Failure Unavailability
PHC	Plant Health Committee
PHT	Primary Heat Transport
PI	Performance Improvement
PIEs	Postulated Initiating Events
PIP	Periodic Inspection Program
PM	Preventative Maintenance
PMMR	Preventative Maintenance Modification Request
PMRB	Preventative Maintenance Review Board
PMT	Post-Maintenance Test
PNERP	Provincial Nuclear Emergency Response Plan
PO&C	Performance Objectives & Criteria
PRD	Pressure Relief Duct
PROL	Power Reactor Operating Licence
PRV	Pressure Relief Valve
PSA	Probabilistic Safety Assessment
PSR	Periodic Safety Review
PSVS	Powerhouse Steam Venting System
PTNSR	Packaging and Transport of Nuclear Substances Regulations
PTP	Performance Testing Program
PULSW	Powerhouse Upper Level Service Water
QSP	Quality of Safety Practices
R&D	Research and Development
RAP	Reconciliation Action Plan
RC	Release Category
RCF	Radiation Calibration Facility
RCHP	Restart Control Hold Point
RCW	Recirculated Cooling Water
RHP	Responsible Health Physicist (Sections 2.2.3, 2.7.2, 2.7.3 and 2.7.4)
RHP	Regulatory Hold Point (Sections 3.2 and 3.2.7)
RIHs	Reactor Inlet Headers
RMI	Reactivity Management Index
RMT	Radioactive Material Transportation
ROR	Regulatory Oversight Report
RP	Radiation Protection
RPO	Refurbishment Project Office
RPPE	Radiation Personal Protective Equipment
RRS	Reactor Regulating System
RTS	Return-to-Service
S&L	Safety and Licensing
SA	Severe Accident
SAA	Severe Accident Analysis
SAFS	Systems Available for Service

Acronym	Word
SAMGs	Severe Accident Management Guidelines
SAT	Systematic Approach to Training
SCAs	Safety and Control Areas
SCBA	Self-Contained Breathing Apparatus
SCDF	Severe Core Damage Frequency
SCO	Station Containment Outage
SCR	Station Condition Record
SDC	Shutdown Cooling
SDS	Shutdown System
SEFDRs	Site Event Free Day Resets
SEM	Security Excellence Meeting
SES	Security and Emergency Services
SG	Standby Generator
SHT	System Health Team
SIIR	Serious Injury Incidence Rate
SIS	Systems Important to Safety
SM	Shift Manager
SMC	Site Management Centre
SMRs	Small Modular Reactors
SOE	Safe Operating Envelope
SOR	Shutoff Rod
SOT	Staying on Top
SPI	Safety Performance Indicators
SPOC	Single Point of Contact
SPOCAI	Smart Performance Objective & Criteria Artificial Intelligence
SPS	Sewage Pumping Station
SPVs	Single Point Vulnerabilities
SREs	System Responsible Engineers
SSC	Systems, Structures, and Components
SSCs	Structures, Systems, and Components
SST	System Service Transformer
SWPA	Safe Work Planning Assessment
SYSImp	System Importance
TCSCA	Timely Completion of Safety Corrective Actions
TDS	Target Delivery System
TERP	Transportation Emergency Response Plan
TG	Turbine Generator
TGD	Transportation of Dangerous Goods Regulations
TIMS	Training Information Management System
TLD	Thermoluminescent Dosimeter
TPARs	Technical Procedure Action Requests
TRA	Threat Risk Assessment
TRF	Tritium Removal Facility
TRIF	Total Recordable Injury Frequency
TSSA	Technical Standards and Safety Authority
U0 CRO	Unit 0 Control Room Operator
USCA	Unit Secondary Control Area
UST	Unit Service Transformer

Acronym	Word
VB	Vacuum Building
VBO	Vacuum Building Outage
VR	Virtual Reality
WANO	World Association of Nuclear Operators
WBC	Whole Body Counts
WHC	Wildlife Habitat Council
WHMIS	Workplace Hazardous Materials Information System
WO	Work Order
WPCP	Water Pollution Control Plant
WPPI	Work Protection Performance Index
WTP	Water Treatment Plant
WWMF	Western Waste Management Facility

Appendix B: System Design and Performance

The subsections in this Appendix contain descriptions and performance details of specific station systems, including details on nuclear safety functions. Significant projects, modifications, and initiatives have been undertaken throughout the current licence term for continuous improvement in the reliability and performance of the Structures, Systems and Components (SSCs), with continued prioritization of safe station operation. These improvements resolve issues such as equipment obsolescence, aging management, maintenance and operator burden, spare parts availability, and applicable performance or design issues identified through performance monitoring and trending. Successful completion of the improvements results in reliable SSC performance throughout the extended life of the station and positive long-term trends in system health. Execution of projects and modifications is planned and completed for each applicable Unit through the applicable work management processes including Darlington NGS Refurbishment, outages, or on-line work. Throughout the subsections in this Appendix, the improvements listed for each system include completed, in-progress, and planned improvements for the current and upcoming licence term.

Safety Related System Tests are performed at their specified schedules for applicable systems and components to ensure all safety functions are reliable and meeting the design and operating requirements. The Preventative Maintenance (PM) program is also in place such that the required maintenance and testing for critical equipment is completed at the specified intervals.

Operational Safety Requirements (OSRs) are in place for applicable systems with safety functions and are in the LCH (refer to Section 2.3 for the list of OSRs). The starting point of the OSR is the determination of the Safety Limits, which are derived from the analysis limits used in safety analysis (NK38-SR-03500-10002, *Darlington Nuclear 1-4 Safety Report: Part 3 – Accident Analysis*). The Safety Limits are used to define the hardware functional requirements and limiting system parameter values in the hardware subsystems. The Safety Limits are also used to ensure there is sufficient margin to the nominal actuation setpoints to account for instrument error and uncertainty.

System performance monitoring is an ongoing process which is planned and completed for every system. The rigour and frequency of each task is applied commensurate with the safety criticality and performance requirements of the system. Critical system performance monitoring tasks performed by System Responsible Engineers (SREs) include:

- Completion of System Health Reports at required frequency for each system. Methodology is in place for classification of system tiers and scoring mechanisms.
- Screening for maintenance work including PM and other work orders/requests for repairs and improvements. Scoping and prioritization of work execution is regularly monitored, and considered for system health improvements and continued safety adherence.
- Performance Improvement (PI) database checks to ensure system operating parameters are within the required ranges. SREs communicate with Control Room Operators (CROs) and Authorized Nuclear Operators (ANOs) as required, for verification of abnormal system trends.
- Monitoring & Diagnostic Center has been implemented to perform additional monitoring on specific PI trends. It utilizes advanced pattern recognition software to build operational profiles, and monitor the condition and performance of SSCs.

- System walkdowns for field observation of system components and parameters.
- Monitoring and trending of the Station Condition Record database, including reportable events per REGDOC-3.1.1.
- ENGAGE software has replaced older software with an enhanced user interface, to facilitate efficient monitoring of PM status and system health report action items.
- Review of station briefing packages and equipment failure review packages for any engineering inputs and support required.

B.1 Special Safety Systems – Emergency Coolant Injection System

The Emergency Coolant Injection (ECI) system is one of the four Special Safety Systems at Darlington NGS. The purpose of the ECI system is to automatically provide make-up water to the Primary Heat Transport (PHT) system following a postulated Loss of Coolant Accident (LOCA). ECI is not required to operate during normal plant operation, but must be in a poised standby mode.

During poised mode, the common ECI System remains pressurized by a recirculating pump that recirculates water through the entire system up to the ECI Injection Valves. Unit ECI System is required to detect LOCA conditions and send signals to start common ECI pumps, open Instrumented Steam Relief Valves for rapid cooldown, start the Standby Generators (SGs), and open ECI Injection Valves.

Short-Term Injection Mode will be initiated in the event of a LOCA large enough that the PHT D2O Pressure and Inventory Control System cannot make up the losses. Short-Term Injection is the mode of operation during which the cooling water is drawn from the Injection Water Storage Tank (IWST). On receipt of a low water level signal from the IWST or sufficient water level signal from the Recovery Sump, Long-Term Injection Mode will be initiated by the Operator. Long-Term Injection is the mode during which the cooling water is drawn from the Fuelling Machine Duct (FMD) and the Pressure Relief Duct (PRD).

Post Accident Water Cooling System (PAWCS) is a safety support system required for long term post-LOCA operation to provide a heat sink for continued heat removal from the fuel in the reactor, and to maintain the water temperature in the FMD and PRD below 65°C. During normal plant operation and during early stages post-LOCA, PAWCS remains in a poised standby state.

As part of system performance monitoring, the Recharge Dashboard is a tool that is used for monthly trending of hydraulic leaks and accumulator recharges.

Completed projects, modifications, and initiatives for the ECI System and PAWCS include:

- PAWCS heat exchangers replacement.

In-progress and planned projects, modifications, and initiatives for the ECI System and PAWCS include:

- OH180 hardware replacements through reverse-engineering of existing communication modules, Input/Output (I/O) boards, and power supplies.
- ECI System and PAWCS motor operated valves and air operated valves replacement.
- ECI System 4kV Motor replacements for eight low pressure ECI System pumps.

- ECI System Group II pressure transmitters replacement.
- ECI System Injection Valves overhaul.
- ECI System flow orifices and feeders replacement.
- Power operated valve/Motor operated valve replacement project which includes ECI recovery isolators and other ECI valve replacements.

B.2 Special Safety Systems – Negative Pressure Control System

The Containment System is one of the four Special Safety System at Darlington NGS. Its purpose is to prevent the release of radioactivity to the environment in excess of regulatory release limits for the site following certain postulated accidents and also during normal operation of the station. The Containment System limits the overpressure transient resulting from a LOCA so as to maintain the integrity of containment, and to quickly return the containment pressure to sub-atmospheric in order to minimize short term releases. This is done by providing a physical barrier to the release of radionuclides, by maintaining containment pressure sub-atmospheric to minimize uncontrolled releases, and by limiting the magnitude and period of any overpressure transient following accidents. Operational procedures for Negative Pressure Containment System (NPCS) elaborate on different operating conditions such as shutdown state, poised state and operating state.

The containment at Darlington NGS is maintained at 3.5 kPa sub-atmospheric. In case of a LOCA, high pressure radioactive airborne particles would overcome the weight of the Pressure Relief Valves (PRV) surrounding the Main Vacuum Chamber (MVC) in the vacuum structure by establishing a flow path from station common containment to the Vacuum Building (VB) via the PRD. Since the VB is maintained at 8 kPa(a), it will take all airborne particles into it to prevent from radioactive release to the public domain. If the MVC pressure continues to rise, it will initiate the dousing system, a self-actuated system, by the pressure rise in the Vacuum Structure resulting in water spray to condense the air for pressure reduction.

The Emergency Filtered Air Discharge System (EFADS) is a part of the NPCS having following functions:

- Maintain containment at a suitable sub-atmospheric pressure in the long-term following a LOCA or less severe accident that will result in increased containment pressure and high activity release into the containment; and,
- Maintain containment at sub-atmospheric pressure in the long-term following an earthquake.

The following graphs (Figure 39) demonstrate the leak tightness of the Darlington NGS Containment from tests that were performed in the past. They include; (i) Station Containment Outage (SCO) / Vacuum Building Outage (VBO) leakage tests, currently completed at a 12-year frequency per the Darlington NGS Licence Conditions Handbook, and (ii) Online Containment leak rate tests performed every 6 months. These results clearly show that the Containment / Structural leakage is below the action and OP&P limits. Hence, the integrity of the containment is well maintained.

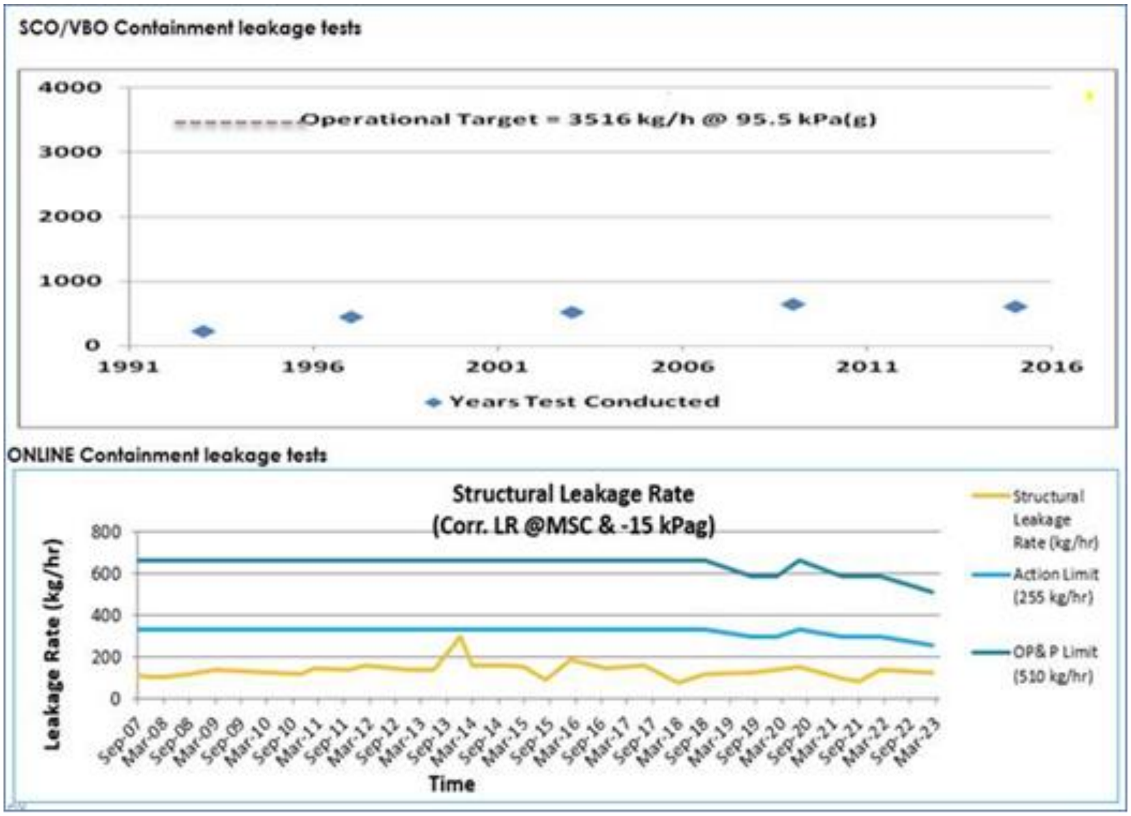

Figure 39: Containment Leakage Tests

Completed projects, modifications, and initiatives for the NPCS include:

- Containment Button-Up System activity monitors replacement. This modification has resulted in a significant reduction of spurious signals.
- Installation and commissioning of the Containment Filtered Venting System.
- Post Accident Radiation Monitoring System replacement which is the monitoring interface of EFADS.

In-progress and planned projects, modifications, and initiatives for the NPCS include:

- OH180 hardware replacements through reverse engineering of existing boards.
- Radiation Protection (RP) teledosimetry penetration upgrade with EQ fiber optic penetration module installation. This modification installs new cable penetration modules with fiber optic and copper conductors to increase data capacity of the Audio Video Teledosimetry System going into the vault.
- MVC pump skid replacement with stainless steel parts to reduce aging and degradation caused from corrosion.
- Upper Vacuum Chamber pump replacement.
- Dousing water heater and controller replacement.
- Hydrogen Ignitor relays replacement.

B.3 Special Safety Systems – Shut Down Systems

Shutdown Systems (SDS) are required to automatically initiate reactor shutdown before the Safety Limit associated with any trip parameter is exceeded. SDS1 and SDS2 are two of the four Darlington NGS Special Safety Systems, providing independent and diverse means of reactor shutdown following Design Basis Accidents (DBAs). The provision of two fast, independent, diverse and highly reliable shutdown systems is in accordance with the requirements stated CSA N290.1-13, *Requirements for the shutdown systems of nuclear power plants.*

The following DBAs, evaluated in the Safety Report: Part 3 - Accident Analysis, result in automatic activation of the SDSs:

- Large Loss of Coolant Accidents
- Transition Loss of Coolant Accidents;
- Small Loss of Coolant Accidents;
- Electrical Failures;
- Control Failures;
- Feedwater System Failures;
- Steam Supply System Failures;
- Moderator System Failures;
- Failures in the Shutdown Cooling System and in the Shutdown Cooling System Rooms;
- Common Mode Events;
- The remaining DBAs occur on a time scale long enough to credit the operator to reduce the power manually using the Reactor Regulating System (RRS), or to manually activate the SDSs.

Completed projects, modifications, and initiatives for the SDS1 and SDS2 include:

- SDS1 Shutoff Rod (SOR) clutch relay cards and RRS logic modules replacements. This completed modification improves reliability and prevents inadvertent dropping of SORs in the reactor core.
- SDS1 clutch relay card power supply replacement.

In-progress and planned projects, modifications, and initiatives for the SDS1 and SDS2 include:

- SDS1 and SDS2 EQ Ion Chamber Detectors replacement;
- SDS1 and SDS2 Flux Detectors replacement;
- SDS1 and SDS2 Ion Chamber Amplifiers and Neutron Overpower Amplifiers replacement;
- SDS1 and SDS2 flow orifices (with their respective pressure tubes and feeders) replacement;
- SDS1 and SDS2 Trip Computer and Display/Test Computer replacement;

- SDS1 SOR drive mechanisms spare procurement and SOR potentiometers replacement;
- SDS2 process transmitters replacement;
- Liquid Injection Shutdown System poison ball level alarm replacement.

B.4 Reactor Regulating System and Liquid Zone Control

The RRS in combination with the Liquid Zone Control (LZC) is required to monitor and control the bulk and spatial flux power distribution across all 14 zones of a CANDU reactor. Under normal operation or reactor power outages, the RRS and LZC must be capable of monitoring reactor power and controlling it within operational limits per CSA N290.4, *Requirements for Reactor Control Systems of CANDU Nuclear Power Plants,* and the Darlington NGS OP&Ps. To meet the operational limits, the RRS is capable of automatically reducing power in the event of an adverse perturbation that directly or indirectly impacts reactor power. The power reduction can either be minor (setback) or major (stepback) depending on the severity of the perturbation. This power reduction provides an increase in heat sink availability as described in the Safety Report Accident Analysis.

The operational safety requirements for RRS drive the safe operating envelope of the RRS and LZC systems. The stepback and setback functions for the RRS require surveillance requirements, as found in the OSR, to minimize the frequency of serious process failures. In addition, the safety limits from the fuel and physics OSR and the moderator OSR, drive various safety surveillance requirements in the RRS. In relation to fuel and physics OSR, the following systems must be monitored:

- Fully Instrumented Nominal Channel Power (FINCH): to ensure the reactor's maximum thermal power is within licence limits, Simulation of Reactor Operation error is within limits, and neutronic power error is within limits.
- In-Core Flux Detectors (ICFDs): to ensure flux tilt is within limits.
- Rod and liquid positions: to ensure safe operations.

In relation to the moderator OSR, the automatic poison addition system must be monitored to ensure the hardware meets design requirements.

Completed projects, modifications, and initiatives for the RRS and LZC systems include:

- Logic Modules replacement for Adjuster Assemblies (AAs), control absorbers and shutoff rod assemblies. The new models contain dual internal power supplies and ensure no spurious rod drives in or out of the core. Control Modules for AAs and control absorbers were also replaced.
- AA maintenance covers were designed to facilitate the removal of AA rods to ensure pressure boundaries during AA rod removal/installation activities.
- LZC valve digital positioners installation to replace old analog positioners.

In-progress and planned projects, modifications, and initiatives for the RRS and LZC systems include:

- RRS Ion Chamber Detectors replacement with a new model made by imaging and sensing technology.

- RRS ICFDs replacement.
- RRS Ion Chamber Amplifiers and ICFD Amplifiers replacement.
- AAs replacement for Cobalt-60 Project, to replace titanium/stainless steel rods with Cobalt rods. This modification is critical for the future production of the Cobalt-60 medical isotope, and will continue to meet the function of flux shaping the core.
- RRS flow orifices, pressure tubes and feeders replacement.
- Reactor monitoring Resistance Temperature Detector replacement for reactor inlet headers, FINCH lines, and channel outlet temperatures.
- Redesign of Liquid Zone pump discharge check valves to improve opening time and eliminate sticking has been initiated.
- Start-up Instrumentation installation during Refurbishment, to allow core monitoring for reactor power under -6 decades.

B.5 Electrical Power Systems – Class I

The purpose of the Class I Power System is a System Important to Safety, and its purpose is to provide a highly reliable supply of DC power to the following load categories:

- 250 Vdc
    - Inverters used for 120/208 Vac and 347/600 Vac Class II power.
    - DC pump motors (DC Lubricating Oil pump and DC Seal Oil pump).
- 125 Vdc
    - Station service circuit breaker control (13.8 KV, 4.16 KV and 600 V circuit breakers trip/close circuits) and protection loads.
- 48 Vdc
    - Channelized safety-related loads (Group 1 Special Safety and Safety Related instrumentation loads for all three channels).
    - Group 2 Special Safety and Safety Related instrumentation loads for the 3rd channel.
    - Process/Electrical Control and logic loads (OH180 Programmable Controllers).

In-progress and planned projects, modifications, and initiatives for the Class I Power System include:

- Class I Batteries replacement will improve reliability and utilize newer models as battery manufacturing has improved in addressing battery leakage issues.
- Class I Rectifiers replacement.
- Class I Ground Fault Detectors replacement.

B.6 Electrical Power Systems – Class II

The purpose of the Class II Power System is to provide a highly reliable supply of AC power to the following load categories:

- Group 1 Special Safety and Safety Related loads for all three channels.
- Group 2 Special Safety and Safety Related loads for the 3rd channel.
- Computers and instrumentation (e.g., Digital Control Computers (DCC) X and Y, Common processes computer, sequence of events monitoring computer.
- Equipment protection/logic loads.
- Emergency lighting and emergency Class I/II Equipment Room Ventilation.

In-progress and planned projects, modifications, and initiatives for the Class II Power System include:

- Uninterruptable power supplies replacements.
- 120/208 Vac Motor Starter replacements.
- 120/208 Vac Switchgear (Unit 0) refurbishment.

B.7 Electrical Power Systems – Class III

The purpose of the Class III Power System is to provide electrical power to specified Class III loads which ensure that, following a loss of Class IV power, the reactor is safely shutdown, the reactor decay heat is removed, the status of steam supply is monitored, and the release of radio nuclides from the containment, if any, is limited. The Class III power system must also supply specific Class III economic loads which are required to minimize the economic consequences of a loss of Class IV power.

The Class III Power System is divided into; Common System, Class II Power Sources, Unit System, and Station Class III Transfer System. Each of these sub-systems is designed to include the "odd" and the "even" divisions for both power distribution systems and control; to provide redundancy and to ensure security for particular systems. Each division is electrically independent of the other, and physically separated. Electrical independence and physical separation for odd and even division equipment is necessary to minimize the probability of equipment failure due to a common mode event.

In-progress and planned projects, modifications, and initiatives for the Class III Power System include:

- OH180 hardware replacements for the Class III transfer schemes and circuit breaker control.
- Circuit breakers and motor protection relays addition for Shutdown Cooling pump motors to allow for additional shutdown cooling capability.
- Unit 0 Switchgear refurbishment, including circuity breakers, buses, transformers, and relays associated with both nuclear safety loads and important economical loads.

- Electrical Signature Analysis online monitoring system implementation for Class III 4.16kV buses, to improve reliability of the electrical motors and provide monitoring to assist in preventing failures.

B.8 Electrical Power Systems – Class IV

The purpose of the Class IV Power System is:

- To supply AC Station Service power to the Class IV service loads (e.g., lighting and receptacles) and process systems (e.g., boiler-feed water system) at 13.8 kV, 4.16 kV, 347/600 V, and 120/208 V distribution voltage levels.
- To provide power directly to the Class III distribution system, during normal operation.

The purpose of the Class IV Transfer Scheme is:

- To transfer the unit auxiliaries supplied from the System Service Transformer (SST) to the Unit Service Transformer (UST) during a unit start-up.
- To transfer the unit auxiliaries supplied from the UST to the SST:
    1. Manually when a loss of the UST is pending or
    2. Automatically following actual (or impending) loss of the UST supply.

In-progress and planned projects, modifications, and initiatives for the Class IV Power System include:

- Unit 0 Switchgear refurbishment.
- LED lighting replacements to improve lighting levels in various station areas including Unit 0 offices and shops, new fuel areas in Fuelling Facility Auxiliary Areas (FFAAs), FMD, Unit hallways and pump houses, Powerhouse, and outdoor system buildings such as SG, Emergency Power Generator (EPG), Emergency Power Supply (EPS), Condenser Cooling Water (CCW).
- Transformer (10MVA) control cabinet wiring system replacement, which is associated with significant loads such as the CCW pump and Boiler Feedwater pump.

B.9 Electrical Power Systems – Standby and Emergency Power Generators

The SG System consists of four 100% capacity gas turbines capable of automatic black starting. Each SG is rated for a minimum continuous output of 22.375 MW (at 40°C inlet temperature), a generator power factor of 0.8, and at a terminal voltage between 95% and 105% of the rated 13.8kV. When operating at an air inlet temperature of 15°C or less, the minimum continuous output is 26 MW.

The SGs make up part of the Standby Class III System. The purpose of the SGs is to provide power to the Standby Class III in the event of a loss of Class IV power and/or LOCA. In both cases, all four SGs are expected to start up automatically and run up to synchronous speed. In the event of a loss of Class IV, the first ready SG will synchronize to either the odd or even Class III transfer bus and pick up all nuclear safety loads. One SG is required to be available to pick up the minimum required Standby Class III loads. Similarly, the second ready SG will synchronize to the other bus and pick up all of the economic (non-nuclear) loads. Two SGs are capable of supplying the entire Standby Class III load for the station. The recommended operating practice is that two SGs are maintained available at all times.

The EPG System consists of three 100% capacity gas turbines capable of starting without external power (black starting). EPG1 is rated at 6.8 MW gross (6.5 MW net) and 4.0 MVAR at 0.8 power factor. EPG2 and EPG3 are rated for 8.0 MW and 6.0 MVAR at 0.8 power factor. The EPGs are capable of supporting Safety Related Emergency Loads (Group 2) connected to the EPS System following a postulated common mode incident within the reapplication time of 30 minutes. EPGs are seismically qualified to Design Basis Earthquake (DBE) Category-C, i.e. the specified performance capability must be retained following a seismic event.

Completed projects, modifications, and initiatives for the SG and EPG Systems include:

- EPG3 installation and improvements to EPS availability. Additional design enhancements were made to EPG3 based on initial operational performance and monitoring, mainly regarding the compressed air supply.
- EPG1 and EPG2 replacements completed with new and upgraded generators to match EPG3.
- SG Control retrofit including replacement of control system components, software, and logic.

In-progress and planned projects, modifications, and initiatives for the SG and EPG Systems include:

- SG Protection Relays replacement with digital multifunction relays to replace the older electro-mechanical relays;
- SG Fuel System duplex fuel filter bypass relief valve replacement to address fuel leak issues.

B.10 Electrical Power Systems – Main Power Output

The purpose of the Main Power Output (MPO) System is to transmit the power from the generator terminal output 22kV to the 500kV Ontario Bulk Electric System Grid. The purpose of the Generator Voltage Output (GVO) system is:

- To transmit the generator output to the low voltage terminals of the Main Output Transformer (MOT).
- To supply power to the high voltage terminals of the UST, through taps off the GVO system.
- To provide voltage source for protective relaying, voltage regulation, synchronizing, metering and other functions, through the use of instrument transformers.
- To limit, by means of generator stator neutral grounding equipment, the phase-to-ground fault currents to a low value and to provide a signal source for protective relaying.

In-progress and planned projects, modifications, and initiatives for the MPO System include:

- MOT and UST replacements.

- MPO protection relays replacement with microprocessor-based multifunction relays, to improve grid reliability and station power supply reliability. Furthermore, dynamic disturbance monitoring is to be installed on the MPO system as part of this project per North American Electric Reliability Council standards for transmission and generation systems.
- Revenue Metering replacement, including current and capacitor voltage transformer replacements at both the MOTs and SSTs, along with updates to the metering cabinets. Completion of this project is critical for Revenue Metering System compliance with the Independent Electricity System Operator (IESO) market rules and Measurement Canada regulations.
- Isolated Phase Bus (IPB) upgrade project through critical component replacements.
- Sulfur hexafluoride synchronizing breakers refurbishment at Bowmanville Substation, including gasket replacements, grading capacitor replacements, and hydraulic mechanism overhaul.
- Transformer control cabinet wiring system replacement, including disconnect switches, relays, control power transformers, terminal blocks, and wiring.
- Phasor Measurement Unit technology for Unit Generators, as this technology will enhance reliability and resiliency of the grid. This technology allows for more comprehensive and accurate data to be supplied to the IESO, and will enable detailed health assessments of local and wide-area power systems.

B.11 Instrumentation and Control – Digital Control Computers

Instrumentation and Control at Darlington NGS is primarily implemented by the DCC system. The DCC system is Safety Related, and its purpose is to control and monitor various plant process systems in the reactor unit.

Completed projects, modifications, and initiatives for the DCC System include:

- I/O chassis 48V power supplies replacement to resolve previous issues with equipment redundancy.
- Replacements of printed circuit boards with reverse engineered or new boards, including for the I/O Controller and Contact Input Scanner.

In-progress and planned projects, modifications, and initiatives for the DCC System include:

- Replacements of printed circuit boards with new reverse engineered Watchdog Timer boards.
- Display Subsystem replacement including display generators, CRT displays, light pens, printers, and all interconnecting cabling. Refer to Figure 40 and Figure 41 below for comparisons of the legacy and new equipment in Unit 2.
- Analog input points expansion with purpose of adding 15 analog input points and associated cabling for each DCC.
- DCC hardware future replacements such as I/O subsystem, I/O power supplies, power distribution units and filters, terminals, and keyboard electronics, along with major DCC software upgrades.

Figure 40: Old CRT display (left) and new touchscreen display (right)

Figure 41: Old display generator (left) and new video display generator (right)

B.12 Instrumentation and Control – Control Facilities

The purpose of the Control Centres is to provide a facility and an environment necessary for the equipment in the area to function, and for personnel to be capable of operating plant equipment. Control centres are those areas which contain the instrumentation, controls, and protection necessary for the operation and monitoring of equipment. Examples are the Main Control Centre, the Local Control Equipment Rooms, and Local Control Rooms.

The control centre is located in the Central Service Area. It contains the Main Control Room (MCR), Control Equipment Rooms for each unit, a Common Services Equipment Room, Fuel Handling Control Equipment Rooms, and a Work Control Area. The MCR is the centralized on-site facility where the site's nuclear units are monitored and operated. The MCR is staffed at all times with licensed operators, and MCR control panels are checked each shift. The MCR contains a control panel and console for each generating unit, the fuel handling control panels, the common services control panel, and the unit and common electrical control panels.

Each unit has a Unit Secondary Control Area (USCA) and a Unit Electrical Secondary Control Area. These are used to shut down, cool down and monitor the nuclear steam supply should the MCR become un-inhabitable. A Common Secondary Control Area (CSCA) contains instrumentation and control necessary to accomplish the same functions for common process systems under these circumstances. The CSCA further provides a location for the Secondary Emergency Operations Centre from which the overall station operations can take place and be coordinated, along with communication with outside agencies.

From a health, safety and security perspective, there is a MCR Breathing Air System to provide breathing air at controlled pressure to the MCR during a potential toxic gas release event. Darlington NGS has made seismic routes (designated pathways) available to provide assured and unimpeded access from MCR to Secondary Control Room areas and other designated areas, following a seismic event or common mode event.

The majority of changes impacting the control room are controlled by the Engineering Change Control process, with a couple of notable exceptions, including business LAN equipment, and some facilities modifications such as the furniture in the Emergency Operations Centre (EOC).

Completed projects, modifications, and initiatives for the Control Facilities include:

- Door locks installation on the MCR and Secondary Control Areas for enhanced security. In order to gain entry, individuals are required to be on a “vital areas” list.

In-progress and planned projects, modifications, and initiatives for the Control Facilities include:

- MCR Annunciation system modification to address legacy design issues as per IIP-OI 034.
- MCR Breathing Air system replacement with Powered Air Purifying Respirator (PAPR) system, consisting of a personal battery powered air pump and filter system connected to a helmet and hood. These systems have been used successfully during Unit Refurbishments.
- MCR Turbine-Generator (TG) controls change as a result of the TG control system replacement.
- MCR Fuel Handling monitor and keyboard configuration modification to improve user interface for Fuel Handling Operations.
- MCR furniture replacement to allow for improved workflow, productivity, ergonomics, and communication between ANOs/CROs.

B.13 Emergency Response Facilities

Emergency facilities are equipped with the necessary equipment to implement emergency response actions as required. This includes voice communications equipment, including back-up, and other equipment which may include fax machines, personal computers, status boards, area radiation monitoring equipment, radiation survey kits, fire-fighting gear and equipment, off-site monitoring vehicles, and meteorological monitoring data read-out equipment. Other support facilities have phone communications equipment, including back-up fax machines and radios as appropriate.

The station telephone system is the primary telephone system with the main emergency response facilities having external trunk lines to provide adequate back-up communications capability. Fax machines equipped with station Private Business Exchange and trunk lines are available. OPGs nuclear stations have an emergency radio communications system with dedicated frequencies. On-site and off-site field teams are equipped with cell phones and/or portable radios. Base radio stations are available at several on-site locations such as the MCR.

OPG emergency response facilities are linked to the Provincial Emergency Operations Centre (PEOC), municipal EOC and regional EOC through landline phone and other communication systems as required to allow information transfer. OPG has also established reliable contingency communication systems. (e.g., Satellite phones). Fixed and portable equipment lists for tasks such as firefighting, accident assessment, process monitoring, radiation monitoring, and meteorological monitoring, are included in site-specific documents.

For the response to an emergency event, the MCR is the first on-site facility to become involved with the response. The EOC is an on-site facility adjacent to the MCR, under the direction of the Shift Manager, where site shift staff assemble to manage and coordinate event response. This facility is also dedicated as the Shift Manager's office and is maintained in a poised state. The power supply to the EOC is station Class IV power. An alternate location for the EOC is located in the Common Secondary Control Area. Facility checks are routinely conducted in this area for emergency response supplies and equipment.

The EOC has a telephone system as the primary communication method, along with backups and alternate lines for redundancy. An efficient communication line between the Shift Manager in the EOC and the Emergency Response Manager in the Site Management Centre (SMC) is established. The SMC is a dedicated emergency response facility where on-call management, technical, and support staff assemble to manage and coordinate the site-wide response to a radiological emergency. Furthermore, a callback line is available and poised for communication with the PEOC during emergency response. Overall, the communication systems and processes are in place to allow for efficient communication between personnel in critical roles during response to an emergency, and ensures safety of all personnel and the public.

Emergency cabinets available to the EOC provide a dedicated supply of emergency equipment to support the response to an emergency. All emergency cabinets are sealed with a blue security seal and an inventory list is located in each cabinet. There are emergency cabinets available for a number of different functions including emergency supplies, RP equipment, in-plant survey team, assembly areas, and emergency flashlights.

In the case of response to Beyond Design Basis Earthquakes (BDBEs), equipment such as laptops, fax machines and radios are available at Darlington NGS to assist the Emergency Response Organization to fulfill their requirements and to communicate with off-site agencies. BDBE radio communications are also available in the EOC, SMC, and throughout the station.

In the event of an extreme external event that requires essential staff to be sequestered at site, 72-hour emergency supplies provide the necessary food, water, hygiene and sleeping requirements until outside aid is brought in. In addition, Radiation Personal Protective Equipment (RPPE) is stocked and maintained at the Darlington NGS site in quantities that consider a response to an emergency with no off-site aid for up to 72 hours. The RPPE is located in regular inventory locations and maintained in accordance with OPG's inventory control procedures and processes. Distribution of 72-hour supplies is intended for extreme emergency situations, and only at the direction of the Shift Manager, Emergency Response Manager or Emergency Recovery Director.

OPG has established processes and defined procedures to monitor, test, and maintain emergency response facilities and equipment to ensure operability 24 hours a day, 7 days a week. This includes testing and facility walk-through frequencies, and covers the different types of documents and equipment. Specific requirements, configuration management and contingency actions for emergency management facilities are contained in applicable facility manuals. The Equipment Important to Emergency Response (EITER) procedures include the framework to assure that when EITER is removed from service (including control facilities) for maintenance or is in a degraded condition, the correct restoration priority is assigned, and any required compensatory measures are implemented. EITER includes systems, structures, and components, as well as essential tools and equipment necessary to implement this emergency plan.

Enterprise Emergency Management maintains facility checks for emergency preparedness equipment and supplies for the CSCA, EOC and SMC. These checks are completed at regular intervals and reported to the CNSC. If an EITER equipment deficiency is discovered by any staff on site, a defined process is outlined to ensure notifications are made, and the equipment and facility condition are documented and returned to service.

Completed projects, modifications, and initiatives for the Emergency Response Facilities include:

- EOC renovation to improve the layout and function of the facility. Equipment replacement included televisions, monitors and computers, LAN cables, and the addition of a second Plant Information computer, along with aesthetic updates such as carpets, paint, and furniture. Refer to Figure 42 below for the renovated EOC.

In-progress and planned projects, modifications, and initiatives for the Emergency Response Facilities include:

- Public Address System upgrade modification is a critical improvement being made to the EITER and will result in improved audibility across the site.

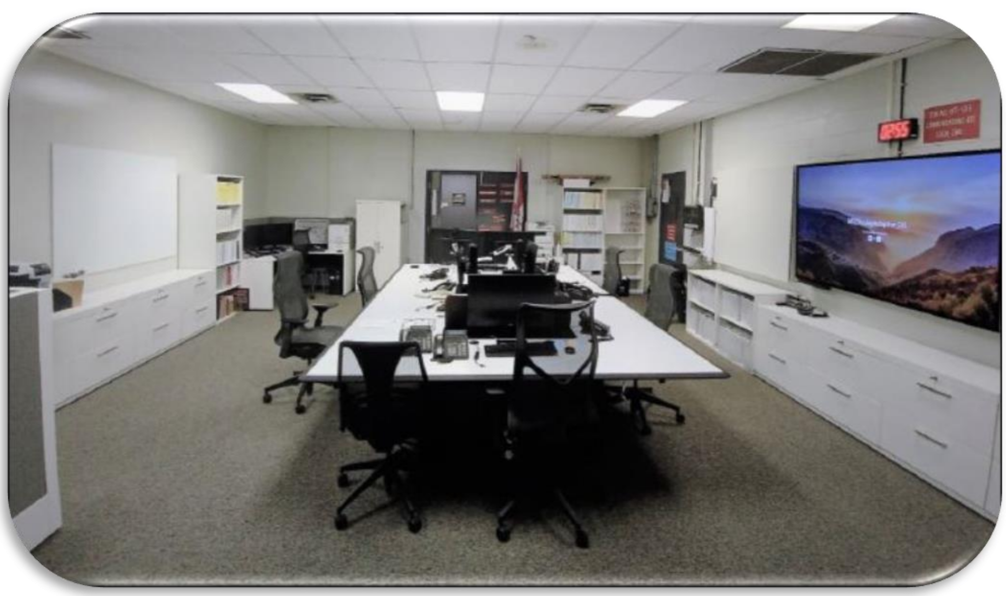

Figure 42: Darlington NGS Emergency Operations Centre (EOC)

B.14 Steam Supply Systems – Feedwater, Main Steam and Steam Bypass

The Boiler Feed System is provided to supply hot, pressurized demineralized water to the steam generators under all operating conditions, including start up and shutdown. Each of the four Units of the powerhouse is provided with a Main Steam System, which is comprised of the Main Steam Supply System and the Steam Generator Steam Relief System. The purpose of the Main Steam Supply System is to carry steam from the steam generators to the turbine-generators under normal operating conditions when electric power is generated. Additionally, the steam is supplied to other miscellaneous systems per requirements.

The turbine bypass system enables the reactor power to be maintained at 70 percent even though the turbine-generator may be tripped, on turning gear or operating at a load lower than 70 percent. The system accomplishes this by absorbing the main steam flow when it cannot be admitted, either wholly or partially, to the turbine.

Completed projects, modifications, and initiatives for the Feedwater, Main Steam and Steam Bypass systems include:

- Feedwater System seismic reinforcement improvements to meet requirements for mitigation of BDBE. Upgrades were made to anchorage and supports for the Deaerator storage tank and Boiler Feed high pressure heaters.

In-progress and planned projects, modifications, and initiatives for the Feedwater, Main Steam and Steam Bypass systems include:

- Auxiliary Boiler Feed Pump (ABFP) mechanical seal replacements and addition of gland injection cooling loop to reduce seal failures caused by high temperatures.
- Main Boiler Feed Pump (MBFP) and ABFP reverse rotation detection system replacements.
- Main Steam System EQ pressure transmitters replacement.
- Procuring spares for critical components (valves, pumps, and pump motors) to enable periodic overhauls and replacement.
- Steam Generator level control valves replacement, and additional modifications to upgrade the associated hand controllers and ABFP/MBFP recirculation controllers.
- Valve replacements including ABFP pressure control valves, Condenser steam discharge valves, and Inter-Unit Feedwater Tie valves.

B.15 Steam Supply Systems – Turbine and Generator

Darlington NGS incorporates a defense-in-depth design approach for the Turbine, Generator and Auxiliaries systems. The Turbine and Auxiliaries system consists of the turbine set; 1 High Pressure (HP) turbine and 3 identical Low Pressure (LP) turbines coupled in series. Live steam flows from the Steam Generators to the HP turbine via 4 control valves and 4 stop valves. After exiting the HP turbine, the wet steam, is partly dried in 4 pre-separators before it enters the 2 moisture separator reheaters. The reheated steam exists the moisture separator reheaters, and flows through 6 intercept and 6 stop valves before it enters the LP turbines. The steam is then expanded before it enters the Condenser where it is condensed. The Turbine Auxiliaries include the turbine Turning Gear, Turbine Bearings, Lubricating Oil, Lube Oil Purification, Gland Seal, and Turbine Supervisory Systems.

The Generator System consists of a 4-pole synchronous generator, the excitation system, Seal Oil System, Stator Cooling Water System, Hydrogen Cooling System and Slipring Dehumidification system. The generators utilize single pass water-cooled stator and direct hydrogen-cooled rotor design. Generator stator coolant flows from the slipring end to the turbine end through the stator bars and some coolant flows through the terminal bushings. Pressurized hydrogen gas is circulated by two fans mounted on either end of the generator rotor.

Completed projects, modifications, and initiatives for the TG systems include:

- Tube bundles in all seal oil heat exchangers across all four Units.
- Replaced TG Auxiliary Lube Oil Pump motor across all four Units.
- Replaced lube oil temperature control valves on each Unit.

In-progress and planned projects, modifications, and initiatives for the TG systems include:

- Turbine and Generator upgrade.
- Turbine and Auxiliaries system modifications as part of the TG Upgrade project during each Unit Refurbishment including: Turbine Electronic Control upgrade, PRV piston ring modification, HP Turbine Layup modification, Electrohydraulic Converter (EHC) modification, Main Output Control and Protection Equipment Room control panel modifications, field instrumentation modifications, Jacking Oil pump and Turning Gear operation project, and Auxiliary Turning Gear cables upgrade.
- Generator and Auxiliaries system modifications as part of the TG Upgrade project during each Unit Refurbishment, including: Stator Rewind, End shield and shaft seal housing modification, Excitation system modification, Hydrogen Cooling skid upgrades, Seal Oil skid upgrades, Stator Cooling Water skid upgrades, Turbine and Auxiliary Instrumentation and Controls System, Turbine Trip and Protection System, EHC modification, TG supervisory system, and Data Acquisition Computer.
- A pilot program to test ultrasonic greasing on reheat drains and second stage reheat drains pump motors.
- Fire Resistant Fluid pump upgrade.

B.16 Plant Auxiliary Systems – Liquid Chlorination System

The Liquid Chlorination System utilizes the properties of 12 wt% sodium hypochlorite (NaOCl) and calcium thiosulphate to mitigate the damage caused by Zebra Mussels and other organic material in the span of the Emergency Service Water (ESW) and Low Pressure Service Water (LPSW) systems, without exceeding an effluent total residual chlorine concentration of 10 ppb (parts-per-billion). The system normally operates from the end of May to the middle of November. Start and end dates vary based upon the requirements listed in the Environmental Compliance Approval, approved by the Ministry of Environment Conservation and Parks.

The Liquid Chlorination System is continually reviewed for improvements to equipment and monitoring practices. Monitoring is completed every shift, including checking the total residual chlorine levels and adjusting the levels as required. Spare parts for the system will also be evaluated and updated as required based on past demand, new operating experience, and any obsolescence issues that arise.

Completed projects, modifications, and initiatives for the Liquid Chlorination System include:

- ESW and LPSW chlorination upgrade to enable continuous chlorination of Units 0 and 1 to 4 simultaneously for more effective prevention of zebra mussel and biofilm growth.
- Permanent Dechlorination building and system installation to ensure that the station water discharge does not exceed 10 ppb total residual chlorine.
- Dechlorination chemical change from sodium bi-sulphate to calcium thiosulphate to remove hazards when working with sodium bi-sulphate.

B.17 Plant Auxiliary Systems – Water Treatment Plant

The Water Treatment Plant (WTP) is used to process water from Lake Ontario into a high purity demineralized water. The WTP is continuously run and monitored by an operator. The operator is displayed information on the key aspects of the plant, such as inflow, outflow, station demand, water storage level, and effluent conditions. Certain conditions of the water such as pH and conductivity are monitored remotely.

The WTP must have enough capacity to support: continuous condensate make-up at 0.125% unit steam flow (USF = 4.72 x 10^6 kg/h) for four units, continuous blowdown of the steam generators at 0.3% USF for four units, emergency blowdown of the steam generators at 3% USF, and miscellaneous process uses in the station distributed by the HP Demineralized Water System at a nominal flow of 15 L/s and an infrequent maximum flow of 30 L/s. It must also include sufficient storage capacity for various different operating states including normal operation, unit startup and unit shutdown. Standards and requirements are in place for chemistry of the effluent from the WTP.

In-progress and planned projects, modifications, and initiatives for the WTP include:

- A new Demineralized Water Plant (DWP) is under construction to replace the function of the existing WTP which has been in service since 1987. A contractor partner will design, build, finance, operate, maintain, and own the new DWP that will supply ultra-pure demineralized water 24 hours a day, 7 days a week, 365 days per year for the extended life of Darlington NGS. The new DWP has a target available for service date of the end of Q2-2024.

B.18 Plant Auxiliary Systems – Circulating Water

The Circulating Water (CW) system is a Safety Related System, and its purpose is to provide a continuous supply of lake water to cool the unit steam condensers under all operating conditions, transient conditions, and during steam dumping to the condenser. A flow of water shall be circulated to condense the steam exhausted from the main turbine for the four units. A critical requirement of the system is to control circulating cooling water to the unit main steam condensers in order to remove waste heat during reactor operation and to improve thermal efficiency of the unit.

The maximum design flow rate required for all four units operating is 126 m^3/sec (10.5 m^3/sec per pump). The lake water enters the Forebay through the Intake tunnel and then the Station through bar screen/travelling screen pairs. The bar screens prevent larger debris from entering, while travelling screens, having finer mesh, screen out small fish and algae. The travelling screens are normally stationary; they start to rotate to allow cleaning by jets of water supplied from the screen wash pumps. The trash removal screen separates debris from the water and discharges it in the trash bin. The Frazil Ice Protection System prevents frazil ice from forming on the bar screens and travelling water screens.

Completed projects, modifications, and initiatives for the CW System include:

- CW System Travelling Screens replacement to resolve degradation due to corrosion observed during inspection of the underwater parts.
- CCW travelling screens bubbler lines replacement to increase diameter of lines for the purpose of preventing lines from being plugged by zebra mussels.

In-progress and planned projects, modifications, and initiatives for the CW System include:

- CW Trash Removal System pump discharge check valves replacement.
- Frazil Ice and Discharge Gate replacements.
- CCW Piping Expansion Joints replacement.
- CW Pumps Vibration Monitoring System upgrades.
- Several proactive component replacements such as valves, relays, motors, vacuum priming pumps, trash screens, and piping in various parts of the system.

B.19 Plant Auxiliary Systems – Compressed Air

The Compressed Air system provides different types of air for various applications throughout the plant. The Compressed Air system is a combination of three different air systems: Instrument Air, Service Air and Breathing Air. Instrument Air provides dry and oil free compressed air to various instruments and services in the station at a required pressure and quantity. Service Air provides compressed air to various parts of the station to progress various maintenance, service and operational functions. The Breathing Air system provides safe breathable compressed air to personnel accessing contaminated or potentially contaminated areas of the station. The air delivered to the user conforms in general composition to the composition of normal air of the lower atmosphere. The oxygen content does not at any time fall below 19% v/v.

Completed projects, modifications, and initiatives for the Compressed Air System include:

- Instrument Air system mass flow meter replacements for flow measurements into Containment (Units 1, 3, 4).
- Breathing air system compressor installations for Refurbishment and upcoming VBO.
- Service air system installation of new compressors which provide higher capacity and additional flow beyond the existing compressors.
- Service water return piping for Service Air compressors replaced and upgraded to stainless steel.
- Breathing air purge tool implementation for more efficient purging of Breathing Air system following maintenance activities.

In-progress and planned projects, modifications, and initiatives for the Compressed Air System include:

- Compressor replacement project in place to replace older air compressors in multiple locations within the Instrument Air, Service Air, and Breathing Air systems.

B.20 Plant Auxiliary Systems – Active/Inactive Drainage and Sewage

Drainage Systems are composed of three sub systems; Inactive Drainage, Active Drainage and Sewage. Under normal operating conditions, the Inactive Drainage System shall collect the inactive liquid waste from floors, equipment, roof drains and open gutters, and shall transfer it to the inactive drainage sumps. Waste collected in the drainage sumps shall then be transported to the Treatment system prior to discharge into to the lagoon and further to the Lake Ontario. Drainage above 107.5 m elevation shall be discharged to the lake via the LPSW shaft.

The function of Active Plant Drainage System is to recover, segregate and transfer active liquid waste generated throughout the station to the Active Liquid Waste Collection System. The active liquid waste will be segregated prior to routing to appropriate collection tanks according to sump analysis. Batches of liquid waste with gross beta-gamma activity exceeding 37 MBq/m^3 (10-3 Ci/m^3) and non-chemical wastes from decontamination will be transferred to decay/treatment tank. The treatment system is designed to treat batches of active liquid waste with toxic levels exceeding the derived toxicity limits and/or the Municipal and Industrial Strategy for Abatement limits and also with gross beta-gamma activity exceeding 37 MBq/m^3 (10^{-3} ci/m^3) using a combination of filters and ion exchangers. The treated effluent returns to the Active Liquid Waste Collection System where it is sampled to ensure it meets requirements and discharged to Lake Ontario.

Under normal operating conditions, the sewage system collects the discharge by gravity from all washrooms, wash fountains, sinks inside the workshops, drinking fountains, and all showers (excluding the emergency showers). Sewage collected by gravity drainage at the various sump pumps, shall be pumped to the gravity sewer system where it will drain to either the east Sewage Pumping Station (SPS) or to the west SPS. The collected sewage in the East SPS shall be pumped north through a forcemain to an outlet manhole and gravity sewer north of the Canadian National Railway (CNR) at Holt Road from which it will drain westerly to the Courtice Water Pollution Control Plant (WPCP) where it will be treated and discharged to Lake Ontario. The collected sewage in the West SPS shall be pumped north through a forcemain to an outlet manhole and gravity sewer north of the CNR on Park Road from which it will drain westerly to the Courtice WPCP where it will be treated and discharged to Lake Ontario.

Completed projects, modifications, and initiatives for the Drainage and Sewage Systems include:

- Inactive Drainage collection header modification (Unit 3 only) to add bypass header connection for purpose of allow access for maintenance to be performed without a system outage.
- Relocation of underground Inactive Drainage line (Unit 0 only) to accommodate for the Heavy Water Management Building (HWMB) West Annex.
- Inactive Drainage Lagoon Aeration System implementation.
- Additional Data Logger installation (Unit 4 only) to increase redundancy for flow measurement and effluent monitoring of inactive drainage being discharged from the station.
- Active Drainage System and D_2O Liquid Recovery (HWMB West Annex) tie-in.

- Active Liquid Waste collection tanks high and low level setpoint changes to prevent stagnant water being left in tanks (decrease low level setpoint) and improve efficiency of the system by processing more water per discharge (increase high level setpoint). As a result, pump operating life will also be increased by requiring less frequent start up.
- Conductivity Transmitter and Cell replacements.
- SPS and Forcemain additions to connect to the municipal sewer system.

In-progress and planned projects, modifications, and initiatives for the Drainage and Sewage Systems include:

- Active Liquid Waste ion exchange column spent process change to optimize the usage of existing resin columns.
- Active Liquid Waste sumps to have an additional pump installed to provide alternate means to pump out sump during maintenance and to increase reliability.
- Inactive Drainage sump pump replacement, to replace existing submersible pumps with outboard pumps.
- Inactive Drainage level switches relocation to improve accuracy of annunciation.
- Active Liquid Waste tank liner replacement.
- Active Liquid Wast tanks chemical addition station to improve current manual chemical addition process.
- Sump level switch upgrade for Sewage system which will create a more consistent duty cycle for the pumps.
- Additional sump pump for drains sewage to create an alternate path for urgent pump out and maintenance purposes.

B.21 Plant Auxiliary Systems – Auxiliary Service Water and Safety Related System – Emergency Service Water

The ESW System is classified as a Safety Related System and as a Group 2 Safety System. During normal station operation, the purpose of the ESW System is to act as the source of firewater for the station, and to act as a source of service water and make-up water for a number of systems. For DBA conditions, the ESW System acts as a back-up source of water for cooling and make-up to systems that may have lost their normal supply because of the accident.

The basic nuclear safety function of the ESW System is to assist in the removal of decay, residual or process heat by providing cooling water (supply and return) or make-up water (supply only) to specified systems when their normal sources of supply might be interrupted as a result of certain design basis events. Additionally, it is to ensure prevention of subsequent process failure and release of radioactivity to the public. To ensure consistent ESW System reliability, the system is designed to operate during normal station operation, rather than being dormant (i.e. to supply some regular station loads).

Auxiliary Service Water (ASW) System has no nuclear safety requirements. ASW is supplied by the ESW System in the Central Service Area , the FFAA East and the FFAA West. It is a cooling water system for cooling of the various continuous and intermittent loads, or for miscellaneous process uses in the Central Service Area, the WTP, the Technical Support Building and the FFAA East and West.

Completed projects, modifications, and initiatives for the ESW and ASW Systems include:

- Vibration Monitoring System upgrade on ESW pumps.
- Restoration of ESW and Fire Water margins by installing Emergency Mitigating Equipment (EME) hose manifolds on the ESW System and implementation of auto-isolation of the ASW System during a Main Steam Line Break (MSLB) signal.
- ESW buried piping line replacement during 2015 VBO, and cathodic protection system installation to extend lifetime of the piping.
- ESW tie-ins for BDBE modifications, such that EME pumps can provide makeup water to Steam Generators and Moderator.
- ASW Containment isolation valves replacement (Units 3 and 4 only).

In-progress and planned projects, modifications, and initiatives for the ESW and ASW Systems include:

- Major piping replacements during Refurbishment for line to the Vault Coolers and Main Supply Headers.
- ESW to PHT system permanent pipe connection to inject ESW for Beyond Design Basis Accidents (i.e. emergency heat sink).
- ESW supply and return line replacement for USCA Air Cooling Units (ACUs);
- ESW 4kV pump motors replacement.
- ESW piping Expansion Joints replacement.
- ESW travelling screen, motor, bubbler, and strainer replacements.
- Isolation valves addition on ASW supply lines to Breathing Air and Service Air compressors, to allow for improved efficiency in maintenance or replacement of compressors.

B.22 Plant Auxiliary Systems – Heating, Ventilation and Air Conditioning

The purpose of the ventilation system is to remove heat, provide general ventilation, minimize cross-contamination inside the station and minimize the release of contaminants to the environment. The system provides separate cooling and ventilation for SDS2 Equipment and Group 2 Instrument Rooms, steam protected rooms and automatic steam venting in the powerhouse in the event of a steam or feedwater line break. The system also provides intake process air for Breathing Air Compressors.

The purpose of the air conditioning system serving the Main Control Centre in the central service area at elevation 115.0 m is to provide a suitable environment for the proper operation and long service life of the computers, electrical and electronic equipment therein, comfortable working conditions for the operating personnel, and to provide emergency smoke removal capabilities.

Completed projects, modifications, and initiatives for the Heating, Ventilation and Air Conditioning (HVAC) Systems include:

- Powerhouse Units HVAC Systems outside air temperature switches upgrade.
- Powerhouse Steam Venting System (PSVS) modification.
- Powerhouse Ventilation fire damper replacement.

In-progress and planned projects, modifications, and initiatives for the HVAC Systems include:

- Powerhouse ACU replacements.
- ACU replacement for Secondary Control Area.
- Glycol Chiller temperature control valves replacement.
- Station Glycol header installation.
- PSVS actuator overhauls.
- MCR HVAC backup Instrument Air compressor/dryer replacement.
- Common Service Area major ventilation systems upgrade.
- Ventilation and Air Conditioning fans replacement.

B.23 Plant Auxiliary Systems – Low Pressure Service Water

The LPSW System is a unitized, once-through type, cooling water system which uses strained Lake Ontario water for cooling various continuous and intermittent loads. Water is drawn from the station's forebay, and after passing through the various loads, is returned to the lake via the CCW discharge duct.

Completed projects, modifications, and initiatives for the LPSW System include:

- LPSW Travelling Screens replacement to resolve corrosion issues for components below surface of water.
- Advanced Algae Warning System development, which has the capability to provide Operations with an alert 72 hours in advance if there is a higher risk of an algae run due to inclement weather patterns. A procedure is also in place for operation of this system.
- Replacement of LPSW pressure control valves.
- Conducted a full LPSW outage on each Unit to replace isolation valves for critical loads.

In-progress and planned projects, modifications, and initiatives for the LPSW System include:

- LPSW booster pumps replacement.
- Several valve replacements within LPSW System including for the Screenwash, Vault Cooler supply, Moderator Temperature Control, Recirculation Cooling Water supply, IPB LPSW isolation, Turbine Hall supply, and Shutdown Cooling isolation.
- Piping replacement for several section of LPSW System piping, including Back Up Bearing Tank standpipe, Small Bore piping, and piping around main LPSW pressure control valve.
- LPSW 4kV Motors refurbishment.

- LPSW pump discharge Expansion Joints replacement.
- LPSW Pump rebuild to address degradation mechanisms such as corrosion by utilizing stainless steel parts for applicable sub-components.

B.24 Plant Auxiliary Systems – Powerhouse Upper Level Service Water

The Powerhouse Upper Level Service Water (PULSW) System is a Safety-Related and Group 1 system. The purpose of the PULSW is to take water from the LPSW in order to provide cooling water to specific equipment, where either the freezing of D_2O is a concern or higher pressure cooling water is required. The equipment serviced by the PULSW are Heat Exchangers, some of which are safety related and/or seismically qualified, or environmentally qualified for a MSLB. An additional safety related aspect of the PULSW is that, following loss of Class IV Power, there are designated loads that are serviced by the PULSW using Class III Power.

The nuclear safety functions of the PULSW System are to:

- Remove decay heat.
- Support the operation of other Safety-Related Systems.
- Maintain Containment Boundary integrity where its piping penetrates through containment.
- Provide post accident monitoring.

PULSW outages have been completed successfully on each unit. This configuration allowed for a significant amount of work to be completed on the PULSW system as the upstream supply was drained. Major equipment such as temperature control valves, isolation valves, discharge check valves, and piping were replaced during the outages. PULSW outages are planned to take place every 12-years, which will continue to allow replacement of critical components such as piping and valves to ensure continued equipment reliability.

Completed projects, modifications, and initiatives for the PULSW System include:

- Shutdown Cooling (SDC) heat exchangers replacement
- Vapour Recovery System Dryers strainer additions to allow for clearing of fouling (e.g. zebra mussels, corrosion products, silt).

In-progress and planned projects, modifications, and initiatives for the PULSW System include:

- PULSW piping replacements for supply and return piping to the SDS heat exchangers, including replacement of various field run copper line sections with stainless steel.
- Temperature and flow control valve positioners replacement for several valves across the PULSW system.
- PULSW 4kV pump motors replacement.
- PULSW Temperature Control Valve full valve replacement.
- PULSW isolators for SDC.

B.25 Plant Auxiliary Systems – Recirculated Cooling Water

The Recirculated Cooling Water System (RCW) System is a Safety-Related and Group 1 system. The RCW System is a unitized closed loop cooling system, containing demineralized water as the working fluid. The purpose of the system is to supply cooling water to certain vital equipment requiring treated water; at a temperature above the freezing point of D_2O, at a pressure sufficiently high to prevent localized boiling in certain heat exchangers, and of a quality sufficiently high to minimize corrosion, fouling and activation by radiation. In addition, following a loss of Class IV power, the RCW System provides continued cooling water flow from a pressurized storage tank (i.e. head tank) to the Heat Transport Bleed Cooler, by gravity. When Class III power is established the RCW System provides cooling water flow to a smaller set of loads that are essential to remove residual heat. Heat rejection from the RCW System is to the LPSW System.

The nuclear safety functions of the RCW System are to remove decay heat by supporting the operation of designated safety-related systems, maintain containment boundary integrity where its piping penetrates through containment, and to provide post-accident monitoring.

During Refurbishment on Units 1, 2 and 3, inspection and cleaning of multiple RCW heat exchangers has occurred. Inspections of these heat exchangers have shown favourable results with no tube plugging required after approximately 30-years in service. Cleaning of these heat exchangers have shown improved results pertaining to heat transfer efficiency. Similar inspections of these heat exchangers will occur during the Refurbishment of Unit 4. Heat exchangers that are not inspected during the Refurbishment outages will continue to be inspected in future unit outages and tracked as part of the Heat Exchanger Program.

Completed projects, modifications, and initiatives for the RCW System include:

- RCW valve replacements for various pneumatic valves and temperature control valves within the system.

In-progress and planned projects, modifications, and initiatives for the RCW System include:

- Temperature transmitter relocation for improvement in reliable temperature control of the RCW System.
- Controller replacements for RCW System

Appendix C: Activities and Nuclear Substances to be Encompassed by the Licence

The information below is provided to satisfy the requirements of Section 3(1)(b) of the *General Nuclear Safety and Control Regulations*.

Activities to be Licensed:

The application for renewal of PROL 13.03/2025 contains information for the activities to be licensed. These activities include those currently licensed in PROL 13.03/2025:

i. operate the Darlington NGS which includes the Darlington NGS Tritium Removal Facility housed within the Heavy Water Management Building at a site located in the Municipality of Clarington, in the Regional Municipality of Durham, in the Province of Ontario;

ii. possess, transfer, use, package, manage and store the nuclear substances that are required for, associated with, or arise from the activities described in i.;

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

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

v. possess, transfer, process, package, manage and store the nuclear substances associated with the operation of the Darlington NGS Tritium Removal Facility;

vi. possess, transfer, process, package, manage and store Molybdenum-99 radioisotope and its associated decay isotopes.

Additional activities requested to be licensed include activities associated with the production of isotopes. Requests to amend the Darlington NGS PROL to include these activities were submitted in References C-1, C-2 and C-3 and these requests are pending Commission decision.

List of Nuclear Substances:

Table 32 below is provided to satisfy the requirements of Section 3(1)(c) of the *General Nuclear Safety and Control Regulations*.

Nuclear Substances Identified:

- Natural Uranium (as fuel bundles);
- Depleted Uranium (as fuel bundles);
- Depleted Uranium (in components, e.g. shielding);
- Irradiated Uranium (as spent fuel bundles that contain fission and activation products including actinides, such as Pu-239);
- Molybdenum-99 (Mo-99) radioisotope (and its associated decay isotopes), and Zirconium target cladding;
- Heavy Water (D_2O, DTO);
- Tritium as gas (DT, T_2), and Tritium as solid (Titanium Tritide);

- Enriched Uranium (in components).

The maximum quantity is interpreted as the maximum amount that can be accommodated in inventory as per design by Darlington NGS (including the TRF for its operation). The data provided are current as of April 2024.

Table 32: List of Nuclear Substances

Nuclear Substance	Form and Location	Maximum Quantity
Natural Uranium	Solid as Fuel Bundles: New Fuel Inventory, New Fuel Transfer Mechanisms, Fuelling Machine Heads, Service Area Rehearsal Facility, Pressure Testing Facility.	10838 bundles *
Irradiated Uranium	Solid as Spent Fuel bundles: All Bays – Storage Bays, Reception Bays, Wet Cask Bays. All Reactor cores – Units 1,2,3,4	461492 bundles * (note 1) 24960 bundles
Depleted Uranium	Solid as Fuel Bundles: New Fuel Inventory, Spent Fuel Discharged to Bays.	*Included in above totals marked with asterisk
Depleted Uranium in components (e.g. shielding)	Solid. Located within the Darlington protected area for use as needed.	1620.32 kg (note 2)
Nuclear substances associated with the production of Mo-99: • Mo-99 radioisotope and its associated decay isotopes • Zirconium target cladding	Mo-98 is irradiated to form Mo-99 in the Darlington NGS reactor core. The material to be irradiated is always encapsulated in the form of target capsules and inserted and removed from the core by the Isotope Irradiation System.	The quantity of activated Mo-99 will not exceed 8766 TBq. The quantity of activated Zirconium target cladding will not exceed 369 TBq.
Heavy Water	Liquid (D_2O, DTO)	6388 Mg (storage capacity)
Tritium	Gaseous (DT, T_2)	7.88 e+16 Bq (2.13 MCi) (note 3)
Tritium	Solid (Titanium Tritide)	2.73 e+19 Bq (737 MCi)
Enriched Uranium in Components (e.g. fission chambers)	Solid. Located within the Darlington protected area for use as needed	1.683 g (note 4)

Notes:
1. Full storage bay and reception/Wet Cask Handling Bay (WCHB) floor based on bay and module dimensions.
2. This is the current inventory. There is no design maximum and inventory may change (may increase) based on operational needs.
3. Value per the Safety Report, Part 3 (Rev 6).
4. This is the current inventory. There is no design maximum and inventory may change (may increase) based on operational needs.

Appendix 3 References	
C-1.	OPG letter, R. Geofroy to D. Saumure, “Darlington NGS – Application for Darlington Nuclear Generating Station Power Reactor Operating Licence 13.03/2025 Amendment for Production of the Cobalt-60 Radioisotope”, April 28, 2023, CD# NK38-CORR-00531-23462.
C-2.	OPG letter, A. Grace to D. Saumure, “Darlington NGS - Application for Amendment to the Darlington NGS Power Reactor Operating Licence 13.03/2025 for Additional Isotope Production”, February 26, 2024, CD# NK38-CORR-00531-25141.
C-3	OPG email, L. Moraru to M. Young, “Darlington NGS – Redacted Application for Amendment to the Darlington NGS Power Reactor Operating Licence 13.03/2025 for Additional Isotope Production”, May 14, 2024, CD# NK38-CORR-00531-25215.

Appendix D: List of Hazardous Substances

The purpose of this Appendix is to document a list of hazardous materials at the Darlington NGS with respect to a licence application requirement under *Class I Nuclear Facilities Regulations* SOR/2000-204.

Under *Class I Nuclear Facilities Regulations* SOR/2000-204, Licence Applications, General Requirements, S. 3.,

An application for a licence in respect of a Class I Nuclear Facility, other than a licence to abandon, shall contain the following information in addition to the information required by Section 3 of the *General Nuclear Safety and Control Regulations*.

- (e) the name, form, characteristics and quantity of any hazardous substances that may be on the site while the activity to be licensed is carried on.

Table 32 contains a list of the hazardous substances.

Table 33: List of Hazardous Substances

Name	Form	Characteristics	Quantity (inventory)	Quantity (in system)
Aluminex	Liquid	Corrosive acid	5 totes, 1000 L each	Consumed in system
Ammonia	Liquid (20%)	Toxic, corrosive base	maximum two totes x 1,020 kg/tote	225 kg as 20% ammonia for station
Argon	Liquified gas	Asphyxiant	1,500 gal tank (liquid argon)	Used as needed
Carbon dioxide gas	Compressed Gas	Mildly toxic, asphyxiant in high concentrations, heavier than air.	12,700 kg	14.4 m^3
Ethylene Glycol	Liquid	Toxic	2 drums, 205 L each	1000 L per unit estimated
Gadolinium Nitrate Hexahydrate	Solid, mixed with D2O	Toxic, severe irritant	~4 containers of 5 kg each	Combined all units: Liquid Injection Safety System: 132 kg Poison Addition Tanks: ~ 5 kg
Helium gas	Compressed Gas	Compressed gas, simple asphyxiant, lighter than air	12 tubes, total 2832 m^3 for station	Normally none. Used when needed.

Name	Form	Characteristics	Quantity (inventory)	Quantity (in system)
			3 tubes, total 708 m^3 for Tritium Removal Facility Additional trailer on site, capacity 3000 m^3	
Hydrazine (35% solution)	Liquid	Corrosive base, Toxic	Feedtrain + Emergency Coolant Injection + Recirculating Cooling Water (RCW) is 1,890 kg as 35% hydrazine for station	Maximum eight totes x 850 kg/tote
Hydrogen gas	Compressed Gas	Flammable Compressed Gas, lighter than air	800 m^3 in multi tube H_2 trailer 900 m^3 in six storage cylinders as backup	4 X 650 m^3 = 2600 m^3 nominalized to atmospheric pressure
Hydrogen gas	Compressed Gas	Flammable Compressed Gas, lighter than air.	Warehouse ~ 15 cylinders @ 197ft^3 Addition station combined: 24 cylinders @ 197 ft^3 when full.	Combined: ~ 60 ft^3
IX resin Cation	Solid	Toxic, irritant	~ 30 containers of 0.5 ft^3 bag and 2 bags in each container	Combined all units: 40 ft^3
IX Resin Anion	Solid	Toxic, irritant	~ 36 containers of 0.5 ft^3 bag and 2 bags in each container	Combined all units: 72 ft^3
IX resin: De-oxygenating Resin	Solid	Toxic, irritant	Not normally in stock; order per demand: 15 containers of 1 ft^3 bag	Combined all units 60 ft^3
IX resin: Lithiated mixed bed resin	Solid	Toxic, irritant	~ 40 containers of 0.5 ft^3 bag and 2 bags in each container	Combined all units: Primary Heat Transport (PHT) system: 48 ft^3 RCW: 28 ft^3

Name	Form	Characteristics	Quantity (inventory)	Quantity (in system)
				End Shield Cooling (ESC): 72 ft^3
IX resin: Neutral Mixed Bed Resin-	Solid	Toxic, irritant	~ 250 containers of 0.5 ft^3 bag and 2 bags in each container	Combined all units: Moderator 160 ft^3 Irradiated Fuel Bay: 720 ft^3 Liquid Zone Control: 40 ft^3 Stator Cooling Water: 8 ft^3 Primary Heat Transport: 40 ft^3 D2O Cleanup system: 36 ft^3 Active Liquid Waste: 120 ft^3
Lime	Solid (powder) made into paste with water.	Corrosive base	Bulk tank – paste 45,400 kg	Consumed in system
Lithium Hydroxide monohydrate	Solid, made into solution for addition	Corrosive base	~ 23 bottles of 0.5 kg each	Combined all units (in liquid): PHT: ~1944 g ESC: 36000 g RCW: ~70 g
Lubricating oil and seal oil Teresso #46	Liquid	Non-toxic during normal use	1,640 L	Estimated 2,800 L of oil in the system piping
Morpholine	Liquid	Combustible liquid, toxic, corrosive base	8 totes x 800 kg/tote	200 kg as 45% morpholine for station
Nitrogen gas	Compressed gas	Asphyxiant	32,000 L bulk supply, approx. 40 cylinders (304 ft^3)	N/A. Used when needed.
Nitrogen liquid	Compressed Liquid	Cryogenic hazard	32,000 L bulk supply	N/A. Used when needed.

Name	Form	Characteristics	Quantity (inventory)	Quantity (in system)
Oxygen gas	Compressed Gas	Strong oxidizer - increases flammability of flammable or combustible material	2 oxygen cylinders (335 ft^3 each) for moderator cover gas, 2 cylinders for Liquid Zone Control gas. 4,780 m^3 bulk storage at TRF.	Approx. 1,340 ft^3
Reolube Turbofluid 46XC Fire Resistant Fluid	Liquid	Mildly toxic	17 drums @ 205 L = 3,500 L	40,000 L (10,000 per unit)
Sodium Hypochlorite 12%	Liquid	Corrosive acid, oxidizer – increases flammability of flammable or combustible material	2 x 27,000 L storage tanks in Water Treatment Plant; 4 x 4,000 L tanks, one in each Low Pressure Service Water pumphouse; 2 x 4,500 L tanks in Emergency service Water	N/A. Diluted into system water.
Sodium Meta-bisulphite 38% aqueous	Liquid	Corrosive acid, toxic	6 x 1,000 US Gallon Storage Tanks	N/A. Diluted into system water.
Sodium Hydroxide	Liquid	Corrosive base	46,000 L max tank volume (connected to system)	Consumed in system
Sulphur Hexafluoride	Compressed Gas	Compressed Gas, mildly toxic	2 1A cylinders, 1.55 ft^3 each, total 3 ft^3	ZERO most of the time. 6 ft^3 during testing.
Sulphuric Acid	Liquid	Toxic and corrosive	38,600 L max tank volume (connected to system)	N/A. Diluted into system water.

Name	Form	Characteristics	Quantity (inventory)	Quantity (in system)
Transformer Fluid - Oil (litres)	Liquid	Non-toxic during normal use.	Currently not in stock.	4,650 L per transformer x 16 = 74,384 L = 75 m^3 plus 1,353 m^3 = 1,428 m^3 total
Transformer Fluid - Silicone (litres)	Liquid	Non-toxic during normal use.	Currently not in stock.	4,650 L per transformer x 22 = 102,278 L
Type 1 heating fuel oil, "Stove Oil", Diesel Fuel	Liquid	Combustible Liquid, toxic	Standby Generator: Total of 4 tanks. Approx. 3720 m^3 of fuel oil in all 4 tanks. Emergency Power Generator: ~ 660,000 L in 6 tanks	N/A. Consumed by equipment.
Standby Generator Lube oil Teresso 32	Liquid	Non-toxic during normal use	300 L/tank (1,200 L total)	Short pipe runs. Negligible amount.
Standby Generator Lube Oil Turbo Oil 2380	Liquid	Non-toxic during normal use	3,420 L in each Standby Generator building (13,680 L total)	Short pipe runs. Negligible amount.

Appendix E: Permits, Certificates and Other Licences

The following are CNSC licences that control other nuclear substances at Darlington NGS.

Waste Facility Operating Licence

Darlington Waste Management Facility, WFOL-W4-355.00/2033

Nuclear Substance and Radiation Devices Licences

Industrial Radiography (812), 12861-1-25.5

Consolidated Use (815), 12861-2-25.3

Basic Servicing (822), 12861-17-25.2

Dosimetry Service Licence

Dosimetry Service, 12861-11-25.9

Class II Nuclear Facilities and Prescribed Equipment Licences

Class II Irradiator (635), 12861-18-26.7

Import/Export Licences

Import:

Import Licence, IL-A4-27071.0/2024
Import Licence, IL-A2-A4-26400.0/2024
Import Licence, IL-A2-A4-26401.0/2024

Import Licence, IL-A2-A4-27029.0/2026

Import Licence, IL-A2-29788.0/2028
Import Licence, IL-A4-29770.0/2028
Import Licence, IL-A2-A4-27029.1/2028

Export:

Export Licence, EL-A4-27070.0/2024
Export Licence, EL-B3-27315.0/2024

Export Licence, EL-A4-26398.0/2025
Export Licence, EL-A3-A4-27530.0/2025

Export Licence, EL-A4-27030.0/2026

Summary of Regulatory Commitments, Regulatory Obligations and Regulatory Management Actions Made/Concurrence Requested

CD# NK38-CORR-00531-25450 P

Submission Title: **Darlington NGS – Application for Renewal of the Darlington Nuclear Generating Station Power Reactor Operating Licence 13.03/2025**

Regulatory Commitments (REGC):

No.	Description	Date to be Completed
	None.	

Regulatory Management Action (REGM):

No.	Description	Date to be Completed
	None.	

Regulatory Obligation Action (REGO):

No.	Description	Date to be Completed
	None.	

Concurrence Requested: None