Canadian Nuclear Safety Commission | Commission canadienne de sûreté nucléaire

CMD 25-H2.1

File / dossier : 6.01.07
Date: 2025-02-25
e-Doc: 7469555

# Written submission from Ontario Power Generation Inc.

# Mémoire d’ Ontario Power Generation Inc.

In the Matter of the

**Ontario Power Generation Inc.**

Application to renew power reactor operating licence for the Darlington Nuclear Generating Station

À l’égard d’

**Ontario Power Generation Inc.**

Demande concernant le renouvellement du permis d’exploitation d’un réacteur de puissance pour la centrale nucléaire de Darlington

**Commission Public Hearing**
**Part-1**

**Audience publique de la Commission**
**Partie-1**

**March 26, 2025**

**26 mars 2025**

Canada

ONTARIO POWER GENERATION

**Allan Grace**
Senior Vice President
Darlington Nuclear

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**OPG Proprietary**

February 24, 2025

CD# NK38-CORR-00531-25966 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 – Notice of Participation at CNSC Public Hearing 2025-H-02 and Written Submission in support of the renewal of the Darlington Nuclear Generating Station Power Reactor Operating Licence**

The purpose of this letter is to notify the CNSC pursuant to Rule 18 of the "CNSC Rules of Procedure", of OPG's intent to appear at Public Hearing 2025-H-02 and to provide the associated written submission in support of the application for renewal of the Darlington Nuclear Generating Station - Power Reactor Operating Licence.

OPG will appear before the Commission regarding Public Hearing 2025-H-02 on March 26, 2025. In support of the hearing, Attachment 1 documents written submission Commission Member Document CMD 25-H2.1 which provides information consisting of items discussed in OPG's original renewal application submitted in Reference 1 and the supplemental to the application submitted in Reference 2.

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. OPG letter, A. Grace to C. Salmon, “Darlington NGS – Supplemental Update in Support of the Power Reactor Operating Licence Renewal Application”, December 18, 2024, CD# NK38-CORR-00531-25844.

**ATTACHMENT 1**

OPG letter, A. Grace to C. Salmon, “Darlington NGS – Notice of Participation at CNSC Public Hearing 2025-H-02 and Written Submission in support of the renewal of the Darlington Nuclear Generating Station Power Reactor Operating Licence”

CD# NK38-CORR-00531-25966 P

**Darlington Nuclear Generating Station Power Reactor Operating Licence Renewal**

**Commission Member Document 25-H2.1**

**(241 pages)**

OPG Written Submission in support of

# Darlington Nuclear Generating Station

## *Power Reactor Operating Licence Renewal*

*CMD 25-H2.1*
*February 2025*

ONTARIO POWER GENERATION

## Land Acknowledgement

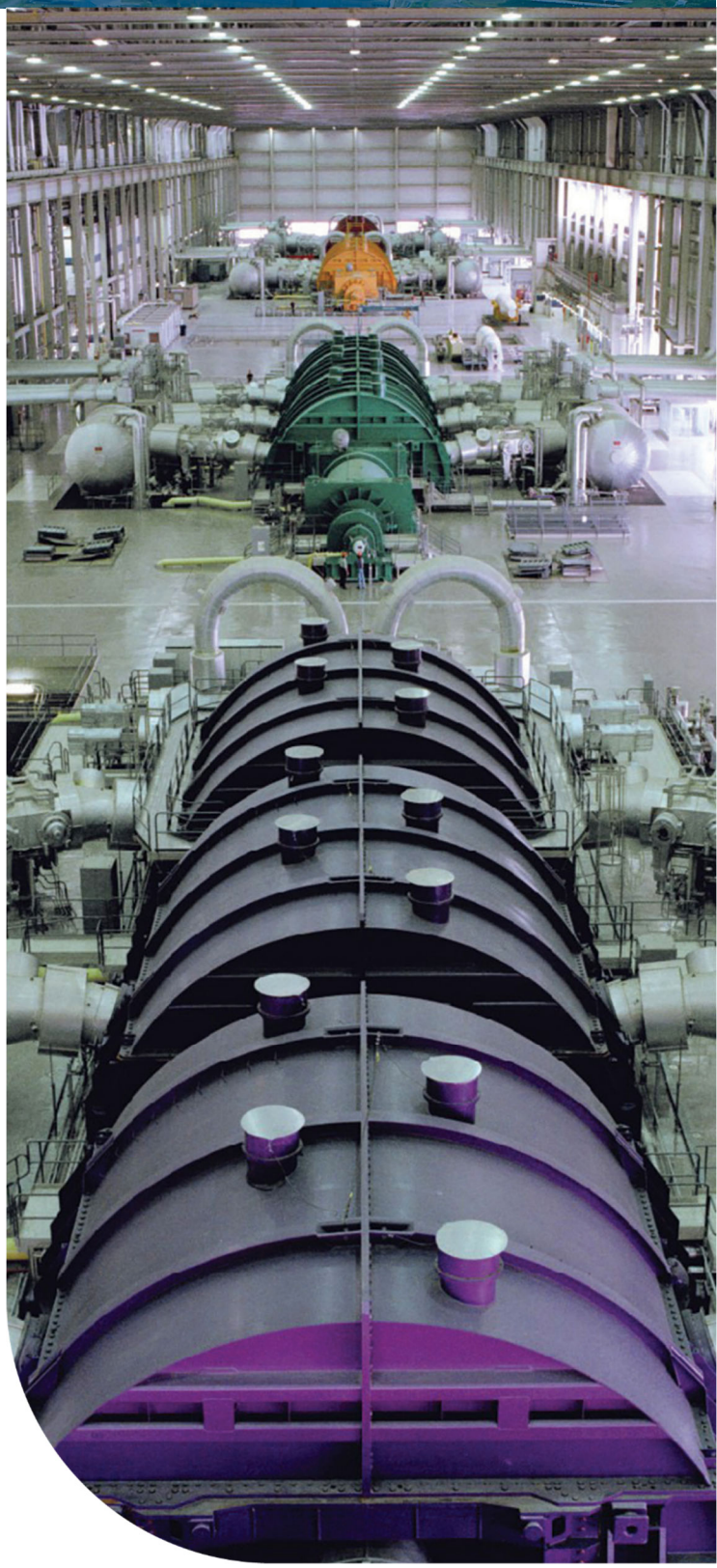
The lands and waters on which the Darlington Nuclear Generating Station (NGS) is situated are the treaty and traditional territory of the Michi Saagiig and Chippewa Nations, collectively known as the Williams Treaties First Nations.

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) is requesting authorization from the Canadian Nuclear Safety Commission (CNSC) for the renewal of the Darlington Nuclear Generating Station (NGS) Power Reactor Operating Licence PROL 13.04/2025 for a 30-year licence term from December 1, 2025 to November 30, 2055.

OPG has submitted a licence renewal application prepared in accordance with the requirements of the *Nuclear Safety and Control Act* (NSCA) and its associated Regulations, as well as the requirements and guidance contained in CNSC regulatory document REGDOC-1.1.3, *Licence Application Guide: Licence to Operate a Nuclear Power Plant*. In addition, OPG has submitted a supplemental application providing updated information on metrics and information that was pending at the time of the application, as well as information related to OPG's responses to CNSC staff's review of the application.

Together, the licence renewal application and supplemental application provide comprehensive information demonstrating that OPG meets all regulatory requirements and is qualified to carry on the requested licensed activities. Further, that OPG will continue 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.

Darlington NGS is a top quartile performing nuclear power plant, with more than three decades of operating experience. OPG has a strong reputation for safe and reliable operations and has earned support and trust

in the communities in which we operate. The requested 30-year licence term coincides with station operational objectives achieved through our refurbishment of the Darlington NGS units.

## 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.

In addition, station reliability has remained strong due to investments and improvements made over the current licence term. 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.

Throughout the licence term, collective and individual worker 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.

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.

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 onsite 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 Safety and Control Areas. 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 the current 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 many other components. This project allows for safe and reliable plant operation through 2055.

In the final quarter of 2024, several major milestones of the Refurbishment Project were completed, including Unit 1 return to service in November 2024. The full Darlington NGS Refurbishment Project is more than three-quarters complete in its 10-year execution phase, realizing strong safety, quality and schedule performance. Darlington NGS Units 2 and 3, each successfully refurbished, fully returned to service in June 2020 and July 2023 respectively.

Refurbishment of Unit 4 – the final unit at Darlington NGS to be refurbished is progressing on schedule, safely and successfully with the completion of the calandria tube removal in September 2024. Unit 4 is forecasted to be returned to service in Q3 of 2026.

## 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. The IIP identifies 17 actions with target completion dates ranging from Q4 2023 to Q4 2028. As of Q3 2024, four of the 17 IIP actions have been completed.

During the proposed 30-year licence term, OPG will continue to perform PSR and associated IIP updates at an approximate 10-year frequency.

## 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 158.6 million Curies (5.87e+18 Bq) of tritium 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.

## 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), Yttrium-90 (Y-90) and Lutetium-177 (Lu-177).

OPG has been producing Co-60, a critical isotope used in medical device sterilization and in food production, at Pickering NGS for decades. With the recent amendment to the Darlington PROL, OPG will be expanding 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 medical procedures each year, helping to detect illnesses like cancer and heart disease.

Additionally, pending regulatory approval, the TDS on Darlington NGS Unit 2 will be used to produce Y-90 and Lu-177. Y-90 and Lu-177 are medical isotopes used for radiation therapy and are proven to provide significant results in the treatment of specific cancers.

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:

- Adding 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 recognizes 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 licensing 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 the 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 July 2024, OPG released an updated version of the company's Reconciliation Action Plan (RAP). The RAP is a public document that serves as a roadmap for how we intend to work in partnership with Indigenous communities, businesses and organizations to advance reconciliation. The updated plan recaps OPG's progress on RAP goals through 2021-23 and shares OPG's outlook for 2024 and beyond.

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 stakeholder groups. OPG fosters open and ongoing dialogue through its comprehensive public outreach program that ensures public communications are informative, timely and accurate. OPG's Nuclear Public Information Disclosure and Transparency Protocol, posted on OPG's website, describes our communication principles and information requirements and reporting. The standard was developed in accordance with CNSC REGDOC-3.2.1, *Public Information and Disclosure.*

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 questions answered.

OPG recognizes that members of the local community, stakeholders and the general public have legitimate interests in licensing activities related to the Darlington station. OPG has continued to use the existing public information program to communicate relevant information, including promotion of opportunities for public involvement in the process.

## Conclusion

In summary, 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 the application and summarized in this written submission, OPG is confident the Darlington NGS will continue to operate safely and reliably through 2055.

OPG continues to be qualified to carry on the activities to be licensed and continues to 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 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.

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# Darlington NGS Licence Renewal

# 1.0 Darlington NGS Licence Renewal

## 1.1 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 serve a city of over 2 million people.

Darlington NGS also includes the Tritium Removal Facility (TRF), which reduces the tritium levels in heavy water inventories. The Darlington NGS site is owned by OPG, which is owned by the Province of Ontario.

OPG has applied to the Canadian Nuclear Safety Commission (CNSC) for renewal of the Darlington NGS Power Reactor Operating Licence (PROL), which expires on November 30, 2025. OPG has requested a 30-year licence term for the Darlington NGS PROL, from December 1, 2025 to November 30, 2055. In May 2024, OPG submitted a licence renewal application (Reference 1) prepared in accordance with the requirements of the *Nuclear Safety and Control Act* (NSCA) and its associated Regulations, as well as the requirements and guidance contained in CNSC regulatory document REGDOC-1.1.3, *Licence Application Guide: Licence to Operate a Nuclear Power Plant*. In December 2024, OPG submitted a supplemental application (Reference 2) which provided updated information on metrics and information that was pending at the time of the application. The supplemental application also provided information related to CNSC staff's review of OPG's application (Reference 3) and OPG's response (Reference 4). The application and supplemental application are available on opg.com.

Darlington NGS is comprised of four Canada Deuterium Uranium (CANDU) pressurized heavy water reactors. The CANDU reactor is a robust technology with multiple safety features, including redundant systems and passive safety mechanisms, and a strong track record of reliability. 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 nuclear professionals who operate and maintain the station have consistently demonstrated their commitment to safety and excellent performance.

Our reactors do more than generate electricity. OPG reactors are utilized to support the radioisotope industry in both the medical and food safety fields. The predictable and reliable nature of OPG reactors enables dependable supply chains for isotope markets and provides opportunities to expand offerings to new isotope markets.

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 licensing 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., annual Regulatory Oversight Report reviews and licence amendment requests.

Together, the licence renewal application and supplemental application provide comprehensive information demonstrating that OPG meets all regulatory requirements and is qualified to carry on the licensed activities. Further, that OPG will continue 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.

## 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:

- 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.
- Implementing 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, 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.

In 2022 OPG made history with an all-women led crew of CNSC-licensed 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 Key Considerations

### 1.3.1 Licence Term

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 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 1, 2 and 3 are complete, and Unit 4 is 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.

As demonstrated in the application and supplemental application, OPG is committed to the continued safe and reliable operation of Darlington NGS and asserts that:

- Nuclear safety will be assured such that plant personnel, the public and the environment are protected.
- The impacts of plant operation to the public, workers and the environment will continue to be of low risk and adequately mitigated.
- Staff are qualified and competent to operate the plant.
- Systems, structures and components at Darlington NGS are fit to continue commercial operation through the next 30-years.
- OPG continues to invest in Darlington NGS to support nuclear safety.
- OPG is committed to continued, meaningful dialogue with Indigenous Nations and communities and members of the public.

### 1.3.2 Station Performance

Throughout the licence term, Darlington NGS continued to maintain a strong performance record that demonstrates OPG's on-going commitment to produce reliable, clean energy while protecting its workers, the public, and the environment. Performance highlights include:

- Darlington NGS has had no lost time injuries since May 2018 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.
- The 2020 Darlington NGS site Environmental Risk Assessment (ERA) and 2024 ERA Addendum 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 continues to be seen as operating to the highest levels of operational safety and reliability. Darlington NGS undergoes an international WANO peer review every two years and is recognized as a top-performing nuclear power plant in the world.

#### 1.3.2.1 Achievements and Initiatives During Current Licence Term

Darlington NGS's strong performance 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 behaviours for establishing a culture that achieves sustainable results and enables continuous performance improvement. Annual *"Staying on Top"* assessments are conducted to ensure OPG is driving excellence in all areas. OPG's 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.

**Darlington Refurbishment Project**

The Darlington NGS Refurbishment Project is a multi-year, multi-phase project that enables 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 many other components at Darlington NGS's four units. To date, Units 1, 2 and 3 have been

successfully returned to service and Unit 4 refurbishment activities are progressing on schedule with planned completion 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.

For example, the following Safety Improvement Opportunities (SIOs) implemented during the refurbishment project were credited in the 2020 Darlington NGS Probabilistic Safety Assessment (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.

PSA results for Internal Events At-Power showed a 26% decrease in the Severe Core Damage Frequency and a 21% decrease in the Large Release Frequency as a result of these SIOs.

## Integrated Implementation Plans

The Darlington NGS Integrated Safety Review (D-ISR) was performed in support of refurbishment and life extension. The resulting IIP report NK38-REP-03680-10185, *Darlington NGS Integrated Implementation Plan*, outlines the improvements that support Darlington NGS's continued safe operation and focus on enhancing the station's safety and reliability. The D-ISR 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. As of December 12, 2024, OPG has completed 570 of 622 of the IIP refurbishment and continuing operation commitments.

In support of continued long-term operation into the next licence term, a 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 report NK38-REP-03680-11940, *Darlington NGS Periodic Safety Review (D-PSR): Integrated Implementation Plan,* was accepted by CNSC staff in Q1 2024 and contains 17 IIP Actions with scheduled completion dates ranging from Q4 2023 to Q4 2028. As of Q3 2024, OPG has completed four of the D-PSR IIP actions.

## 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 Units 1, 2 and 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. Additionally, a containment filtered venting system has been installed to filter radioactive materials from the vacuum building, preventing their release.

The EME is deployed in two phases. Phase 1 is the rapid deployment of on-site mobile equipment for immediate restoration of reactor cooling, monitoring and containment protection. Phase 2 is the 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.

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 158.6 million Curies (5.87e+18 Bq) of reactor heavy water tritium from Ontario CANDU reactors. Initiatives to improve and ensure continued detritiation capability include:

- Commissioning of the West Annex building, which has an additional 2100 Mg of storage capacity for heavy water, as well as drum handling facilities.
- Installation of a wet scrubber on the recombiner outlet and ventilation systems of the TRF to further enhance tritium reduction.

## 1.3.3 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 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 OPG's 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 Electric Power Research Institute Global Innovation Effectiveness Cohort reviewed OPG's innovation practices and processes and recognized the X-Lab Innovation Team for industry-leading practices. Global Innovation Effectiveness 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

OPG's Training department 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 expose the Operators to enhanced procedures, and 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 and provides opportunities 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 to better model transients, start-up and shutdown evolutions are in progress and targeted for completion mid-2025.
- 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 utilize 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.

## 1.3.4 Improvement Plans and Significant Future Activities

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.

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. Further details are provided in Sections 2, 3, and 4 of the application and summarized in relevant sections of this written submission.

## Completion of the Darlington Refurbishment Project

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 1, 2 and 3 is complete, and Unit 4 is currently in progress. Completion of the refurbishment project is on track for 2026.

## 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 oil turbine, and the installation of additional Cryogenic Refrigeration System hydrogen compressor capabilities. This work will improve safety and TRF 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), Yttrium-90 (Y-90) and Lutetium-177 (Lu-177) with a 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 the 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. Large scale 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 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:

- 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 OPG's roadmap 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.

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 July 2024, OPG released an updated version of the RAP. The refreshed plan recaps OPG's progress on RAP 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 RAP includes the addition of over 20 new commitments that were developed through internal discussions and input from Indigenous Nations, communities and businesses.

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.

## OPG's Climate Change Plan

In 2020, OPG released its first-ever climate change plan, establishing key goals 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 invest in technology to meet the changing demands of the electricity system.
- 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

# 2.0 Safety and Control Areas

The 14 Safety and Control Areas (SCAs) are a set of technical areas used by CNSC to assess, evaluate, review, verify and report on regulatory requirements and performance. The SCAs are further divided into specific areas that define the key components of each SCA.

The licence application (Reference 1) and supplemental application (Reference 2) detail the policies, programs, standards, procedures and processes implemented at Darlington NGS to meet the requirements of the *Nuclear Safety and Control Act* (NSCA), the regulations made under the NSCA and the operating licence. A summary of those descriptions, along with highlights of Darlington's strengths, achievements and planned improvements are provided in the subsections below.

## 2.1 Management System

OPG maintains a nuclear management system in accordance with the 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 the nuclear management system is to ensure that all OPG nuclear facilities are operated and maintained using sound nuclear safety and defense-in-depth practices to ensure radiological risks to workers, the public, and the environment are As Low As Reasonably Achievable (ALARA), and consistent with the OPG *Nuclear Safety and Security Policy* and the best practices of the international nuclear community.

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.

### 2.1.1 Management System

OPG's mature and effective Nuclear Management System documented in charter N-CHAR-AS-0002, *Nuclear Management System* (the Charter) provides the framework for programs, standards and processes which collectively ensure that Darlington NGS operates safely, and that safety is the foremost consideration in management decisions and actions.

The Charter takes its authority from the *Nuclear Safety and Security Policy* established by OPG's Board of Directors. In accordance with the policy, the Chief Nuclear Officer (CNO) is accountable to the Chief Executive Officer and Board of Directors to establish a management system that fosters nuclear safety and security as the overriding priority. Every OPG employee 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, Environment and Health and Safety). For those 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.

An overview of the OPG Governing Document Framework is provided in Figure 1.

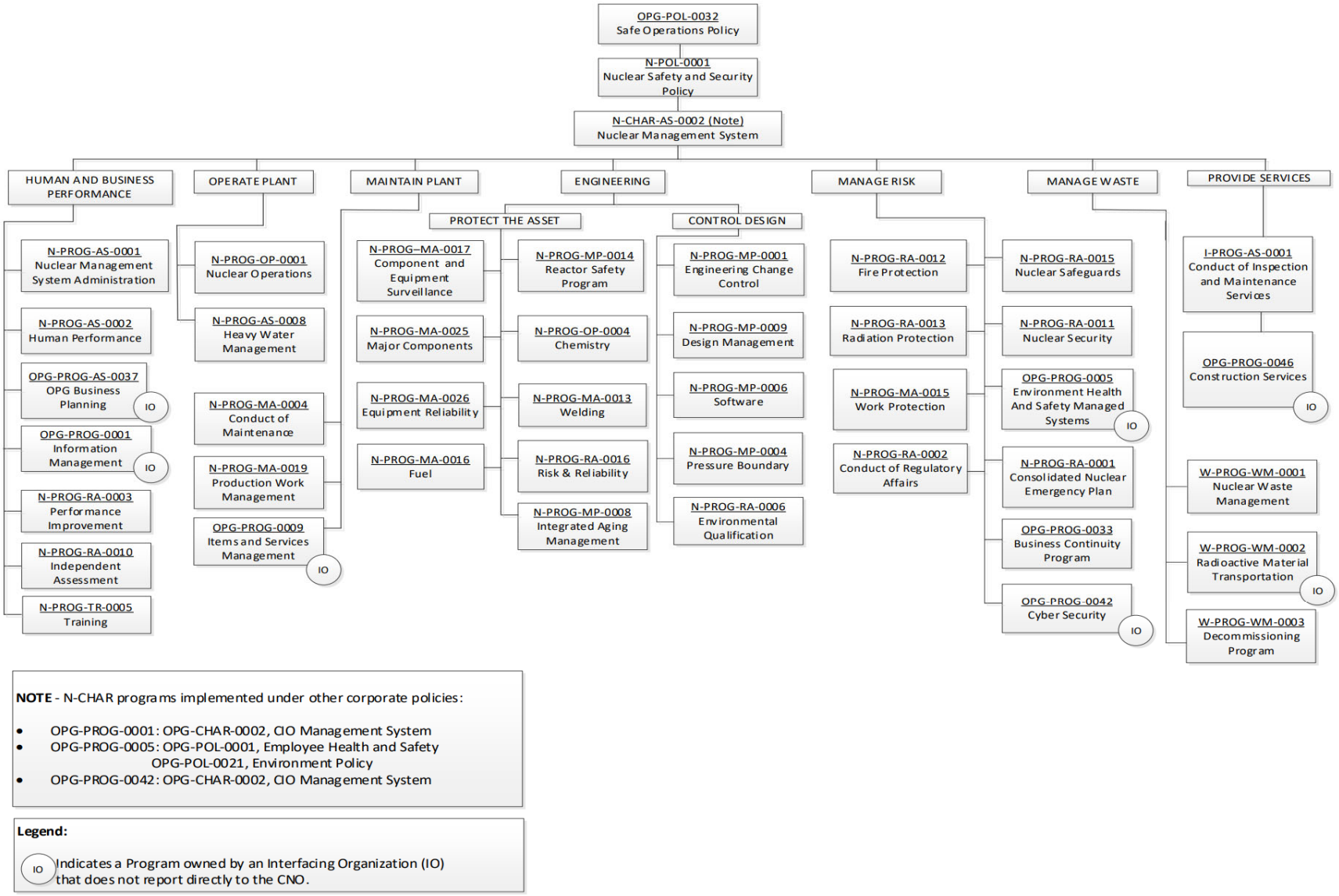



Figure 1: OPG Governing Document Framework

## 2.1.2 Organization

The *Nuclear Management Systems Organizations* standard describes the organization and responsibilities of OPG in support of the Charter and CSA N286-12. The objectives are to maintain a sufficient number of qualified staff to safely operate, maintain, and support the nuclear generating stations, and to maximize the efficiency and effectiveness of the OPG workforce.

Changes to the organization structure are controlled through managed processes that assign accountabilities and requirements for preparing, reviewing, approving and implementing organizational changes. The Darlington NGS organizational chart information is updated each year and submitted to the CNSC.

Appendix B provides an organization chart identifying OPG Nuclear and Nuclear-interfacing (Corporate) organizations as well as the positions with responsibilities for the management and control of licensed activities at Darlington NGS.

### Staffing Management

OPG 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.

OPG has a number of internal and external recruiting programs to attract a diverse and high performing workforce. These 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 Equity, Diversity, and Inclusion (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, OPG 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.

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's *Independent Assessment* program provides processes to perform comprehensive and critical evaluations of all activities affecting OPG nuclear facilities. The program ensures the nuclear management system is reviewed with sufficient frequency to confirm its continuing effectiveness. The program includes internal

assessments performed by Nuclear Oversight and external assessments performed by the Nuclear Safety and Review Board (NSRB).

An annual audit plan based on key risk areas, legal and regulatory requirements identifies the specific audits to be conducted by Nuclear Oversight in the upcoming year.

The NSRB provides the CNO with an independent assessment of OPG activities that may impact on nuclear safety and performance. The NSRB reports to the CNO who reports to the President and Chief Executive Officer on nuclear related matters. The NSRB also reports annually to the Generation Oversight Committee of the Board of Directors whose responsibilities include overseeing the safe, secure and efficient operations of OPG's generating facilities and compliance with nuclear, health and safety, and environmental laws and regulations.

As a learning organization, Darlington NGS strives for continuous improvement. The *Performance Improvement* program 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 (see section 2.3.3), self-assessment, benchmarking, operating experience, and nuclear safety culture.

Self-assessments and benchmarking for functional and line organizations are utilized to evaluate actual performance against management expectations, industry standards of excellence and regulatory requirements. *Self-assessment and Benchmarking* governance provide methods for identifying shortfalls in the performance of processes, programs, practices, behaviours, roles, responsibilities and organizational expectations. The process is aligned with the World Association of Nuclear Operators (WANO) performance objectives and criteria, which is a comprehensive guideline of industry practices, standards and lessons learned from operating experience and reflects a global standard for nuclear excellence.

Adverse conditions identified during the performance of audits or self-assessments are documented via Station Condition Records and corrective actions are assigned as required.

In addition, OPG performs regular program health and performance reviews for all applicable programs within the nuclear management system. *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, and program action plans.

A Fleetview Program Health and Performance Report for every program is completed at least once per year. Programs that directly impact or support nuclear plant safety, reliability and generation complete a report tri-annually and the reports are provided for CNO and Nuclear Executive Committee review. 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 additional oversight to 14 key nuclear programs. Corporate Functional Area Managers (CFAMs) and Site Functional Area Managers collaboratively use the Governance, Oversight, Support and Perform 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 Governance, Oversight, Support and Perform 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 establishes processes 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 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 then verified to be complete and effective. Refer to Section 2.3.3 for further details.

The Performance Improvement program also establishes processes to ensure internal and external Operating Experience (OPEX) is evaluated, distributed to appropriate personnel, and applied to implement actions that improve plant safety and reliability.

External OPEX information is received weekly through the CANDU Owners Group (COG) and reviewed to identify any vulnerabilities and weaknesses that could result in similar events or problems at OPG stations. 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. Actions are identified when required to address these vulnerabilities or weaknesses and to implement lessons. External OPEX is also used to keep OPG staff informed of relevant industry information.

Internal events and lessons learned are also reviewed and communicated as appropriate to WANO, INPO, COG, and other OPG sites.

As part of ongoing improvements for the OPEX process and use of OPEX at Darlington NGS, a number of initiatives were completed during the licence term. These include:

- In 2021, OPG developed and released a new OPEX database to facilitate 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. In support of OPG staff daily activities, the OPEX database also provides a readily available repository of all previous external OPEX and site reviews/responses to new OPEX with searching capabilities.
- In 2024, the OPEX Health Metrics indicators were revised to challenge the status quo for indicators with consistent green scores over a long period. Target score for green, white, yellow and red ranges were also revised to further improve performance and challenge the fleet for maintaining excellence. Part of the OPEX Health Metrics revision included automation of some KPI 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.
- Integrated Station Brief meeting packages now include OPEX items from the weekly COG screening package as well as INPO Industry Reporting and Information System (IRIS) reports for key consequential events, for discussion

and to understand lessons learned that are applicable to the station. The key consequential events from the IRIS reports are communicated to COG to ensure they also get included in the external OPEX COG screening packages.

**Planned Improvements**

Additional OPEX improvement initiatives currently in progress include:

- Development of a new web-based OPEX search engine that will be able to extract information from various internal databases. The new search engine will be user friendly, easy to navigate and able to provide quick access to key OPEX events relevant to line organization tasks.
- Establishing a Plant Information Center Impact Identifier program to support line organizations in understanding how internal events that are 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 Darlington NGS ensures the station physical configuration for all essential Structures, Systems and Components (SSC) matches the configuration documents for all plant states. The implementing standard for Configuration Management ensures configuration information is maintained accurate, consistent and readily accessible along with defining clear scope, responsibilities, authorities and interfaces among organizations.

Changes which may affect configuration are controlled 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.

Change Control programs 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 Station Condition Records.

The *Engineering Change Control* (ECC) program ensures design changes (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).

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 during the current licence term 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.

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

The *Nuclear Safety and Security Policy* 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 OPG'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.

OPG's Traits of a Healthy Nuclear Safety and Security Culture are detailed in Figure 2. These 11 Safety and Security Culture Traits are incorporated into OPG's organization and administrative procedures starting at the policy level and cascading throughout the Nuclear Management System, programs and procedures.

# 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 2: 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 to identify areas for improvement and 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 that included 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 areas where additional focus is required, such as: expanding the qualifications of the workforce, 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.

The results were documented in a self-assessment report and communicated to staff. 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 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) which is tasked with overseeing the KPI that reflect the state of the organization's nuclear safety and security culture. The panel is comprised of the senior plant leadership team and convenes at regular intervals 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 a Periodic Safety Review strength as it exceeds the requirements of 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 3 depicts Trait 4 *Leadership Safety Values and Actions*.


Figure 3: 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.

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 ensure that a strong Nuclear Safety Culture is pervasive throughout the organization.

**Safety Culture and Organizational Effectiveness**

OPG monitors organizational effectiveness through the use of 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.

Employee Engagement surveys are also used to pulse 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, the annual SOT assessment and Employee Engagement surveys 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. 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 it 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

The *Information Management* program establishes a set of standards and procedures for the management of OPG's information throughout its life-cycle, regardless of media, to ensure consistent and appropriate use. The program describes requirements for a management system of activities related to information and establishes uniform and efficient processes for management, maintenance, and final disposition of records and documents throughout OPG. It also establishes the overall process for OPG 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, and controls for document revision, review, approval and authorization.

The Information Management program is applicable to all OPG employees, 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. These include applications to allow workers to electronically submit and file records in Asset Suite/Curator, a system to electronically manage vendor document deliverables for Refurbishment, and tablets that allow for the use of electronic work packages in the field.

Planned and in-progress improvements include upgrading/modernizing the security document access process to take advantage of evolving encryption protections, decreasing the amount of legacy paper records in physical vaults and scanning quality assurance records for ease of access and secure fast retrievals.

### 2.1.8 Supply and Contractor Management

The *Items and Services Management* program establishes a governing document framework that meets regulatory requirements and ensures effective and efficient planning for and procurement of items and services. The program interfaces with the Contract Management program for managing contracts related to contractor services.

The Supply Chain organization is responsible for providing necessary services and materials to Darlington NGS in a timely manner. Supply Chain confirms all the quality aspects for receipted materials based on designated quality requirements, while the contract owner confirms quality aspects for services. Vendor quality is maintained through audits, receiving inspections, and vendor oversight and surveillance.

The Counterfeit, Fraudulent and Suspect Items (CFSI) program requires all suppliers to have an implemented CFSI program. These are 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 indicate that OPG's CFSI program is an industry-leading, well established and effectively implemented.

### 2.1.9 Business Continuity

The *Business Continuity* program establishes a managed system for business continuity and provides direction related to business and operational continuity and recovery planning. The program is aligned with OPG's business goals and objectives

and ensures that if a disruption occurs, or if there is a threat of disruption, critical business and operational processes will continue to be available or resume to at least the defined minimum operability within required time limits. The program is structured to be adaptable to a range of hazards or a combination of multiple hazards including a Human Health Emergency (e.g., COVID-19 pandemic).

Darlington NGS's business continuity plans were revised in 2022 to reflect an approach which considers 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 procedure which replaces previous pandemic plans. It 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 procedure 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.

## 2.2 Human Performance Management

OPG has an effective Human Performance program that meets or exceeds all applicable regulatory requirements and related objectives to enable effective human performance at Darlington NGS. The Human Performance program ensures that sufficient personnel are in place in all relevant job areas and have the necessary knowledge, skills, procedures and tools in place to safely carry out their duties.

### 2.2.1 Human Performance Program

The goal of OPG's *Human Performance* program is to continually reduce the frequency and severity of events of consequence through the systematic reduction of human error and the management of defenses in pursuit of zero events of consequence. 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 to monitor and correct any organizational deficiencies to minimize human error.

The *Human Performance* Program creates continuous improvement within the organization and reduces 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.

Over the current licence term, a number of initiatives were introduced to increase staff awareness and understanding of the factors that influence Human Performance and to provide staff with a set of tools and references to predict, manage, and prevent error-likely situations. These included:

- Enhanced communications (e.g., station spotlight, weekly focus area), increased awareness during periods 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;
- Leveraging Station Condition Records and Corrective Actions Plans to improve performance trends;
- In 2022, OPG implemented a Fail Safe Strategy which focuses on adding barriers, capacity, and defenses 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;
- Implementing and enhancing Observation and Coaching (O&C) in 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 observes another supervisor perform an O&C and providing feedback to improve performance.

Since 2020, O&Cs have been recorded in a data repository software. The data is trended and reviewed in various forums.

- Focusing 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.

The effectiveness of the Human Performance program has resulted in Darlington NGS achieving top industry performance in Site Event Free Day Resets. From September 2021 to April 2023, Darlington NGS set a record of 1074 days between events. The last event occurred on November 29, 2024.

## Planned Improvements

OPG is aligning with current industry best practices by enhancing its 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.
At the center of the *Core 4+* event prevention tools is *Stop When Unsure* that is to be used at anytime during the job process, as illustrated in Figure 4.


Figure 4: 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.

### 2.2.2 Personnel Training

OPG's *Training* program for regular staff, contractors, temporary personnel and other staff assigned work at OPG is compliant with CNSC regulatory document REGDOC-2.2.2*, Personnel Training,* and provides the structure, processes, and tools for defining, developing, implementing, documenting, assessing, and improving the training required to ensure staff have the appropriate knowledge, skills, and attitudes for safe and efficient plant operation.

Training and qualification information for all staff and contractors is stored and tracked in the Training Information and Management System (TIMS) database. The system also provides automatic updates via email for upcoming scheduled training and identifies expiring qualifications to employees and their supervisors. In 2023 alone, TIMS tracked a total of 36,644 hrs of training for Darlington NGS, comprised of computer-based training, classroom and on-the-job training.

The health of training is carefully monitored to ensure 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. 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.

## Innovation in Training

The objective of innovation in training is to incorporate innovative solutions and technology into OPG training. Line and Training Managers effectively collaborate to create learning solutions and technologies that support exemplary worker and station performance. Examples of innovative training at OPG include:

- Fuel Handling Simulator – Operations Training instructors have 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 expose Operators to enhanced procedures as well as to fine tune what are now first-of-a-kind procedures.
- Virtual Reality Crane Simulator – Maintenance Training instructors improved crane operator performance by incorporating a virtual reality 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 virtual reality 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 to better model transients, start-up and shutdown evolutions are in progress and is targeted for completion mid-2025.

## 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. Improvement initiatives in support of continued operational excellence include:

- The creation of Proficiency Heat Maps and Individual Development Plans
- 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 the 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 in Facilitative Leadership Techniques to enable learning and development.

## Operations Training

The development of knowledgeable, skilled, and highly competent Operations staff at Darlington NGS is accomplished through comprehensive initial and continuing training programs for non-licensed Operators and for persons in Certified positions. The training programs are SAT based and incorporate OPEX as a key element of continuous learning and performance improvement.

JIT training is delivered to ensure critical evolutions are conducted safely and efficiently and to reinforce 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 such as the turbine-governor control system have been modified.

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, implementing well established Human Performance tools to prevent and mitigate errors, and 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 psychology behind the Human Performance tools. Trainees are provided with 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.

Maintenance Training have implemented innovative solutions using virtual interfaces, such as the 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 and to support onsite work preparation and rehearsal.

## Engineering Training

Engineering training focuses on the core elements of nuclear professionalism and culture by concentrating on the key elements of conduct and behaviours. Engineering training includes an extensive Learning on Demand library of videos and other presentation material to share lessons learned.

An important component of the continuing 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 for the application of expected behaviours within the engineering community and is used as an opportunity to reinforce culture.

## Leadership Training

OPG Leadership training uses 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, and 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. 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. Some 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, an international partnership with EDF Energy UK that 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

Emergency Preparedness Training and Enterprise Emergency Management teams maintain alignment through formal reviews of potential training needs identified in field

performance observations during 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, OPG implemented a broad improvement initiative 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), 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*.

Darlington NGS's PROL requires individuals who are appointed to the following positions have valid CNSC certification:

(i) Responsible Health Physicist;

(ii) Shift Manager (SM);

(iii) Control Room Shift Supervisor (CRSS);

(iv) Authorized Nuclear Operator (ANO);

(v) Unit 0 Control Room Operator (U0 CRO).

OPG 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. OPG initial and continuing training programs are SAT-based as required by REGDOC-2.2.3 Vol III and REGDOC-2.2.2.

OPG's continuing training program for Certified Operating staff is at a mature stage. It 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 industry peers, Darlington NGS 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; create a culture of continuous learning, promote conservative decision-making; recognize and mitigate proficiency shortfalls, improve operator training, promote understanding of procedures important to the protecting the core and utilize independent oversight. Integral to the above 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 established processes. 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 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 5 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.

To ensure long-range Certified Operating staffing requirements are met, OPG has established a fleet level team to model staffing numbers to 2030 and incorporate into the 5-year Authorization Training Plan. 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. This 5 year plan is reviewed annually by the fleet team and updated based on Certified Operating staffing demand, identifying 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 industry partners through COG, Darlington NGS will be investigating opportunities to optimize and strengthen the initial training programs for Certified Operating staff. 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

OPG administers 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) in accordance with the CNSC documents:

- 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.

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 and are modelled to operate and respond as plant systems do under normal and transient conditions.

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 includes written tests and simulator-based comprehensive simulator tests and diagnostic simulator tests for all Certified Operating staff.

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.

## Planned Improvements

The Licence Conditions Handbook 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

Darlington NGS Minimum Shift Complement is the minimum number of qualified workers who must be present within the facility 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.

Station procedures and instructions document and describe the qualifications and minimum number of workers required under all operating states (including Refurbishment, where applicable) and their roles and responsibilities. Policies to prevent minimum shift complement violations as well as the mitigating measures to be taken in the event a violation occurs are also documented.

### Management of Minimum Shift Complement

OPG uses the Minimum Complement Coordinator Program as the approved information management system dynamic software program to manage the minimum shift complement system. The system possesses many capabilities, including:

- Assignment of Emergency Response Organization (ERO) roles for each shift.
- Tracking ERO/shift complement staff as they arrive (badge in) and leave (badge out) the protected area.
- Forecasting staff requirements.
- Various reporting including expiring qualifications, time exception and several accounting lists.

To ensure the Minimum Complement Coordinator Program uses the most up to date information, it is live linked to the TIMS database to ensure the qualification of staff assuming minimum shift complement roles and the OPG time reporting software to track staff schedules.

Changes are made to the software annually to update it by adding improvements, increasing efficiency and making it more robust.

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.

### Changes to Minimum Complement

During the licence term, Darlington NGS has gone through organizational changes that have led to changes to the Minimum Shift Complement. These include changes 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.

## 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 its 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 fitness for duty are in place 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.

Fitness for duty is addressed through initial and continuing training elements that focus on explaining OPG policies, expectations, and the various employee support programs available.

Other training includes:

- The Continuous Behaviour Observation Program – The program is designed to develop a supervisor's and manager's ability to recognize and respond to behaviours that could impact worker performance and safety.
- Additional training for SMs and CRSSs on monitoring fitness for duty for safety sensitive and safety critical personnel.
- The Fitness for Duty: Policy of Managing Alcohol and Drug Use program – training is provided through computer-based training courses for workers and supervisors.

If an OPG Security Officer suspects a worker is unfit, they will deny access to the facility and notify the 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.

Procedures are also in place to monitoring and control the Hours of Work (HoW) for Nuclear Broad Population and Safety Sensitive employees to meet the requirement set out by CNSC REGDOC-2.2.4, *Ontario Employment Standards Ac*t and Collective Agreement provisions. It includes guidance and instruction on:

- Hours of work (Including Regulatory limits, shift schedules and special exceptions).
- 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 (SPOC). OPG has implemented a new time keeping and reporting system 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.

## Employee Programs

OPG strives to create a work environment that fosters optimal physical and mental fitness of its 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).

## 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.

### 2.3.1 Conduct of Licensed Activity

The *Nuclear Operations* program implements a series of standards and procedures to ensure that Darlington NGS is operated safely, reliably and in accordance with regulatory requirements. The program establishes safe, uniform, and efficient operating practices and processes that provide nuclear professionals at Darlington NGS the ability to ensure the facility is operated in such a manner that the PROL, the *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 *Nuclear Operations* program implements instructions and requirements for consistent and safe operation of Darlington NGS. These include instructions on the systematic approach to operational decision making, identifying and reporting common and site-specific performance, the control of fuelling operations, and management's expectations on conservative decision making with regards to the safe operation of the plant.

The following subsections describe critical aspects of the Nuclear Operations program.

#### 2.3.1.1 Heat Sink Management

Heat sink management sets the requirements for the 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, two additional and conceptually different Auxiliary Shutdown Cooling (ASDC) pumps were installed 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

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.

### 2.3.1.2 Response to Transients

The roles and responsibilities of operating crews when responding to transients are defined 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.

### 2.3.1.3 Reactivity Management

OPG implements 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.

The reactivity management performance of the station is measured using the Reactivity Management Index (RMI). The RMI is a standard calculation used in the industry to gauge performance and facilitate benchmarking comparisons between individual plants and utilities. Figure 5 provides the average Darlington NGS RMI from 2015 to 2023. 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.

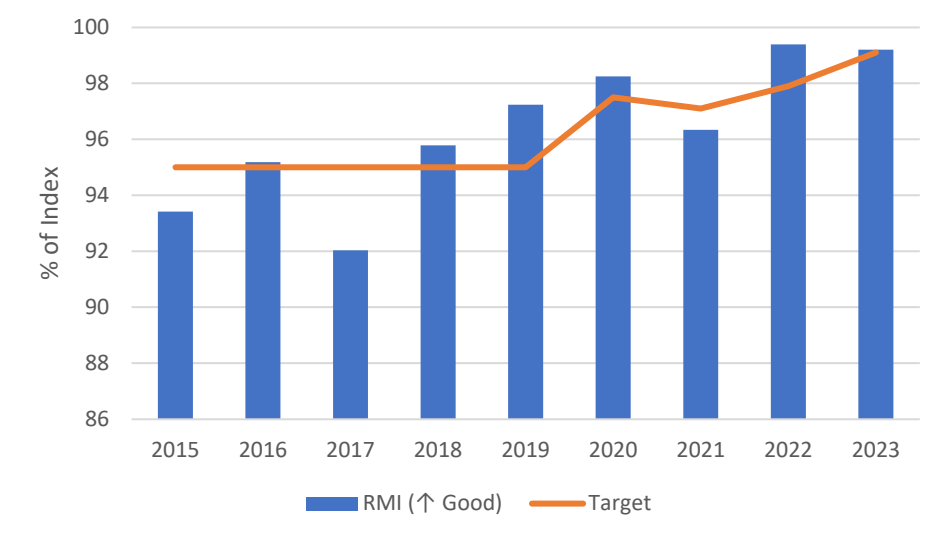



Figure 5: Darlington Average RMI vs Target (by Year), 2015-2023

### 2.3.1.4 Plant Status Control

OPG ensures that configuration of the station systems and components are monitored and controlled through the tracking of 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 6). 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.

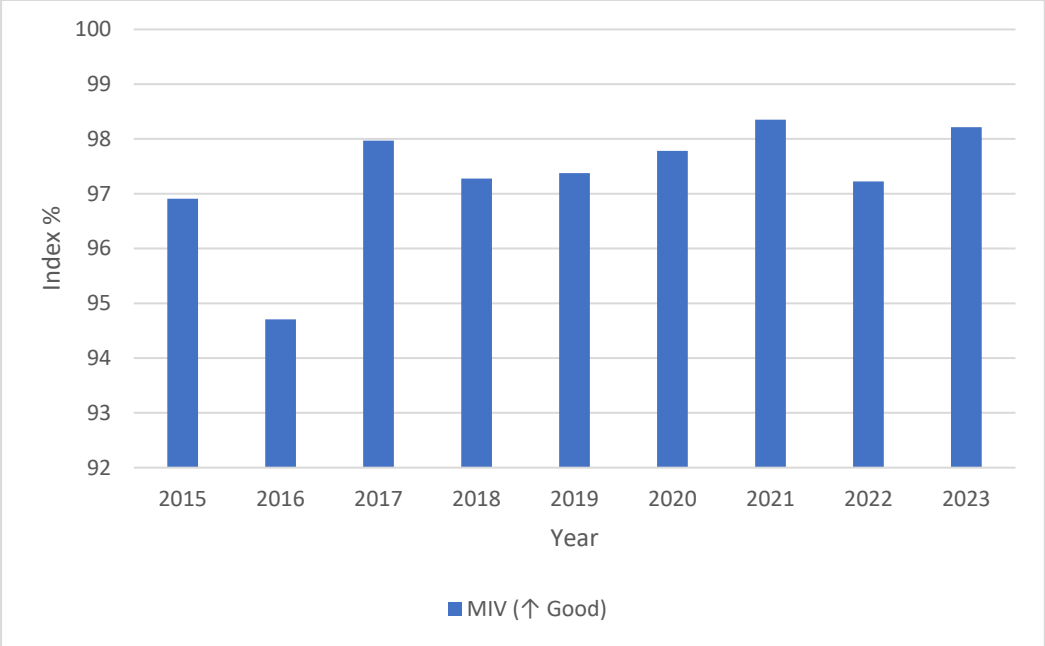



Figure 6: Average Mispositioning Index Value (by Year), 2015-2023

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 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 Operator Shift Log 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.

**Planned Improvements**

Current ongoing initiatives for the Plant Status Control program include:

- Creation of over 4000 new harsh environment tags.
- 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.

### 2.3.1.5 Work Protection

The *Work Protection* program describes the management processes, corporate governance 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 standards and procedures to ensure physical and administrative barriers are established between the energy source and the worker.

Operations provides oversight to the work protection program as follows:

- 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 7. An improvement in WPPI has been realized in the current licence term.

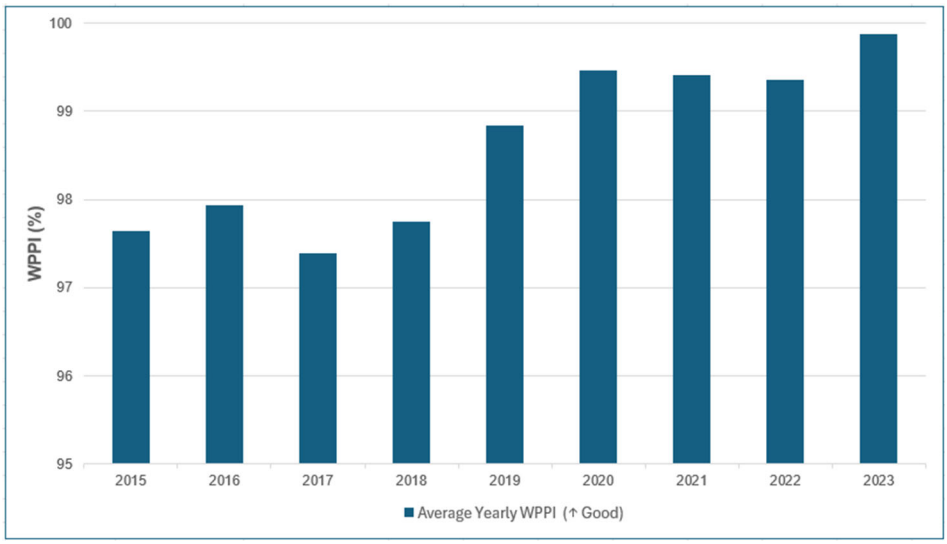



Figure 7: Darlington NGS Yearly Average WPPI

### 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. 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.

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 Technical Procedure Action Request (TPAR) backlogs and improve the

prioritization of implementing procedure updates. This includes the 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.

## Planned Improvements

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.

As part of implementation, OPG is developing a trial subset of procedures currently limited to Main Control Room panel checks and Operator Test Procedures.

### 2.3.3 Reporting and Trending

OPG's *Performance Improvement* program establishes the processes that support the conduct of Performance Improvement 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.

Adverse conditions are reported via Station Condition Records (SCRs). Each SCR is reviewed and dispositioned by an SCR coordinator 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 8 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, processes are in place for evaluating, integrating, accessing, and sharing OPEX information for applicable SCRs. Refer to Section 2.1.4 for further details on the OPEX process.

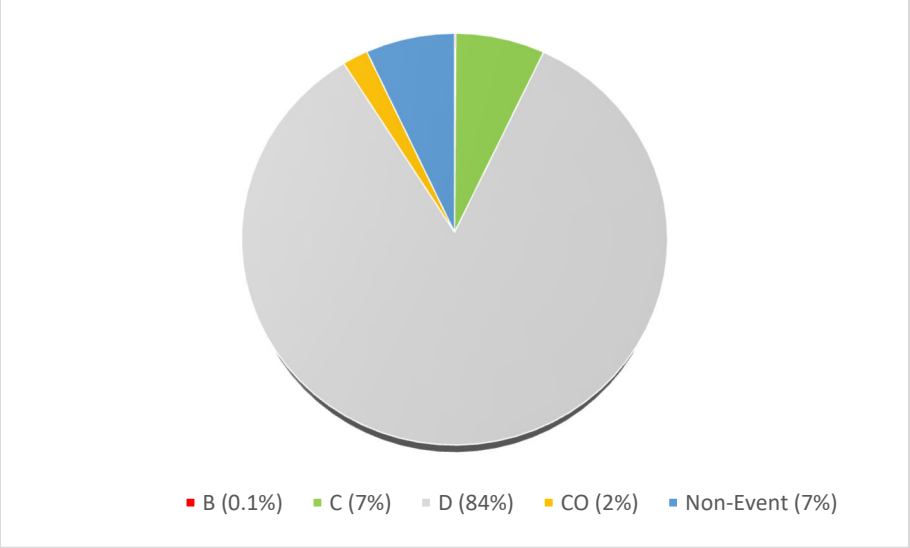



Figure 8 : Distribution of SCR Categories (Avg)

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 Performance Improvement 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 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 codes through Smart Performance Objective & Criteria Artificial Intelligence, 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**

Darlington NGS submits scheduled and unscheduled reports to the CNSC in accordance with REGDOC 3.1.1, *Reporting Requirements for Nuclear Power Plants* During the current licence term, there were 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 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 Improvements**

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 the requirements of CSA Standard N290.15 2010, *Requirements for the Safe Operating Envelope for Nuclear Power Plants*. OPG governance 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. SOE is critical to the implementation of the *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. 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 Compliance Tables 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 OSR safety limits and availability requirements in the OSRs. 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.

A Nuclear Oversight audit of the Reactor Safety program across OPG's nuclear facilities was conducted in May and June 2023, found the Reactor Safety program to be effective as a whole and 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 Emergency Operating Procedure (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). Severe Accident (SA) management provides an additional layer of defense-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 9.

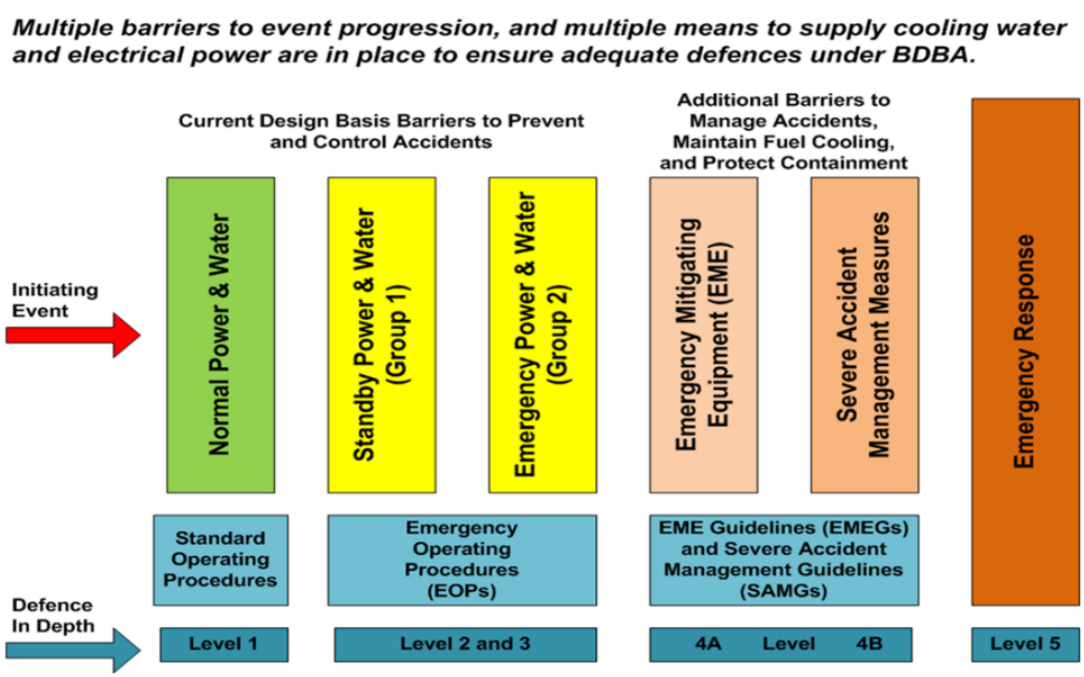



Figure 9: Barriers to Event Progression

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 the OPG *Consolidated Nuclear Emergency Plan*.

## 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 *Reactor Safety* program establishes organizational responsibilities and key program elements for the management of issues related to the Nuclear Safety Analysis and the following major aspects of safe operation:

- Safety Analysis Basis and Safety Report updates;
- Safe Operating Envelope (SOE) (see section 2.3.5);
- Beyond Design Basis Accident (BDBA) Management.

The Safety Analysis Basis includes the Nuclear Safety Analysis and assessments performed to demonstrate regulatory and design requirements are met and to determine safe operating limits. Safety analysis consists of three primary parts:

- Deterministic Safety Analyses;
- Hazard Analyses;
- Probabilistic Safety Assessments (PSA).

The existing safety analysis of 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* and REGDOC-2.4.2, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants*.

All software used by OPG for the Deterministic Safety Analysis and Probabilistic Safety Assessments are governed by the *Software* program which is compliant 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*.

### 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 and upset conditions at the plant.

DSA is used to determine the limits that define the SOE of the plant, which is defined 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. Refer to Section 2.3.5 for further details on the SOE.

The results of the Darlington NGS DSA are documented in, *Darlington Nuclear 1-4 Safety Report: Part 3 – Accident Analysis* and the *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 station SOE to satisfy OPG's *Nuclear Safety and Security Policy* requirement to control reactor power, cool the fuel, and contain radioactivity (3 C's).

REGDOC-2.4.1, *Deterministic Safety Analysis*, issued in 2014, provides the regulatory requirements for DSA. As DSA that had been performed up to that point were not fully compliant with the REGDOC, OPG developed a REGDOC-2.4.1 Implementation Plan in 2014 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.

The scope of the REGDOC-2.4.1 Implementation Plan 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 Primary Heat Transport (PHT) system tritium concentration limits.

### Primary Heat Transport (PHT) System Aging Management Strategy

PHT aging management is one of the major programs contributing to maintaining DSA at Darlington NGS. 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 *Integrated Aging Management* program.

The objective of the strategy 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 and submitted to the CNSC in 2009. Key parameters and safety phenomena for all important systems and sub-systems with direct interfaces with the PHT system main circuit were identified and the critical accident scenarios from the perspective of PHT system aging impacts were determined.

OPG reports to the CNSC on the status of its HTS-AMS and the progress of safety analysis related to PHT system aging. The latest HTS-AMS was updated for the 2021-2025 period and submitted to the CNSC in March 2021. The latest progress report on safety analysis related to PHT system aging was submitted in 2023.

The Refurbishment of all four Darlington NGS reactor units will significantly improve issues associated with safety margin erosion due to aging. However, OPG's programs for monitoring the aging processes and implementing strategies to maintain safety margins will continue.

## 2.4.2 Hazard Analysis

Hazard Analysis for Darlington NGS is performed in compliance with REGDOC-2.4.2, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants*. The Darlington Hazards Screening Analysis was last updated in 2019 as part of the 5-year update cycle for the Darlington NGS PSAs. The hazard screening analysis was conducted as

per OPG's PSA Guides and documents the hazard identification and screening of both internal and external hazards applicable to Darlington NGS. The scope of the hazard screening analysis addresses hazards on both the reactors and non-reactor sources.

OPG is currently updating the Darlington NGS Hazard Screening Analysis for the 2025 Darlington NGS PSA updates. The scope of work for this hazard screening analysis update includes the potential hazards that will arise from the construction activities taking place on the Darlington New Nuclear Project site. The updated analysis 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. The updated hazard screening analysis 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.*

**Planned Improvements**

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. As such, Darlington NGS intends to perform a forward-looking climate risk assessment using the methodology found in Electric Power Research Institute *Climate Vulnerability Assessment Guidance for Nuclear Power Plants,* 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. OPG will 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. A risk analysis will be used to prioritize adaptation strategies considering the available adaptive capacity.

## 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 (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 (Large Release Frequency (LRF)).

The PSAs are updated every 5-years as required by REGDOC-3.1.1, to ensure that the PSA models accurately reflect the current design and operation of the station. The

most recent update of the Darlington PSAs was in 2020. As shown in Table 1, for each PSA performed, the OPG Safety Goals were achieved for SCDF and LRF, demonstrating that the current design and operation of Darlington NGS poses an acceptable level of risk to the public. The updated PSA models are used to support the day-to-day operation of Darlington NGS.

**Table 1: Results of 2020 Darlington NGS PSAs**

| 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 |

OPG is performing an update to the Darlington NGS PSAs which is 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 its 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 Beyond Design Basis Accident (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 Severe Accident 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 severe accidents, to ensure that the risk from the operation of nuclear reactors remains low. The ability to control, cool and contain are challenged in a severe accident, 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 Anticipated Operational Occurrences and design basis events. The response to a severe accident 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. OPG last performed SAA as a part of the Level 2 Internal Events PSA update for Darlington NGS in 2020, and in response to the Fukushima Action Items. Extensive analysis has been carried out to identify BDBAs with the potential to transition to severe accidents. 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.

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, Emergency Mitigating Equipment Guidelines, 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 part of the update for the Level 2 PSA scheduled for completion in December 2025, OPG will also review and update the suite of SAA for Darlington NGS.

### 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 Irradiated Fuel Bays 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 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 Safety and Licensing 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 Industry Standard Toolset 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 Industry Standard Toolset 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 CANDU Safety Issues (CSI) 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. For the Darlington NGS station, all 12 non-LBLOCA Category 3 CSIs were previously recategorized to a lower category. One of the LBLOCA related Category 3 CSI was recategorized to a lower category in 2013 and the remaining three were recategorized in 2023.

OPG has demonstrated that appropriate control measures have been implemented and currently are in place to address all sixteen CSIs and maintain safety margins.

## 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.

### 2.5.1 Design Governance

OPG's design program ensures that facility SSCs 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 the resulting documentation are controlled in a manner consistent with the plant's licensing basis.

The Design Management program sets the overall requirements for the execution and control of activities that provide design support and documentation for the nuclear facility. The program defines the minimum set of documentation that identifies and describes the design basis, design outputs, design processes, and the procurement engineering process. The Design Management program complies with CSA N286-12,

*Management system requirements for nuclear facilities* and CSA N285.0-08 (and update no. 2), *General Requirements for Pressure-Retaining Systems and Components in CANDU Nuclear Power Plants*.

The Engineering Change Control (ECC) program 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 basis. 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.

OPG's Configuration Management standard 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.

The Software program complies with CSA N286-12 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.

OPG reviews any modification at Darlington NGS which may affect the International Atomic Energy Agency (IAEA) monitoring systems or equipment, 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 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 Licence (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 site lies south of the south limit of the South Service Road of the MacDonald-Cartier freeway (Highway 401). 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. As shown in Figure 10, Darlington NGS occupies half of the site west of Holt Road in Lots 21 to 24 inclusive. A water lot was provided for the water intake tunnel and the discharge pipe from Lake Ontario.

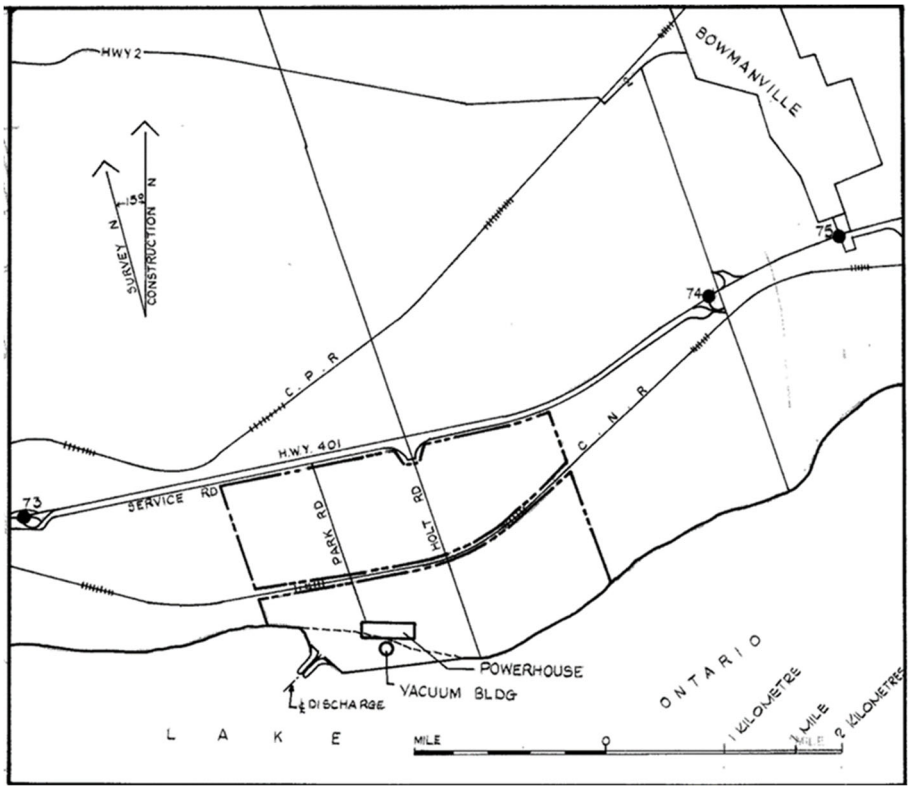



Figure 10: Darlington Site and Surrounding Area

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 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. A detailed description of all site characteristics is provided in the 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 and Structure Design

Darlington NGS is comprised of four CANDU pressurized heavy water reactors, with each unit having a core fission power of 2776 MW(th) and a nominal net unit output of 881 MW(e).

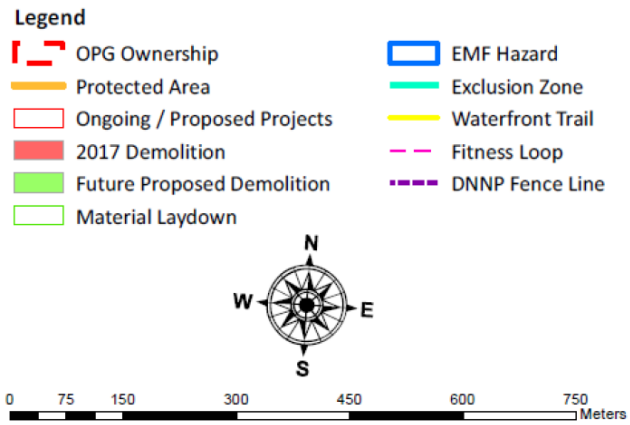
The Darlington NGS site contains buildings and structures including:

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 generator sets buildings, Emergency Power Supply fuel management structures, and emergency electrical rooms and associated tunnels.
7. Two administrative buildings (Operations Support Building and Engineering Services Support Building/Darlington Learning Centre).
8. A Water Treatment building.
9. Two Fueling Facility Auxiliary Areas, including two Irradiated Fuel Bays.
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, Auxiliary Security Building and the Refurbishment Project Office.
19. Nuclear Sustainability Services – Darlington.
20. Auxiliary Heating Steam Boiler House.
21. Containment Filtered Venting System Outdoor Shielding Space.
22. HWMB West Annex.

A general layout of the Darlington site is provided in Figure 11.


HOLT RD
1ST LINE
504
SF6
502
COOT'S POND
CN RAILWAY
OLD HOLT RD.
2ND LINE
444
EMF
PARK RD
450
401
P414
424
423
443
F5N
P403
P412
513
411
512
416
P355
P331
P332
356
357
359
313
F2N
FSS
P456
P1
P2
WTP
P3
P4
8
415
P353
362
329/330
312
F2SW
F2SE
208
1
P354
358
363
311
207
T204
16
15
17
18
20
23
ZMN
WF
U1
U2
0
U3
U4
EF
9
364
3RD LINE
F6
F7
F9
F8
P455
PW
RPC
RCC
45
47
63
51
58
59
50
46
48
55
54
56
62
22
65
36
42
43
32
31
38
39
61
40
T44
CCVS
300
VSF
138
125
124
141
128
131
136
140
143
142
LAKESHORE ROAD
L9
112
113
114
116
118
201
PARKING
302
UFD53
UFD54
RMA




| 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 11: Darlington Site - General Layout**

Plant states and operational configurations considered in the design of the Darlington NGS are described in the Darlington NGS Safety Report. Design for reliability and safety design concepts incorporated into the station are described in Part 2 of the Safety Report. Part 3 of the Safety Report provides a detailed description of the accident analysis for Darlington NGS and presents the analysis of all Design Basis Accidents to demonstrate that the safety design objectives of all postulated accidents are met.

The design of Darlington NGS utilizes a defense-in-depth methodology with redundant safety systems and barriers to control the reactor power, cool the fuel, and contain radioactivity, for the protection and safety of workers, the public, and the environment. There are five physical barriers in place at Darlington NGS to restrict radioactive exposure:

- 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.

Darlington NGS also has four special safety systems to shut down the reactor, cool the fuel, and prevent radioactive releases following any abnormal events:

- Two independent and diverse Shutdown Systems, which are designed to rapidly shut down the reactor by introducing sufficient negative reactivity to make the reactor subcritical.
- The Emergency Coolant Injection (ECI) system, which ensures fuel cooling is maintained.
- The Negative Pressure Containment System (NPCS), which is designed to prevent the release of radioactive material to the environment.

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.

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.

The station and system design considers the mitigation of acute radioactive releases, severe accident 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). The 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. The intention is to prevent an event from progressing to a severe accident. SAMG has a focus on both containment integrity and fuel cooling, and its use is initiated if an event has progressed to the severe accident 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.

### 2.5.4 System and Component Design

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 Safety Report Part 1 and 3, Design Manuals, system design drawings and design guides.

#### 2.5.4.1 Pressure-Retaining Structures, Systems and Components

The *Pressure Boundary* (PB) program 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. PB requirements for all states of work, from design through procurement, installation and testing, are implemented through OPG Nuclear governing documents.

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. OPG's PB Certificate of Authorization was most recently renewed in 2023, following a successful audit by the TSSA and new certificates were issued. These certificates will expire on April 15, 2026, before which the 3-year rolling renewal process will continue.

As was done for Units 1, 2 and 3 refurbishment, Enterprise Project Contractors (EPC) perform PB activities under their own Certificate of Authorization for the refurbishment of Unit 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.

### 2.5.4.2 Environmental Qualification of Equipment

OPG's *Environmental Qualification* (EQ) 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 Accidents conditions and this capability is preserved over the life of the plant. The implementation of these program requirements provides consistent methodology, programmatic controls, and interfaces for establishing and maintaining EQ of equipment and components at Darlington NGS. Darlington's EQ program complies with CSA N290.13-05 and update no. 1, 2009 *Environmental qualification of equipment for CANDU nuclear power plants*.

EQ program controls are integrated into the engineering change governance to ensure engineering changes conform to EQ requirements.

### 2.5.4.3 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 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 IEC 61000 series, *Electromagnetic Compatibility*, of standards.

### 2.5.4.4 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, Shutdown Systems, 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 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. The most recent Darlington NGS SPSA (also known as DARA Seismic) was submitted to the CNSC in 2020, and demonstrated that the seismic Severe Core Damage Frequency and Large Release Frequency meet the OPG safety goals. The next SPSA submission will be in 2025 per the 5-year submission requirement of REGDOC-3.1.1, Refer to Section 2.4.3 for details.

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. 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.

### 2.5.4.5 Fire Safety and Fire Protection System

OPG implements and maintains a Fire Protection Program at Darlington NGS in accordance with CSA N293-12 (R2017), *Fire Protection for Nuclear Power Plants*. The Fire Protection Program establishes provisions to prevent, mitigate and respond to fires such that fire risk to OPG workers, the public, environment, nuclear physical assets, and power generation is acceptably low and controlled.

In accordance with N293-12, 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.

In addition, 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 expected.

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. See Section 2.10.3 for additional discussion regarding the Fire Protection program.

During the current licence term, significant projects / modifications were undertaken to improve the reliability and performance of fire safety and the fire protection system. These projects have and will continue to ensure Darlington NGS's 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 – the Darlington NGS PA system provides paging for voice instructions, fire alarm signals, and 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 2.10.3, for further information on PA System improvements.

3. Increased coverage of Transformer Deluge System – As part of the refurbishment project, the deluge systems for the main output transformer, unit service transformer, and system service transformer are being upgraded to increase coverage to the adjacent non-absorbing ground areas as per code requirements. 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 Fire Hazard Assessment and Fire Safe Shutdown Assessment (see section 2.10.3 for details), additional fire detection coverage is being provided certain higher-risk areas of the plant
5. ESW Pump Oil Spill Containment Dikes – Also as a result of the Fire Hazard Assessment and Fire Safe Shutdown Assessment, 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.

### 2.5.4.6 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

The Fuel program at Darlington NGS 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 the licence term 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 was 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

Darlington reactors are refuelled on-power by remotely controlled Fuelling Machines (FMs) located at each face of the reactor. The FMs 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 Irradiated Fuel Bays in the Fueling Facility Auxiliary Areas. Storage of the discharged fuel is maintained in the adjacent storage bays until ready for transfer to 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.

Over the licence term, OPG has completed a number of projects, modifications, and initiatives which have improved the reliability and performance of the Fuel Handling (FH) Systems. In-progress and planned replacement of FH equipment and components over the next licence term will provide continued improvement in reliability and performance of the FH Systems.

## Design of the Reactor Internals

Darlington NGS refurbishment resulted in the 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 Target Delivery System 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 was 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. A recent amendment to the PROL allows Darlington NGS to operate with cobalt adjuster rods to generate the Cobalt-60 radioisotope (Reference 6). This modification is planned to be first commissioned in Unit 1 return to service. 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 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 at Darlington NGS is designed to warn operations staff of vibration problems and requires replacement due to aging, obsolescence, and spare parts issues.
6. End Shield Cooling Shield Tank Overpressure Protection 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 Beyond Design Basis Earthquakes.
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 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. Pressure and Inventory Control 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 modification: the Gaseous Fission Product 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.

## 2.6 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.

### 2.6.1 Equipment Fitness for Service / Equipment Performance

**Equipment Reliability**

The objective of OPG's Equipment Reliability (ER) program 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 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 provides oversight, direction, and leadership for resolving ER issues and implementing actions from System and Component Health Plans. The Plant Health Committee consists of managers and/or directors from the key functional organizations at Darlington NGS involved in implementing ER actions.

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 the 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.

Figure 12 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. Darlington NGS has maintained an average ERI score of 86 points since 2017.

Darlington NGS has focused on several initiatives to sustain its improved ER. Key actions include backlog reduction, PM program sustainability, establishing System Health Teams, and improvements to scheduling of critical PM work orders to ensure equipment reliability.

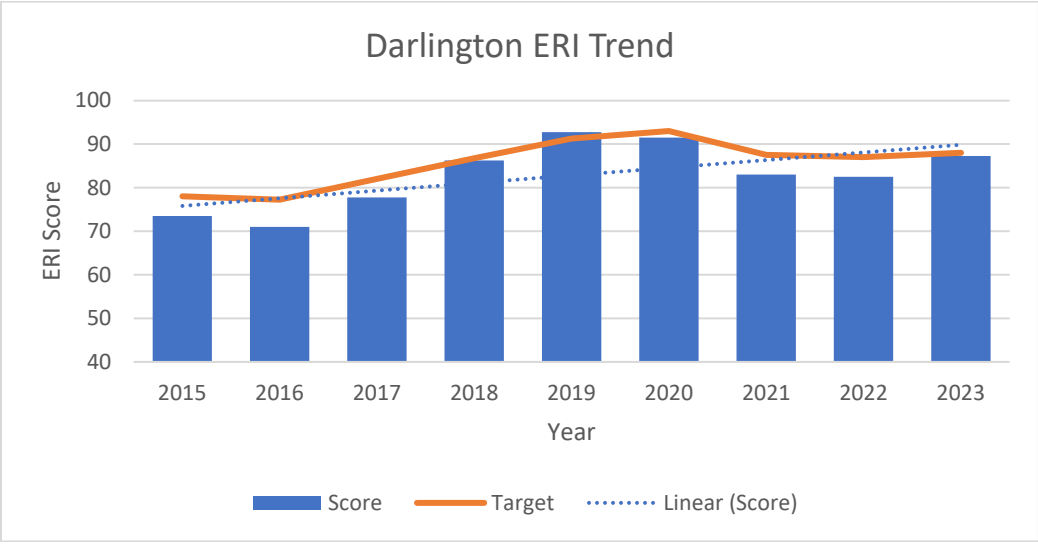



Figure 12: ERI Trend from 2015 to 2023

In 2024, the ER key performance indicator transitioned from ERI to the Institute of Nuclear Power Operators (INPO) Equipment Performance Index. 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.

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 to continuously improve performance.

Over the current licence term, Darlington NGS undertook 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 many other 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.

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 behaviours. 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 System Health Teams 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 System Health Teams facilitate cross-functional analysis and collaboration, enhancing equipment reliability through improved self-awareness and proactive self-correction.

## Reliability of Systems Important to Safety

The *Risk and Reliability* program 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 Risk and Reliability program requires the operational performance of SIS be monitored, assessed and reported and the component reliability data be compiled, analyzed and applied to maintain unavailability models. Supporting program procedures provide requirements for reliability monitoring and reporting of SIS and CIS, in accordance with CNSC regulatory documents REGDOC-2.6.1 *Reliability Programs for Nuclear Power Plants* 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.

Per REGDOC-3.1.1, the reliability and performance of SIS/CIS is documented and reported through the Annual Risk and Reliability Report. The Annual Risk and Reliability Report 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 of each system. Furthermore, SIS operational performance is evaluated through routine testing. The field reliability data collected from operability testing and other sources is then incorporated into system unavailability models to improve the accuracy of Predicted Future Unavailability calculations.

Annual Risk and Reliability Reports have been submitted to the CNSC each year of the current licence term with annual SIS performance documented and directly compared

to respective reliability targets. The most recent report was the 2023 Darlington NGS Annual Risk and Reliability Report, which demonstrated all SIS operated within their defined reliability targets during the reporting year. The 2024 report will be submitted in May 2025.

## 2.6.2 Maintenance

Darlington NGS meets the requirements of REGDOC-2.6.2 *Maintenance Programs for Nuclear Power Plants*, which states that effective maintenance is essential for the safe operation of a nuclear power plant. Specifically, the Darlington NGS facility is monitored, inspected, tested, assessed and maintained to ensure that Systems, Structures, and Components (SSCs) function as per design.

The Darlington NGS Maintenance program is designed 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 and equipment to ensure they continue to operate as expected.

The Maintenance program interfaces with the Production Work Management program 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 Production Work Management program details the requirements for identifying, prioritizing, planning, scheduling, and executing work, including for planned and forced outages, in support of the operation, maintenance and modification of the plant.

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 majority of maintenance activities are divided into preventive or corrective maintenance. The results of all maintenance activities are fed back through an optimization process which enables the continuous improvement of the program.

### 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 to the end of year projection to meet the station target of 70 Work Orders in 2024.

## Preventative Maintenance Activities

The Predefined Process (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, therefore predefines 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, 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. Preventative Maintenance Review Board focuses on operating experience and critical evaluations of 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 Work Orders 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. A T-

review refers to work being executed in an upcoming work week. For example, 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.

### Planned Improvements

OPG 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 Work Orders based on available operating experience.

## 2.6.3 Aging Management

OPG's Integrated Aging Management (IAM) program is an overarching and comprehensive program, which provides the framework for managing plant aging and demonstrates how the current processes and programs meet the requirements for effective aging management in accordance with REGDOC-2.6.3, *Aging Management*.

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 13.

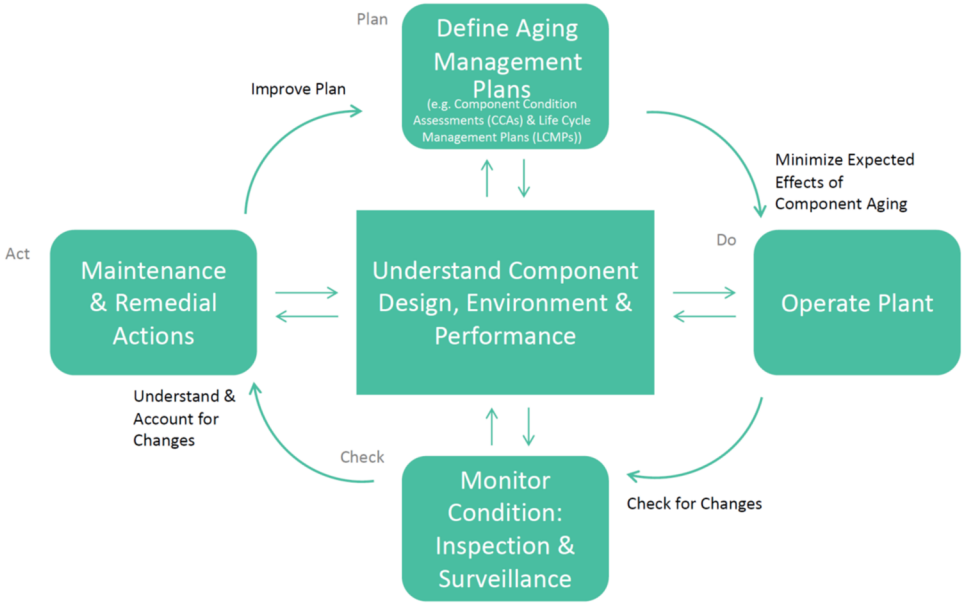



Figure 13: Integrated Aging Management Process

## 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.

*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 Life Cycle Management Plans (LCMPs) 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.

*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.

*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.

*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.

*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.

Several other programs, processes and activities  and include such 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 also support aging 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 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.

Aging Management Plans are addressed via LCMPs for major components (feeders, fuel channels, reactor components and structures, and steam generators)  A 10-year outlook detailing the required inspection and maintenance activities is provided within each of the plans and updated annually to capture the operation of Darlington NGS Units 1 to 4 into and out of refurbishment.

#### 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.

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* 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 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 establishes the strategy or identifies 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. It 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 to increase the overall integrity of the fuel channel during accident scenarios. Potential contact between the calandria tube and Liquid Injection Shutdown System 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 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 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 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 2.6.5 for further details on PIP.

**Planned Improvements**

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. In September 2024, OPG submitted the Darlington NGS Transition Plan which provides the plan and schedule for completing the work required for compliance with the 2021 edition of CSA Standard N285.7.

## 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 robust processes to control plant chemistry, allowing plants to remain fit for service.

OPG implements a chemistry program, which specifies the processes, overall requirements, and staff accountabilities to ensure effective control of plant chemistry, including the provision of analytical services. These activities are performed to ensure critical plant equipment performs safely and reliably over the life of the station. The chemistry program complies with CSA N286-12 and interfaces with the environment program to limit and monitor the release of chemicals and radioactive material.

## 2.6.5 Periodic Inspection and Testing and Structural Integrity

The objective of the Periodic Inspection Program (PIP) is to ensure the structural integrity of nuclear plant systems and components, including containment components in Darlington NGS.

The programs are documented in specific PIP plans and associated inspection schedules, and are administered under corporate and station governing documents.

The Darlington NGS PIP for CSA N285.4 *Periodic Inspection of CANDU nuclear power plant components*, 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 Darlington NGS PIP for CSA N285.5 *Periodic inspection of CANDU nuclear power plant containment components*, 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, 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.

The Darlington NGS PIP for CSA N287.7 *In-service examination and testing requirements for concrete containment structure for CANDU nuclear power plants*, 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 latest 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 Vacuum Building Outage. 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.

The Darlington NGS PIP for CSA N291, *Requirements for nuclear safety-related structures,* 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, steel structures and components, masonry wall, and roofings. Selected components shall be inspected at least once every 6-years. For inaccessible areas, inspection shall be at frequency agreed upon by the CNSC.

#### 2.6.5.1 Structural Integrity

OPG performs inspections to confirm structural integrity 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 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.

## 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).

To achieve and maintain high standards of radiation protection, the RP program implements a series of standards and procedures for the conduct of activities at OPG nuclear sites and with radioactive materials. The program includes 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.

### 2.7.1 Application of ALARA

OPG manages facility collective dose through the implementation of 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 the implementation of dose reduction initiatives, application of ALARA principles, and past operating experience and performance. The ALARA department provides oversight on the facility's performance against the established targets and establishes corrective actions, where required, with support from senior plant management.

The Darlington NGS site ALARA strategy identifies the initiatives, actions and programs that support these objectives, and how 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 ALARA department plays an important role in managing the station Collective Radiation Exposures (CRE) and ensuring it is ALARA, by advocating for the workforce to be aware of the core ALARA principles and helping work groups 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. Darlington NGS 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, the latest RP events and the status of a 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 the current RP performance and score.

## Lessons Learned

The majority of annual station collective dose occurs during major planned maintenance outages. 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. 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 constraints 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 licence term, 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. These interfacing processes ensure a comprehensive and robust review of radiological safety 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 at Darlington NGS, including those for contractors and visitors, are managed within Exposure Control Levels that are below Administrative Dose Limits, which are in turn below the regulatory limits.
OPG manages worker exposure to radiation by:

- 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; and
- Avoiding unplanned exposures and controlling the use of licensed radioactive devices and equipment.

Implementing procedures and standards provide requirements and direction for meeting these objectives.

### Action Levels and Administrative Dose Limits

As per the requirements of the *Radiation Protection Regulations* and the operating licence, OPG has established Action Levels for Darlington NGS. Action Levels are a specific radiation dose or other parameter that, if reached, may indicate a loss of control of part of the RP program. Exceeding an Action Level requires notification and reporting to the CNSC, investigation of the cause, and corrective action as required.

OPG also sets Administrative Dose Limits (ADL), which are internal dose limits designed to ensure individuals do not exceed regulatory dose limits. During the licence term, no internal ADL or regulatory dose limit were exceeded for any source of radiation.

## 2.7.3 Radiation Protection Program Performance

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.

During the current licence term, collective and individual doses at Darlington NGS were managed well below administrative and regulatory dose limits. 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 14 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 14 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.

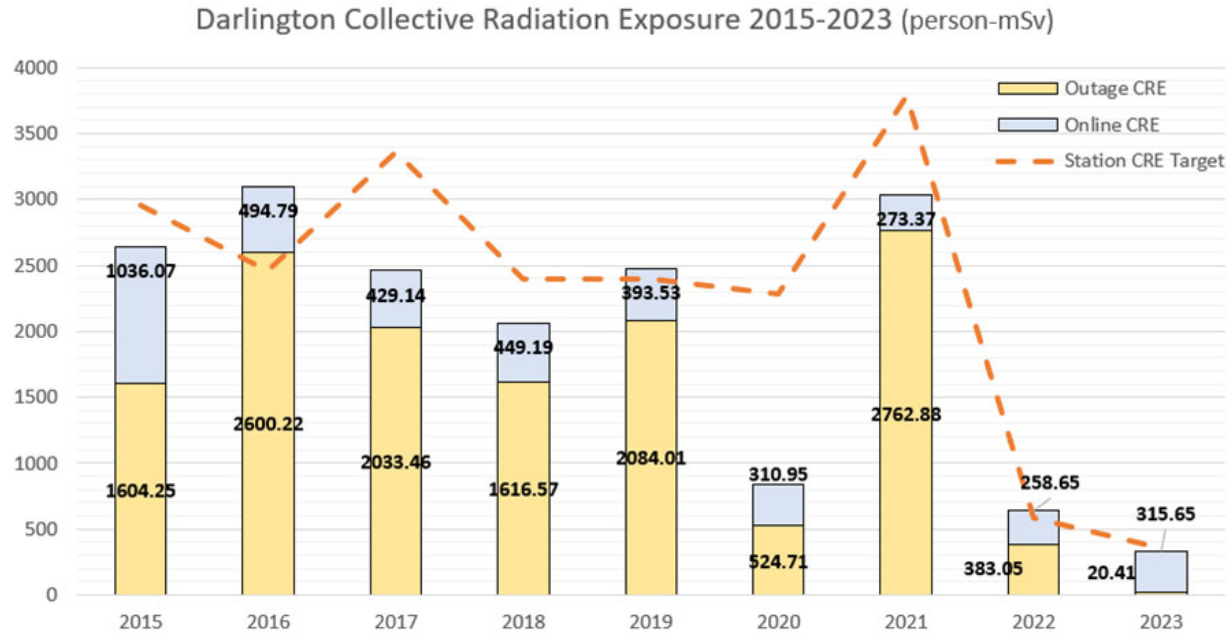



Figure 14: Darlington Collective Radiation Exposure 2015-2023 (person-mSv)

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.

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.

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 protected area (inside the inner security fence) of Darlington NGS is divided into zones to facilitate the movement of personnel and materials and to control access to areas where radioactive systems are present. Indoor areas of the station are divided into 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'. Zone boundaries are marked and changes to the boundaries are approved by the Responsible Health Physicist.

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. 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. All materials released into Zone 1 or the public domain are monitored for contamination.

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 identify relevant job-site specific hazards to allow for the safe conduct of work activities. Day-to-day conditions at Darlington NGS are routinely monitored 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

During the licence term, OPG successfully implemented a variety of enhancements and methods to improve radiological hazards control. These include:

#### Minimizing Worker Dose Exposure During Longer Outages

Units 1, 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 was 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 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 Radiation Personal Protective Equipment Usage Working in Wet Conditions

Darlington NGS has updated the procedures including standards and expectations on the use of Radiation Personal Protective Equipment 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
- 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.

## 2.8 Conventional Health and Safety

OPG is committed to preventing workplace injuries and ill health, and continuously improving employee health and safety performance. OPG's Health and Safety Management System (HSMS) is structured in accordance with the requirements of ISO 45001 *Occupational Health and Safety Management*. The foundation of the HSMS is the *Employee Health and Safety Policy*, which describes the approach and commitments to Conventional Health and Safety for the organization, and the requirements and accountabilities of all employees.

OPG's Environment, Health and Safety Managed Systems program puts the Health and Safety Policy into action. The goal of the program is to ensure a healthy and

injury-free workplace by managing risks resulting from the activities, products, and services associated with OPG operations. The program and supporting governing documents establish processes 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 requirements of OPG's *Health and Safety Policy* are met.

The Environment Health and Safety Managed Systems program 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 the achievement of OPG's business objectives.
- Contractor health and safety.

### 2.8.1 Performance

During the current licence term, Darlington NGS continued to demonstrate excellent safety performance throughout its operations.

OPG reports quarterly to the CNSC on Safety Performance Indicators (SPIs) per REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants.* SPI for Conventional Health and Safety include Accident Frequency Rate (AFR), Industrial Safety Accident Rate (ISAR) and Accident Severity Rate (ASR).

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. Figure 15 provides the Accident frequency Rate at Darlington NGS from 2015 to Q3 2024.

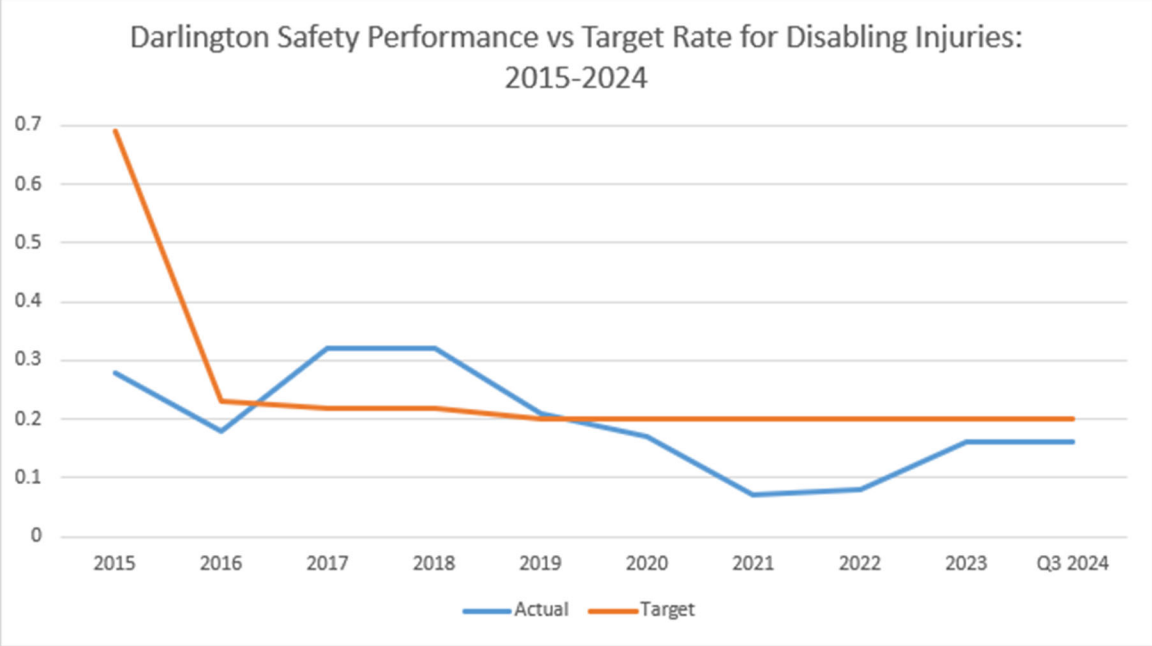



Figure 15: Darlington NGS – Accident Frequency Rate 2015-2023 Q3 2024

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 from 2019 up to Q3 2024, as shown in Figure 16.

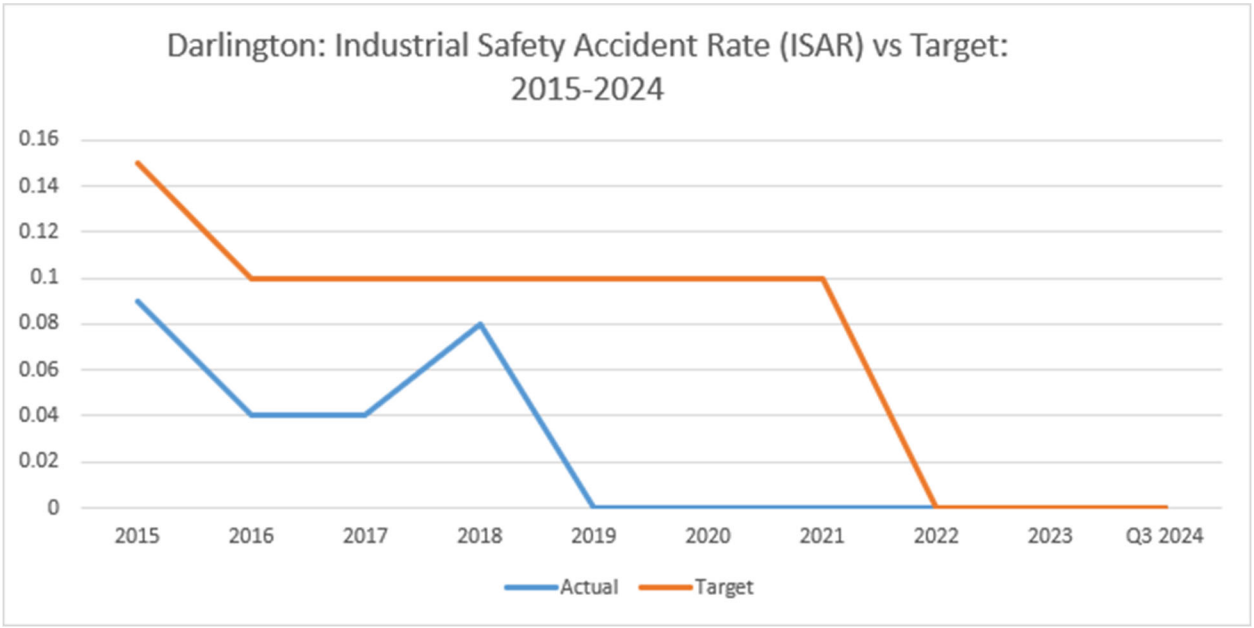



Figure 16: Darlington NGS – Industrial Safety Accident Rate (ISAR) vs. Target 2015-2024

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, as shown in Figure 17. There are no targets set for ASR.

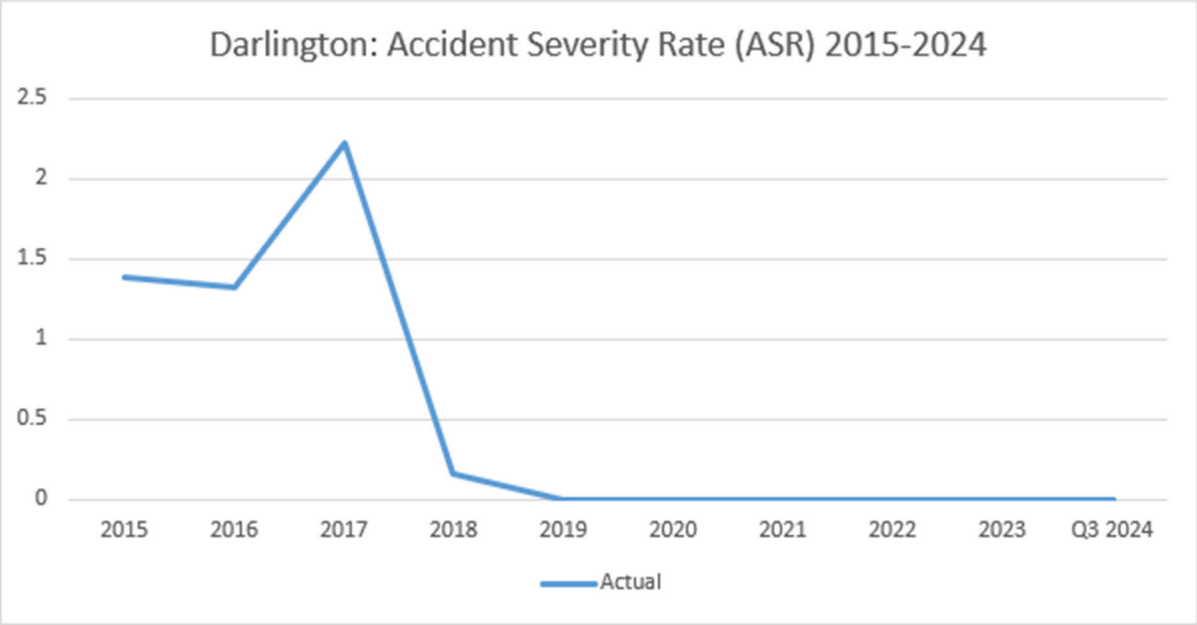



Figure 17: Darlington NGS – Accident Severity Rate (ASR) 2015-2024

In addition to REGDOC-3.1.1 SPIs, OPG tracks other proactive metrics to demonstrate its commitment to excellence and continuous improvement. These include the Serious Injury Incidence Rate (SIIR) and Timely Completion of Safety Correction Actions (TCSCA).

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.

The 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 as shown in Figure 18.

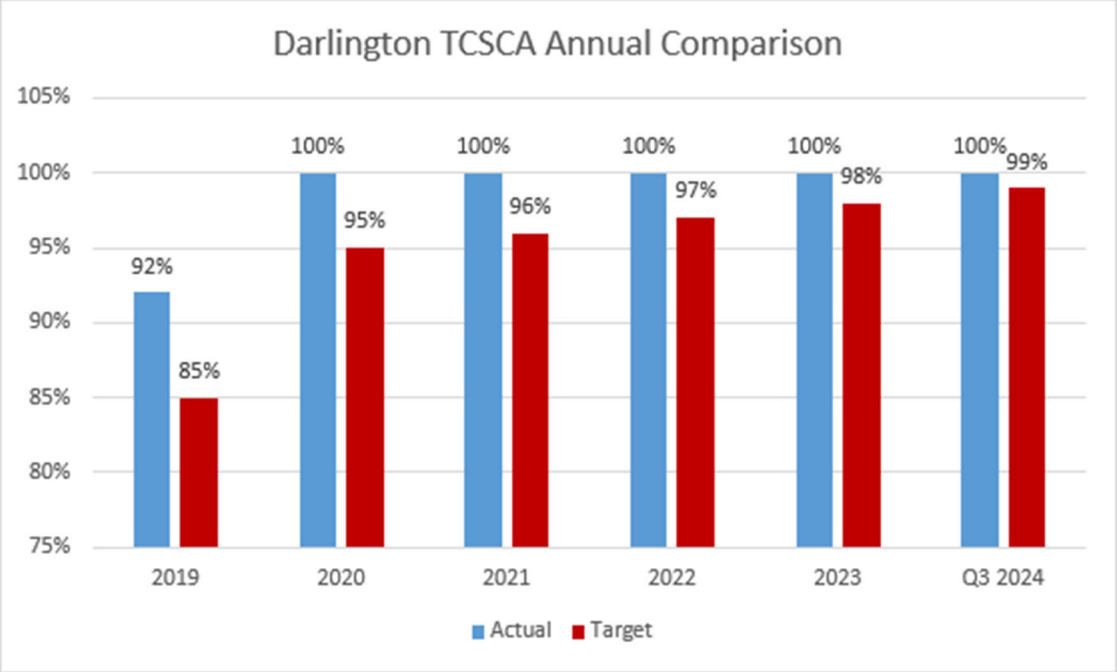



Figure 18: Darlington NGS – TCSCA Annual Comparison

## 2.8.2 Practices

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. 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 that 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 the HSMS, OPG seeks to continuously ensure excellence in everything we do. Key Performance Indicators (KPI) are monitored by conducting field assessments,

document reviews and interviews with stakeholders to help identify systematic issues before they result in near-misses, injuries, and events.

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 regard 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.

The Internal Responsibility System 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 Internal Responsibility System 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.

## 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. 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.

### 2.8.2.1 Refurbishment Health and Safety Practices

Nuclear Refurbishment complies with the Environment Health and Safety Managed Systems program 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 are 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 built 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

Darlington NGS continuously strives for excellence and continued improvement in 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.

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, there are strong defenses in place to ensure the event occurs safely. It shifts the focus to learning; and proactively applies lessons to future work. OPG has streamlined its safe work planning process with Fail Safe built into the application. OPG has introduced hazard assessment tools 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.

## 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 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.

### 2.9.1 Environmental Management System

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.*

The objectives of the OPG Environmental Policy are to:

- Establish an EMS and maintain registration for this system to 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.

Following a successful recertification audit, OPG's ISO 14001 EMS certificate was renewed in July 2024 and is valid for 3-years.

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. 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.

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 5.3.6 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, 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. During the current licence term, there were 13 infractions (as of September 30, 2024), most of which were related to Environmental Compliance Approvals (ECAs).

## 2.9.2 Environmental Risk Assessment

In accordance with CNSC regulatory document REGDOC-2.9.1 *Environmental Protection Policies, Programs and Procedures* and REGDOC-3.1.1 *Reporting Requirements for Nuclear Power Plants*, 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 support of licence renewal, OPG prepared an Addendum to the 2020 ERA to serve 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 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 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.

### 2.9.3 Assessment and Monitoring

OPG maintains an Environmental Monitoring Program (EMP) in the vicinity of Darlington NGS compliant with CSA N288.4-10, *Environmental Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills*. 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 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 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).

Darlington NGS 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. 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.

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 19 and Figure 20. 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.

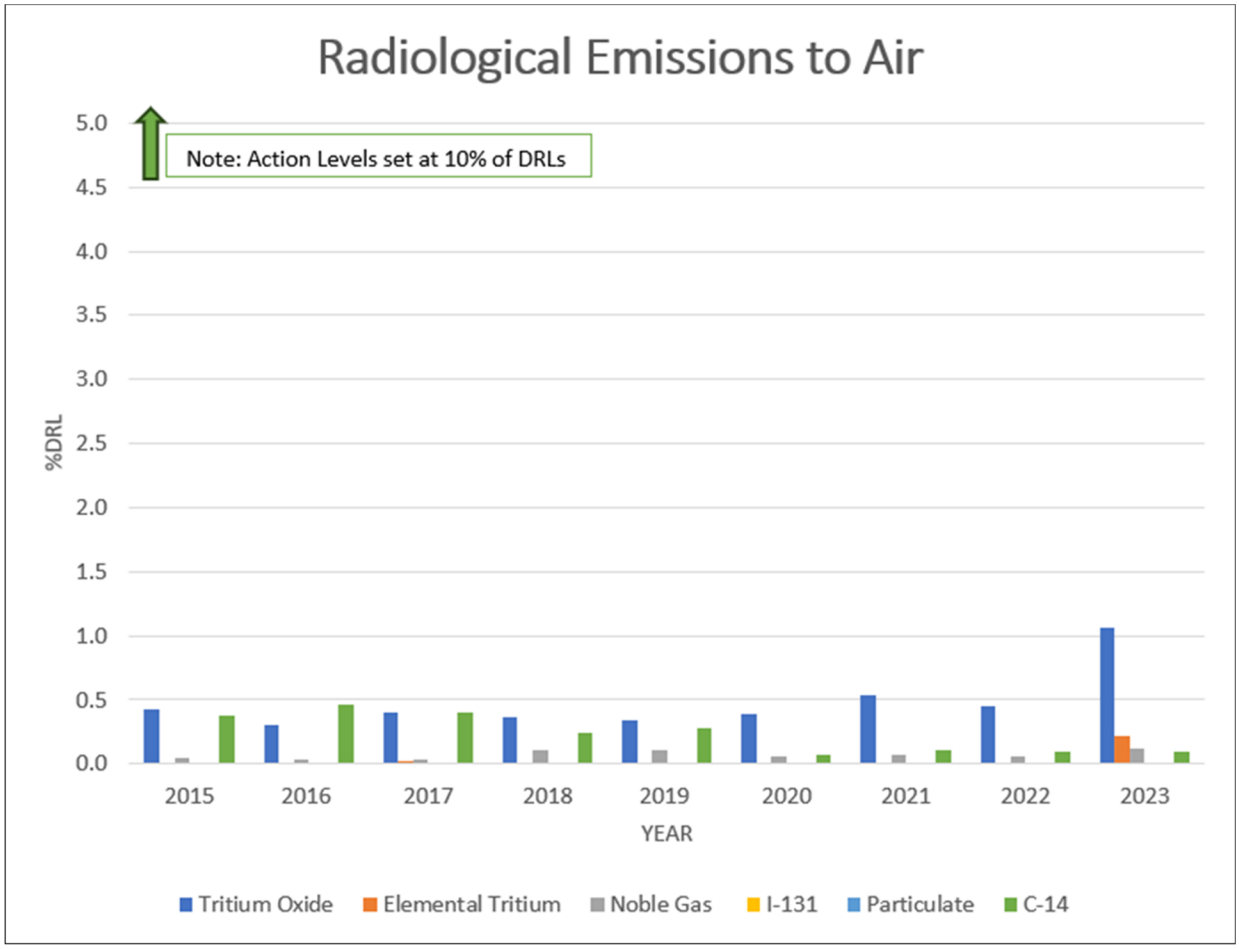



Figure 19: Radiological Emissions to Air

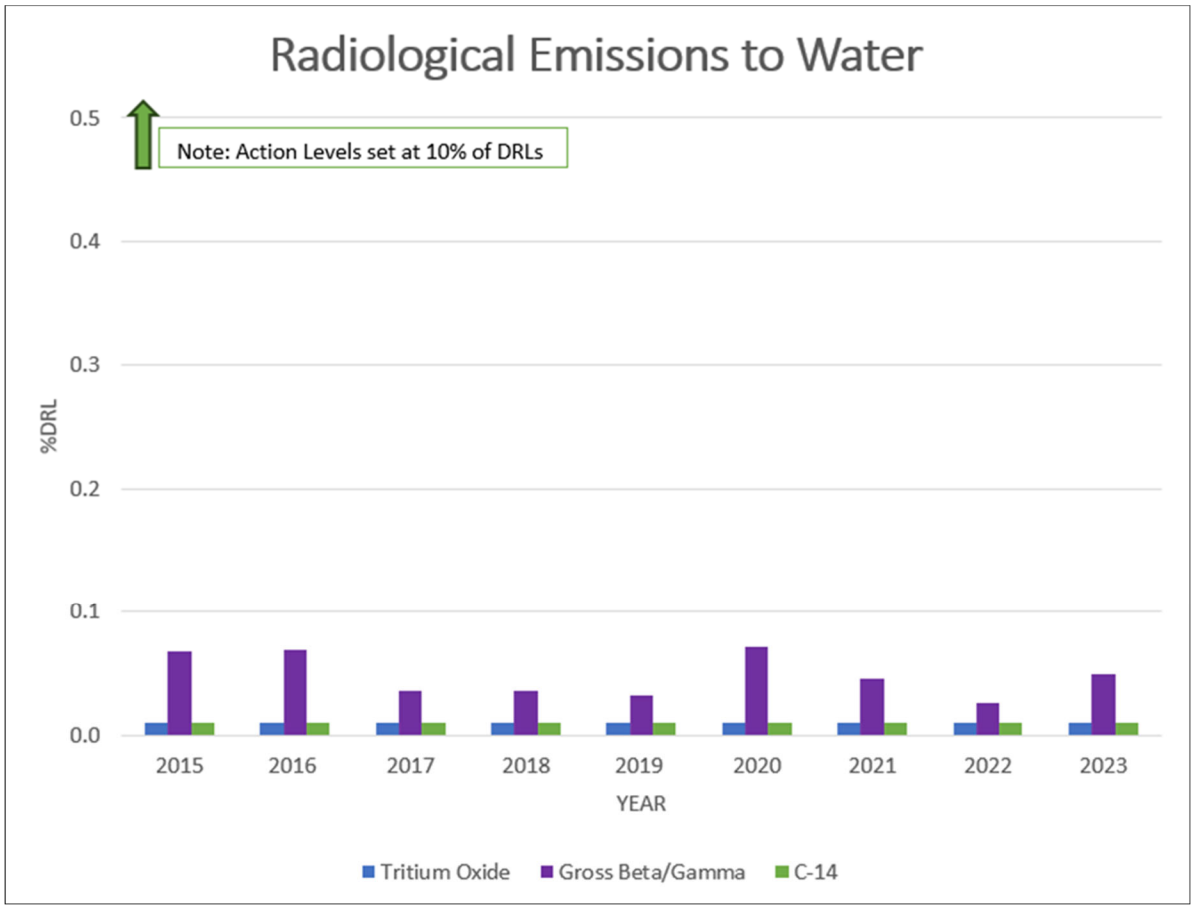



Figure 20: Radiological Emissions to Water

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. Exceeding an EAL requires notification and reporting to the CNSC, investigation of the cause, and corrective action as required.

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. OPG took corrective actions to minimize further releases as well as implementing longer-term corrective actions. These 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 strengthening 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 from site operations. These hazardous substances include sulphur dioxide, nitrogen oxides, carbon dioxide, hydrazine, ammonia and ozone-depleting substances.

During the current licence term there were seven ozone-depleting substances releases (as of September 30, 2024) from refrigerant leaks.

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.

### 2.9.4.3 Groundwater Protection and Monitoring Program

The Darlington NGS site has a Groundwater Protection Program and Groundwater Monitoring Program (GWMP) 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 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 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 licence term. The 2023 inferred shallow groundwater contour map is provided in Figure 21 below. 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.

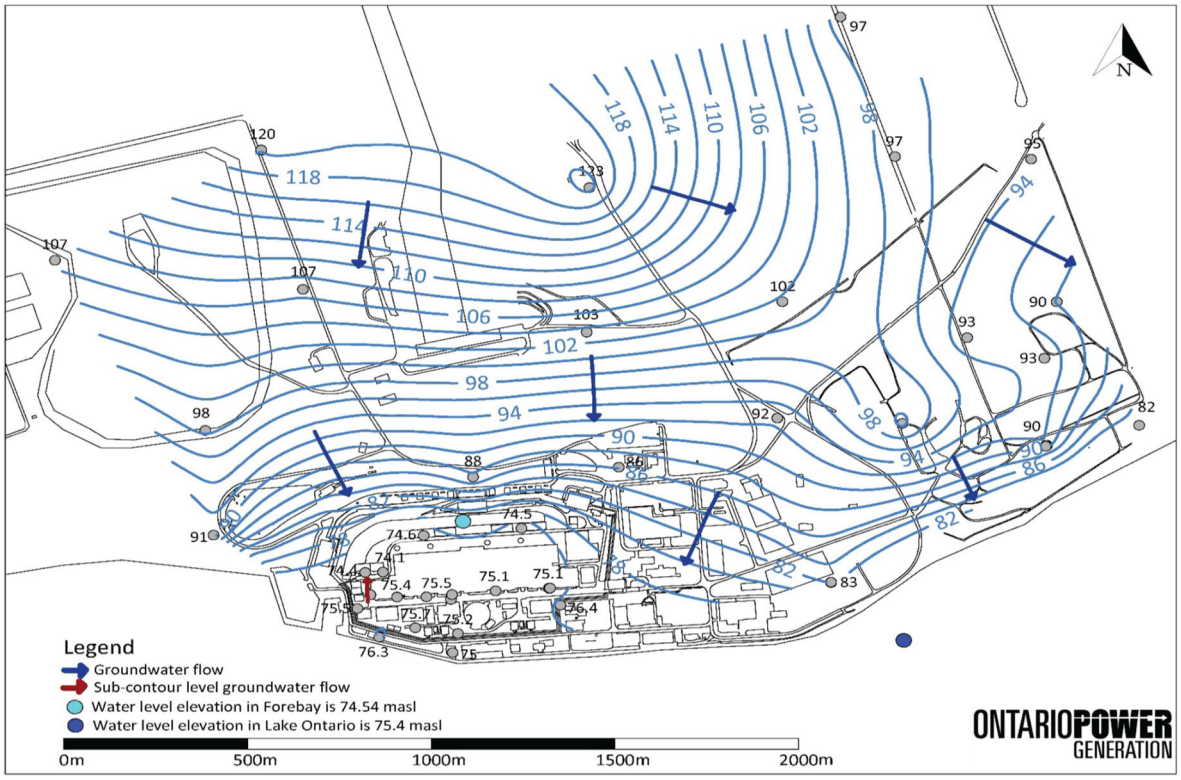



Figure 21: 2023 Inferred Shallow Groundwater Contour Map

Groundwater quality data is collected on an annual basis 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 and benzene, toluene, ethylbenzene, and xylenes (BTEX).

With respect to tritium, results indicate that concentrations remain 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 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.

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 petroleum hydrocarbons and BTEX sampling did not indicate any concerns during the licence term.

The 2023 Darlington Nuclear Groundwater Monitoring Program Results NK38-REP-10140-10036, is available on opg.com.

### 2.9.4.4 Spill Management Program

The Darlington NGS site has a framework in place 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.

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. 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.

## 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 22 and illustrated in Figure 23, 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.

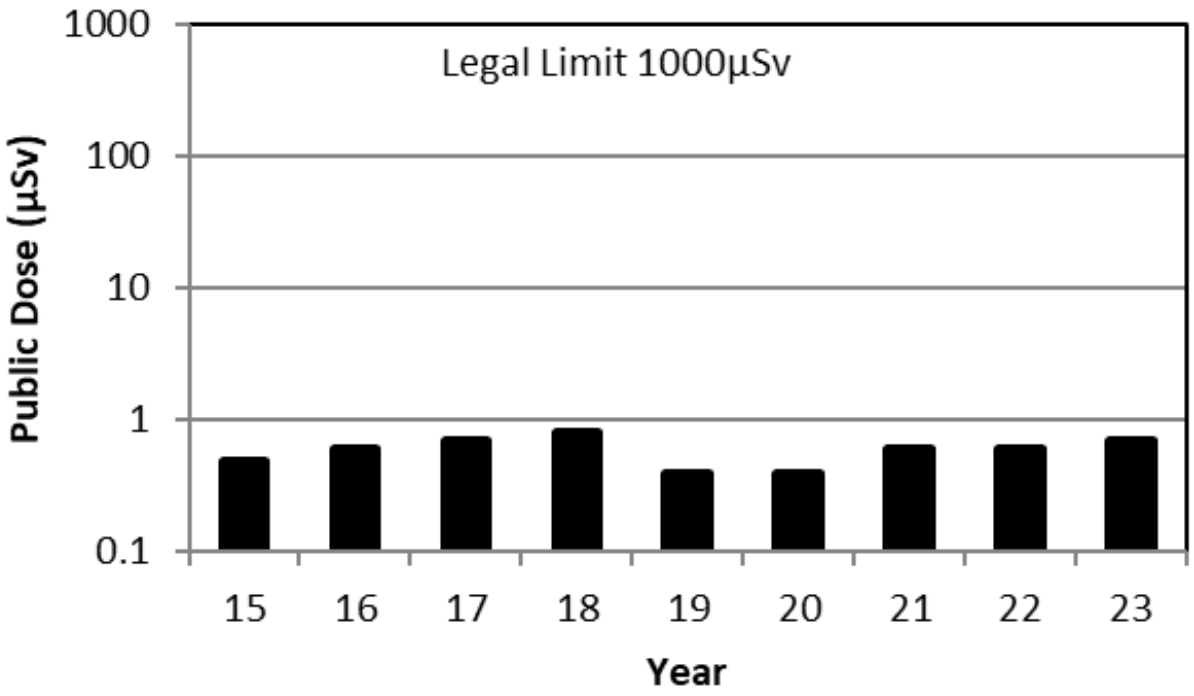



Figure 22: Public Dose Limits

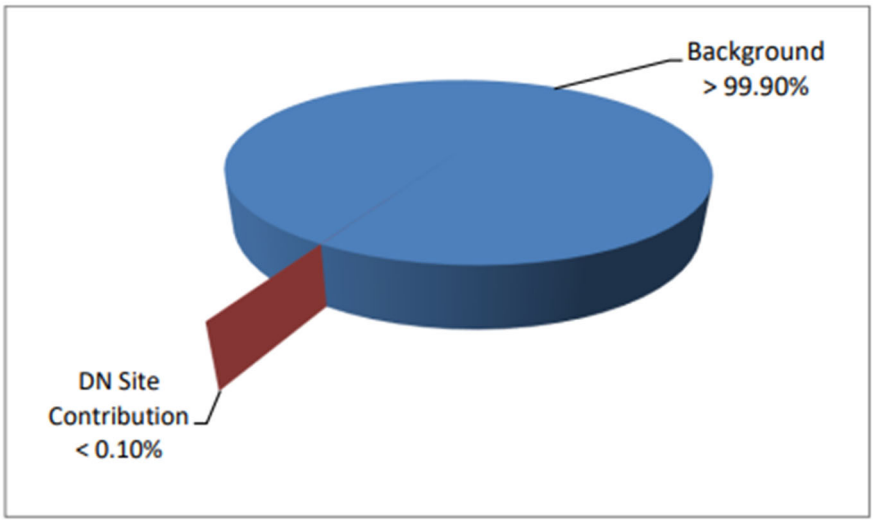



Figure 23: Background Radiation vs. Darlington NGS Site Contribution

### 2.9.6 Fish Impingement and Entrainment

Fish protection is integrated into the design and location of the intake of the Darlington NGS.

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 7), 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 the 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 ichthyoplankton (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 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 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.

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 exceed regulatory requirements and related objectives. Emergency preparedness measures and fire protection response capabilities are in place at Darlington NGS to prevent and mitigate fire hazards and the effects of nuclear and hazardous substance releases both onsite and offsite, to protect workers, the public and the environment.

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.

### 2.10.1 Conventional Emergency Preparedness and Response

#### 2.10.1.1 OPG Emergency Management

The OPG 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 program are to protect the health and safety of employees, contractors, the public and responders; the environment; OPG and third-party property; OPG's assets and reputation; and 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.

Additional details about the Nuclear Security program can be found in Section 2.12.5.

### 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

OPG maintains a procedure for abnormal waterborne tritium emission response which provides direction for response to an abnormal waterborne tritium emission from OPG's nuclear sites, and 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 describes the managed system for RMT at OPG Nuclear. The RMT program ensures safe, compliant, and efficient transportation of radioactive material.

Under this program the *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 table-top drill was conducted on October 20, 2023 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 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

OPG's Nuclear Emergency Preparedness program is documented in the *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 24).

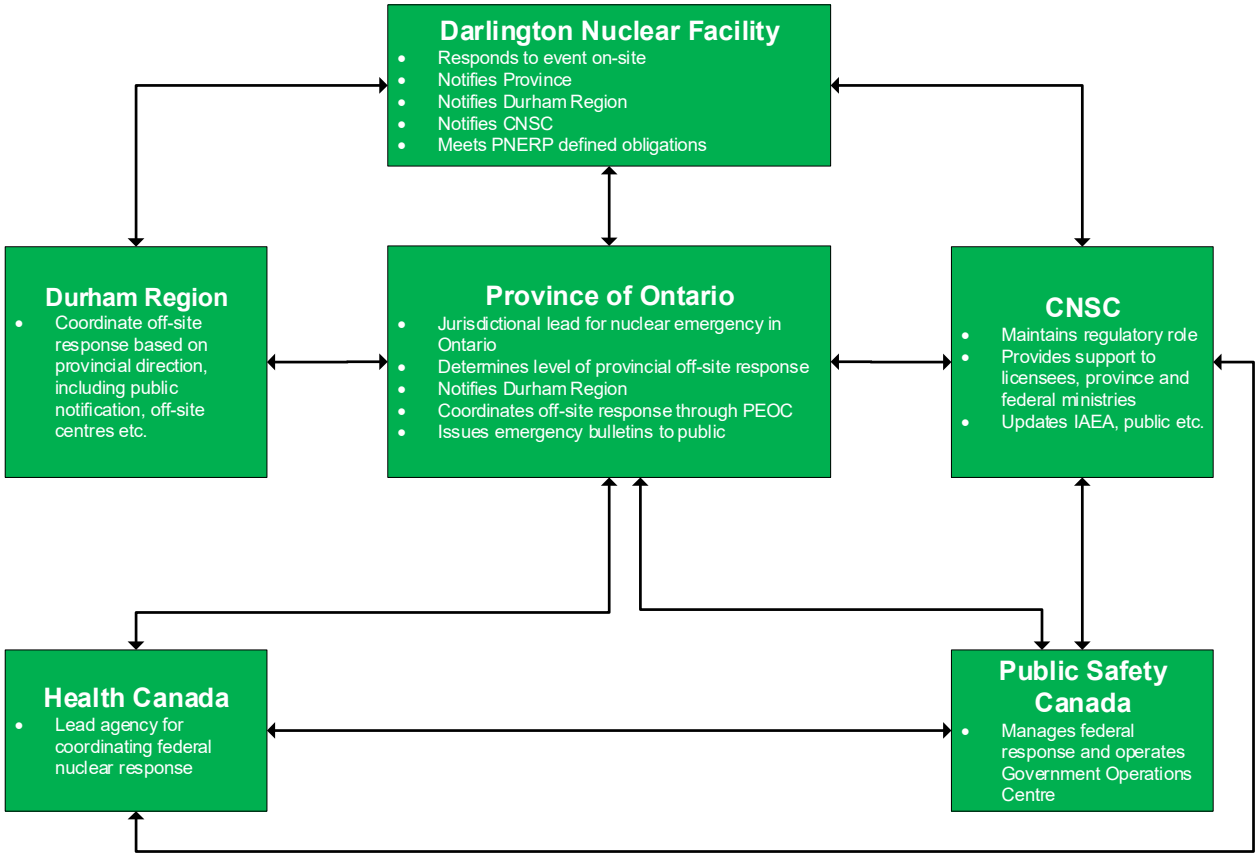



Figure 24: Emergency Response Agency Interactions

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 plans to

conduct a public consultation process, to be completed by March 2025, with the objective of obtaining a Cabinet approved PNERP in 2025. 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

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.

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, the following lessons 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 10 km 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 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. 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 Potassium Iodide Working Group 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, OPG 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 was invited to attend this event again in June 2024 and looks forward to further opportunities to directly engage with the Métis Nation of Ontario.

In 2024, OPG also 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.

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.

OPG's 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 OPG's response as needed.

### 2.10.2.6 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.

### 2.10.2.7 Remote Evaluation

OPG Enterprise Emergency Management 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.

### 2.10.2.8 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.

### 2.10.2.9 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 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.

### 2.10.2.10 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.

### 2.10.2.11 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.

### 2.10.2.12 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 was 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 program 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.

As per the requirements of the operating licence, 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 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, and National Building Code of Canada. The 2024 Annual Plant Condition Inspection was completed in July 2024.

A Code Compliance Review 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 National Fire Code of Canada and National Building Code of Canada.

Darlington NGS's Fire Protection Assessments, which consist of the Fire Hazard Assessment and Fire Safe Shutdown Assessment, were completed in 2021 and submitted to the CNSC in compliance with the Darlington NGS PROL. In general, the 2021 Fire Protection Assessments 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 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 Combustible Materials Safety Permits (CMSPs), Ignition Source Permits (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 Fire Protection

OPG's fire protection program is being followed for the refurbishment project. During refurbishment, OPG:

- Prepares fire protection strategies.
- Performs Fire Hazard Assessment and Fire Safe Shutdown Assessment for the islanding areas and refurbishment units.
- Acts as Controlling Authority (i.e. person who has control over the CMS permit process) and fire protection subject matter expert for CMSPs.
- Acts as ISPs issuer.
- Provides 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 is established between OPG and the Municipality of Clarington Emergency and Fire Services Department, to provide mutual aid agreements between OPG and Clarington. As part of this Memorandum of Understanding, 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 Air-Pak X3 for firefighting. The purchase of new Self-Contained Breathing Apparatus 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 Clarington Emergency and Fire Services response.

In the past four years, Darlington NGS ERT has been incorporating aerial drones from the OPG Security and Emergency Services 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. 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 Peterborough 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 fire blanket as part of its fire response tools.

## 2.11 Waste Management

OPG maintains waste management programs that ensure adequate provisions are in place to limit the generation of radioactive and conventional waste and, if waste is created, to control/manage its handling, storage, and disposal. Two waste management programs manage the elements of this SCA. Together they 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 includes OPG 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 management, and CNSC requirements for nuclear facilities.

The Nuclear Waste Management Program is a mature and effective program with the objective to ensure that 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.

### 2.11.1 Waste Management Practices

Waste is generated due to day-to-day operations of the plant. Waste streams are handled and processed at Darlington NGS to ensure the safety of employees, the public, and the environment, while applying best practices to reduce and effectively segregate the generated waste. Procedures provide direction to workers for the segregation and handling of potentially radioactive solid and liquid waste resulting from operation and maintenance activities.

The generated waste paths at Darlington NGS can be categorized as follows:

- Solid radioactive waste, which is shipped to a licensed waste management facility for incineration or long-term storage (compactable and non-processible).
- Radioactive oil, which is shipped to a licensed waste management facility for incineration.
- Radioactive liquid chemicals, which are either solidified on site and shipped to be stored at a licensed waste management facility or are shipped to be incinerated at a licensed 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

Radioactive waste is characterized as Low Level Waste (LLW), Intermediate Level Waste (ILW) or High Level Waste (HLW).

After LLW and ILW has been processed at Darlington NGS, it's transported to the Western Waste Management Facility, where it is further volume reduced and stored on an interim basis. The LLW in storage buildings at the Western Waste Management

Facility is also 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.

ILW from 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.

HLW consists of used reactor fuel. After at least 10-years of storage in the Irradiated Fuel Bay, used fuel is loaded into Dry Storage Containers and transferred to the Darlington Waste Management Facility (DWMF) where it is processed and stored under the facility waste management licence.

#### 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 2025 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 licenses as required.

### 2.11.2 Waste Characterization

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 waste is further characterized as conventional solid waste or hazardous chemical waste.

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.

### 2.11.2.1 Radioactive Solid Waste

Figure 25 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 Low and Intermediate Level Waste 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 Low and Intermediate Level Waste generated annually is expected to be closer to pre-refurbishment averages.

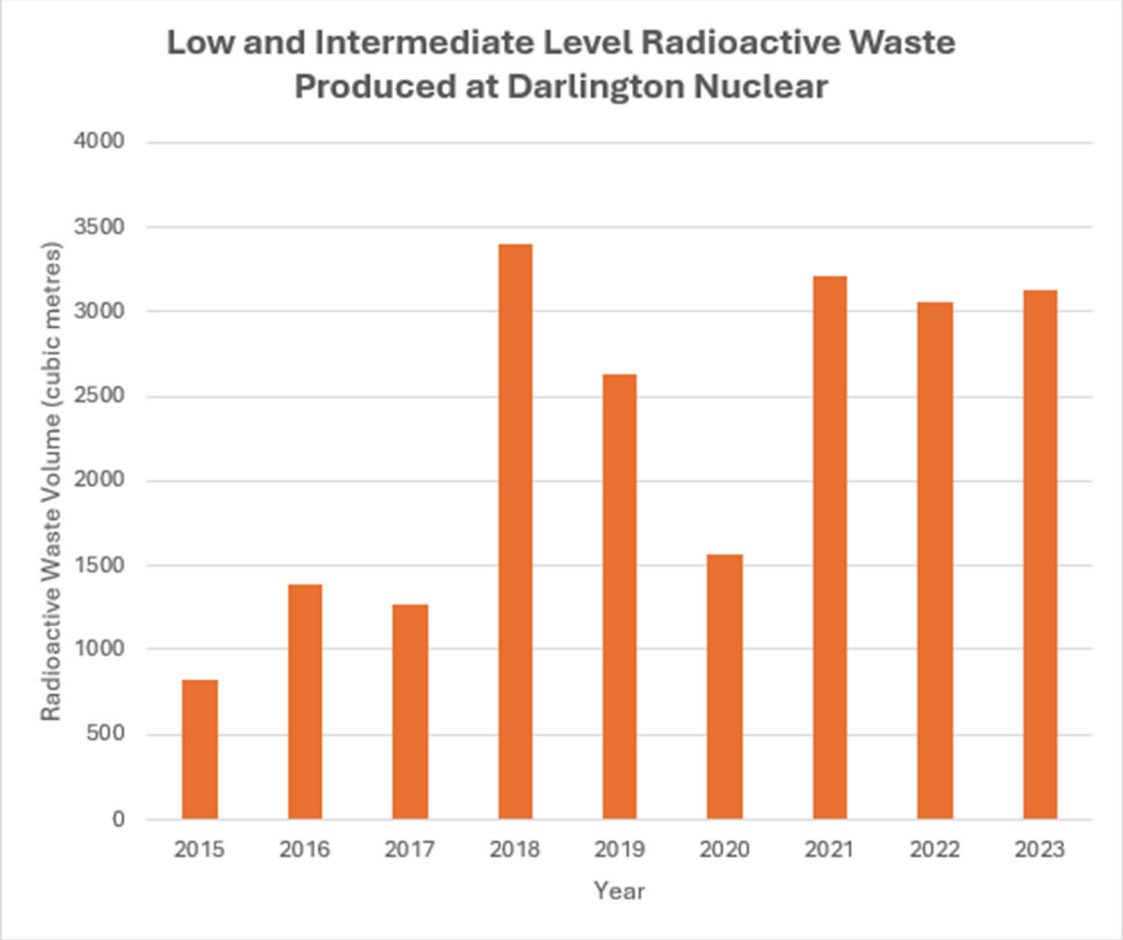



Figure 25: Low and Intermediate Level Radioactive Waste

### 2.11.2.2 High Level Waste

Approximately 22,000 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 DSCs and safely stored at the DWMF. At the end of 2023, just over 900 Dry Storage Containers 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 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

The conventional waste generated at Darlington NGS is confirmed to be free of contamination, 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.

## 2.11.3 Waste Minimization

Waste minimization is a shared responsibility amongst all Darlington NGS employees and waste generators are expected 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 $m^3$. 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%).

A new storing and segregating area was implemented in 2024, which will further help 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 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 of the facility. 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 CSA standard N294-19, *Decommissioning of facilities containing nuclear substances*, CNSC Regulatory Guide G-219, *Decommissioning Planning for Licensed Activities*, and G-206, *Financial Guarantee for the Decommissioning of Licensed Activities*, per the Darlington NGS licence and Licence Conditions Handbook.

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. The Darlington site PDP is available on www.opg.com.

### Planned Improvements

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.

## 2.12 Security

The objective of the *Nuclear Security* program at Darlington NGS is to ensure the safe and secure operation of the station by supporting the protection of nuclear assets at OPG Nuclear in accordance with regulatory requirements and OPG policies. Through the use of equipment, personnel and procedures, the Nuclear Security program 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 *Nuclear Security* program meets the expectations of the Nuclear Management System by establishing, implementing, maintaining and improving a nuclear security program that encompasses all licensing activities. This includes performing annual Security Threat Identification and Risk Assessments to identify credible threats to a specific site or facility. Any credible threats identified in the Threat Risk Assessment (TRA) are taken into account in the design of the physical protection system.

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 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 has also established a comprehensive and enhanced oversight body, including a fleetwide functional peer team, which reviews security performance and trends regularly. Security performance and results are reviewed and challenged at the Nuclear Executive Committee on a regular frequency to continually drive performance. 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 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 behaviour 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 vital areas at Darlington NGS and implemented physical protection measures, including access control, and measures designed to delay unauthorized access, taking into account the Design Basis Threat (DBT) and any other credible threat identified by the TRA.

OPG Security will continue to operate at a high standard and meet the CNSC licensing requirements throughout the life of the Darlington NGS.

### 2.12.1 Facilities and Equipment

The OPG Security Program ensures that 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 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.

## 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, Auxiliary Security Building, or Refurbishment Project Office. 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 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 also has physical protection measures against forced land vehicle penetration of the protected area.

## 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 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* and in accordance with the *Nuclear Security Regulations*. Sealed source security measures include 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.

## Physical Protection Systems

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. Alarms within the protected area are responded to by armed NSOs.

OPG employs a defense-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**

OPG Nuclear Security has a primary communications system which is interoperable with Durham Regional Police Service, 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 Central Alarm Station, 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 Durham Region Police Service to provide off-site armed response force support to the Darlington NGS. The Durham Region Police Service provides response capability for Darlington NGS in the event of identified security incidents.

As required by the *Nuclear Security Regulations* and REGDOC-2.12.1, *High Security Facilities, Volume I: Nuclear Response Force, Version 2*, 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. 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. The Durham Regional Police Service provide support to this tactical plan.

## 2.12.3 Security Practices

Frontline Darlington NGS Security personnel consist of two roles, NSOs and Armed Nuclear Security Officers (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.

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 regulatory requirements. Each person requiring unescorted access must complete a Nuclear Site Access Security Clearance Form and be approved through the clearance process per REGDOC-2.12.2, *Site Access Security Clearance*.

Prescribed information is controlled and released only on a 'need to know' basis to those who possess the appropriate security clearance.

During the current licence term, 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 Behavioural Observation Program. 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

OPG Nuclear Security has been operating with an onsite armed response force since January 18, 2010, and maintains a program to provide ongoing training for ANSOs (also referred to as the Nuclear Response Force) and unarmed Nuclear Security Officers (NSO). 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. 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.

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. 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.

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.

In accordance with the *Nuclear Security Regulations*, OPG Nuclear Security conducts a large-scale security exercise 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. Internal audit and CNSC inspection observations are used in the development of training objectives for subsequent years. The most recent exercise at Darlington NGS was in March 2023.

### 2.12.5 Cyber Security

OPG has established an enterprise-wide cyber security program which provides 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*. Moreover, OPG has implemented a Nuclear Cyber Security procedure which identifies systems that are Cyber Essential Assets and the requirements to protect them from internal and external cyber threats, up to and including the design basis threat.

## 2.13 Safeguards and Non-proliferation

Darlington NGS has an effective Safeguards and Non-Proliferation program that implements measures to meet 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.

Throughout the current licence term, the OPG Safeguards program was successful in meeting all international Safeguards and Non-Proliferation agreements.

From 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.

## 2.13.1 Nuclear Material Accountancy and Control

OPG's Safeguards and Nuclear Material Accountancy program includes activities to 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. Reports of inventory status are submitted to the CNSC and IAEA as required by the licence and REGDOC-2.13.1 *Safeguards and Nuclear Material Accountancy*.

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 prevents 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. 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.

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, during the licence term the IAEA was able to successfully replace 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

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 the Design Information Questionnaire (DIQ), Operational Program, and Additional Protocol.

The 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.

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.

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 the routine trilateral meetings with the IAEA and CNSC. 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 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.

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.

### 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.

## 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 and ensure that packaging and transport of nuclear substances is conducted safely.

OPG's Radioactive Material Transportation (RMT) program establishes the 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.

### 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, 2015).

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 Packaging and Transport of Nuclear Substances Regulations. 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 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 licence term 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.

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

# 3.0 Facility-Specific Information

This section highlights the facility-specific information associated with Darlington NGS Power Reactor Operating Licence (PROL) 13.04/2025.

## 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.

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, 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 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.
- Plant modifications to reduce environmental airborne tritium oxide emissions (i.e. wet scrubbers) were implemented. :
    - 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 allowing the time between cryogenic refrigeration system-only outages to be extended from 10,000 hours to 15,420 hours.
- 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.

In addition, during the licence term a helium-3 recovery system was commissioned and placed into service allowing OPG to harvest helium-3 from stored immobilized tritium containers. Helium-3 is an inert decay product of tritium. It 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.

### Planned Improvements

A decision to extend the TRF operation through 2055 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 many other components in Darlington NGS's four units. Progress as of Q4 2024 is shown in Figure 26.

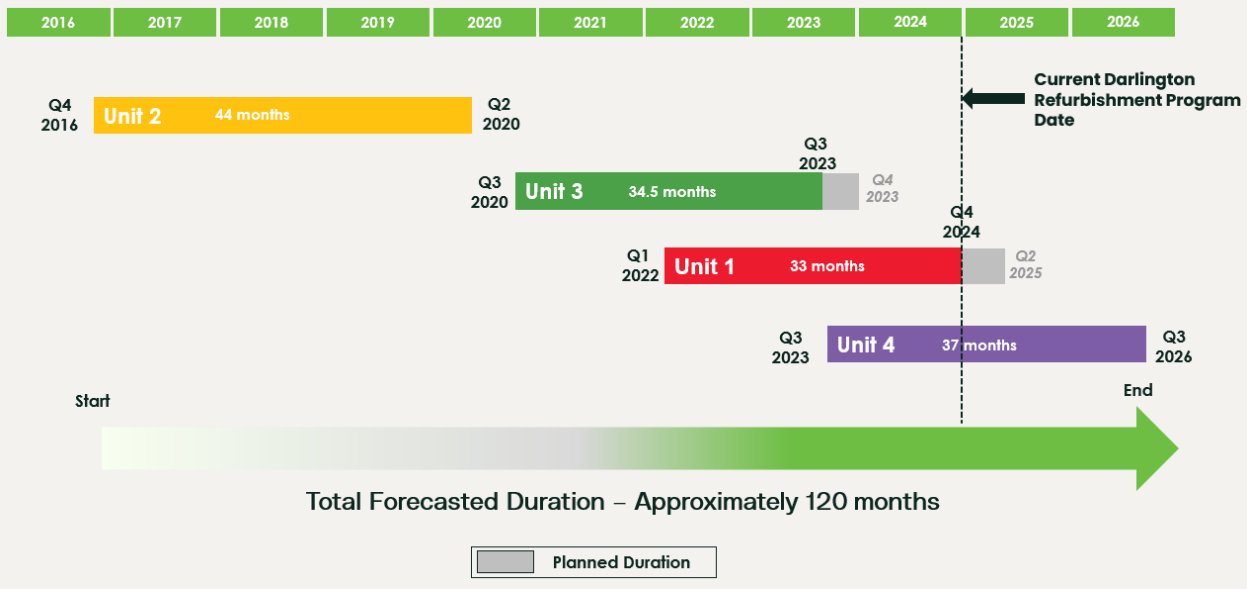



Figure 26: Refurbishment Progress

Three 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, 160 days ahead of the public commitment. 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.
- Unit 1 was successfully returned to service on November 27, 2024, 140 days ahead of the public commitment. Unit 1 was completed with 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.

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 the 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.

### 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, 570 of 622 of the IIP refurbishment and continuing operation commitments have been completed up to December 12, 2024.

Some of the key station improvements that have been implemented include:

- 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 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 the Reactor Regulating System in each unit based on performance indicators to ensure flux tilt is within limits.
- Implementation of a Containment Filtered Venting System: this system provides controlled and filtered emergency venting of the containment to prevent over-pressurization and ensure containment integrity. The system 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: these enhancements include duplication of the programmable controller logic of the current Powerhouse Steam Venting System 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 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.

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 2 below (complete data up to Q4 2023). As of Q3 2024, the Program is approaching over 56 million hours worked with one Lost Time Injury, which occurred in May 2019.

**Table 2: 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).

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 metric was implemented in 2023 as a monitoring metric to assess safety practices in real time. The Quality of Safety Practices 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 is being piloted to assess the quality of direct controls implemented to address high-energy hazards within safe work plans.

### 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 were 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 3 provides a summary of the radiological safety performance up to Q3 2024 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 3: 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 |

### 3.2.4 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 4 return to service.

### 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 27).

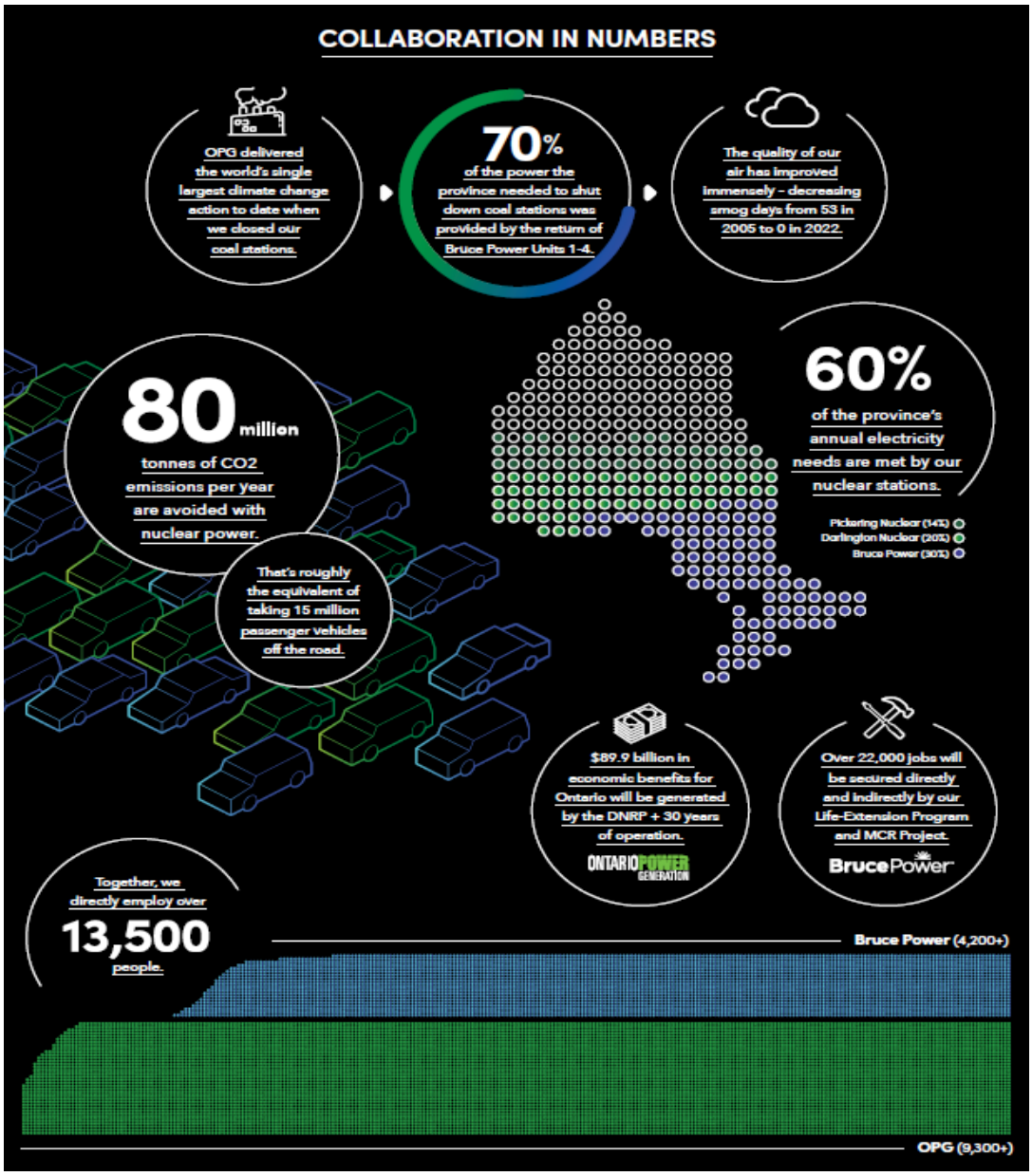



Figure 27: Collaboration in Numbers

### 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 Regulatory Hold Points (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 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 that will be the focus of the run-up activities leading up to full power and unit availability for commercial operation.

### Unit 4 RTS

Completion of 51 Systems-Available-for-Service declarations is planned and will support RTS and the removal of each of the eight Restart Control Hold Points, 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)

In support of continued long-term operation into the next licence term, OPG completed a Periodic Safety Review (D-PSR) to confirm that the design, condition and operation of the Darlington NGS supports continued commercial operation from 2025 to 2035. The D-PSR is a subsequent review which builds on previous OPG Integrated Safety Review (ISR)/PSR work such as the Pickering PSR2 (programmatic components applicable to Darlington NGS) and the Darlington NGS ISR, performed in support of refurbishment and life extension. PSR are typically conducted at 10-year intervals.

The D-PSR was conducted in accordance the PROL 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.

Through the periodic safety review process, 23 global issues were identified. Proposed resolution plans were developed for each global issue then ranked to determine activities that will be the most effective in enhancing the 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 a defense-in-depth Assessment to demonstrate the extent to which the safety requirements of defense-in-depth are fulfilled and to support mitigation of the global issues. The assessment concluded that Darlington NGS Units 1-4 design and operation have effective barriers in all levels of defense-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 defense-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 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 Integrated Implementation Plan (IIP), NK38-REP-03680-11940. The IIP was accepted by the CNSC in March 2024 (Reference 8).

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. As of Q3 2024, four IIP actions have been completed and CNSC closure has been requested. 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 9).

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)*.

## 3.4 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.

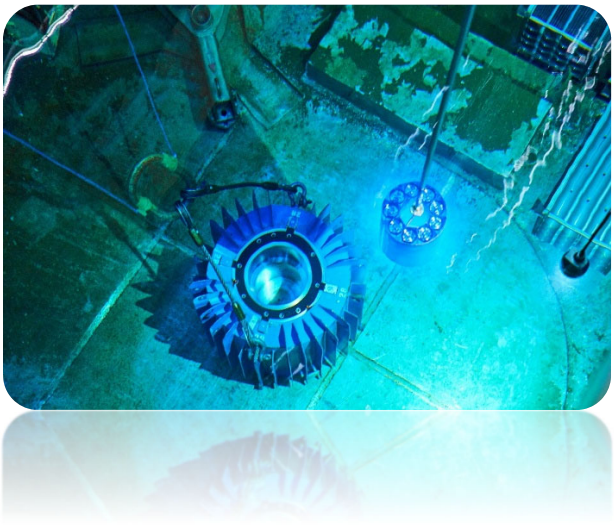
OPG, and its family of companies, produce isotopes by leveraging reactor neutrons. The reactor cores are analyzed to be safe in this configuration and processes and procedures are in place to ensure safe handling and hand-off of the resultant isotopes to OPG's strategic partners.

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. 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.

### 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 (Reference 6). With this licence amendment, 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 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 Q4 2025 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.

## Yttrium-90 (Y-90) and Lutetium-177 (Lu-177)

In February 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) on Unit 2 (Reference 10). A Commission hearing for this application is scheduled for spring 2025.

Darlington has recently submitted a letter of intent to the CNSC for a PROL amendment to install Target Delivery Systems on additional units (Reference 11).

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
# Indigenous Engagement

# 4.0 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 *Aboriginal Engagement,* that provides information for licensees on carrying out Indigenous engagement activities.

## 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 Rights Holders 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 Licence 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 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 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;
- Huron-Wendat Nation;
- Mohawks of the Bay of Quinte;
- Métis Nation of Ontario Region 8;

- Saugeen Ojibway Nation;
- Mississaugas of the Credit First Nation;
- Kawartha Nishnawbe.

## Indigenous Community Meetings and Indigenous Engagement Plan

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.

Preliminary engagement activities between August 2023 and February 2024 generated productive discussions about the PROL application, including the early identification of interests and concerns from Indigenous Nations and communities. Following these preliminary activities, OPG developed a draft Indigenous Engagement Plan (IEP) to guide engagement activities on the Licence Renewal Application. 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 prepared comment disposition tables to demonstrate how comments did or did not influence the IEP update. OPG issued a final working version of the IEP as well as sharing the comment disposition tables in early January 2025. 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.

In addition to engaging on the draft IEP, OPG has made efforts to share and engage on the content of the Licence Renewal Application. All Indigenous Nations and communities listed in the IEP were provided with a link to the Licence Renewal Application on OPG's website. 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.

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 licensing 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 endeavour 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.

## Engagement Outlook (2025 and Beyond)

OPG is steadfast in its commitment to supporting meaningful engagement during and after the licensing 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.

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

# 5.0 Additional Matters of Regulatory Interest

## 5.1 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.

The EA Environmental Impact Statement (EIS), NK38-REP-07730-10002, *Environmental Impact Statement Darlington Nuclear Generation Station Refurbishment and Continued Operation,* and its 15 associated Technical Supporting Documents (TSDs) were submitted to the CNSC in 2011 (Reference 13). 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 13).

In 2013, OPG applied for the renewal of Darlington NGS' operating licence, including refurbishment (Reference 14), and provided an addendum to the original application for renewal in 2015 (Reference 15). The current licence was granted effective January 1, 2016.

### Mitigation and Follow-up Activities

The EA identified follow-up and monitoring program activities 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 Safety Review (D-ISR) Integrated Implementation Plan (IIP) and are being tracked through IIP report NK38-REP-03680- 10185 *Darlington NGS Integrated Implementation Plan*.

A summary of all IIP-EA actions is provided in the Table below.

Table 4: 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 | Closed |

| IIP-EA Action Number | Description | Status / Notes |
|---|---|---|
| | effective in minimizing air/soil/water quality effects on humans and biota. | |
| IIP-EA-003 | Reducing traffic disruption during peak periods and maintaining safe traffic conditions both on-site and off-site during the Refurbishment phase. | Closed |
| 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 Action Number | Description | Status / Notes |
|---|---|---|
| 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 effects on survival rates for round whitefish embryos. | 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).<br><br>The descriptions and timeline of the current open activities for this IIP objective are to:<br><br>(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 |

| IIP-EA Action Number | Description | Status / Notes |
|---|---|---|
| | | target completion by 2030, pending Commission approval); and,<br><br>(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).<br><br>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 for Darlington NGS (Reference 7). The combined IIP and Fisheries Act Authorization open activities are:<br><br>(1) To prepare a sampling plan for fish impingement and entrainment by 2028 (OPG is currently targeting to complete the individual |

| IIP-EA Action Number | Description | Status / Notes |
|---|---|---|
| | | sampling plans for impingement and entrainment in 2026); and,<br><br>(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.<br><br>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).<br><br>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 Action Number | Description | Status / Notes |
|---|---|---|
| IIP-EA-015 | Confirming the liquefaction potential of foundation materials in the Protected Area is acceptably low. | Closed |

In October 2024, OPG submitted a request for Commission approval to process a new revision of the *Darlington NGS Integrated Implementation Plan*, NK38-REP-03680-10185 R004 (Reference 16). 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. 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.

## 5.2 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 17.

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

As required by the *Nuclear Liability and Compensation Act*, OPG maintains financial security in an amount equal to $ 1 billion for the Darlington NGS in 2024.

### 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.

## 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

regulatory document 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.

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 site (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 several 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.

### 5.3.1 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.

### 5.3.2 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. 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.

### 5.3.3 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.


### 5.3.4 Community Outreach

Since 2023, OPG has 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.

Outreach activities to interested groups and communities 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.


- 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.



Additionally, 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.

### 5.3.5 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.

## 5.3.6 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. 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 Wildlife Habitat Council 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.

### 5.3.7 Employee Communications

OPG 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.

Annual communications strategies are developed 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.

# 6.0
# Overall Conclusions

# 6.0 Overall Conclusions

As demonstrated in the application, the supplemental application and this written submission, OPG continues to be qualified to carry on its licensed activities and continues to 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.

Darlington NGS has demonstrated strong safety and reliability performance during the current licence term resulting in many significant achievements. OPG programs within each of the 14 Safety and Control Areas meet or exceed regulatory requirements and OPG continues to invest in Darlington NGS ensuring that:

- Nuclear safety will be assured such that plant personnel, the public and the environment are protected.
- The impacts of plant operation to the public, workers and the environment will continue to be of low risk and adequately mitigated.
- Staff are qualified and competent to operate the plant.
- Systems, structures and components at Darlington NGS are fit to continue commercial operation through the requested 30-year licence term.

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.

OPG respectfully requests the Commission approve the renewal of the Darlington NGS Power Reactor Operating Licence for a 30-year licence term, from December 1, 2025 to November 30, 2055. With the improvements and future activities planned, as outlined in the application and summarized in this written submission, OPG is confident the Darlington NGS will continue to operate safely and reliably through the requested 30-year licence term to 2055.

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2. OPG letter, A. Grace to C. Salmon, “Darlington NGS – Supplemental Update in Support of the Power Reactor Operating Licence Renewal Application”, December 18, 2024, CD# NK38-CORR-00531-25844.
3. 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.
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5. 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.
6. 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.
7. 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.
8. 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.

9. 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.

10. OPG letter, A. Grace to D. Saumure, “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.

11. 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.

12. 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.

13. 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.

14. OPG letter, B. Duncan to M. Leblanc, “Darlington NGS - Application for Renewal of the Darlington Nuclear Generating Station Power Reactor Operating Licence 13.00/2014”, December 13, 2013, CD# NK38-CORR-00531-16490.

15. 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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# Appendix A: Commonly Used Acronyms

| Acronym | Word |
|---|---|
| ADL | Administrative Dose Limits |
| AIA | Authorized Inspection Agency |
| AIMs | Abnormal Incident Manuals |
| ALARA | As Low as Reasonably Achievable |
| ANO | Authorized Nuclear Operator |
| ANSO | Armed Nuclear Security Officers |
| ASDC | Auxiliary Shutdown Cooling |
| ASR | Accident Severity Rate |
| ASU | Aerial Support Unit |
| BDBA | Beyond Design Basis Accident |
| CANDU | CANada Deuterium Uranium |
| CFAM | Corporate Functional Area Manager |
| CFSI | Counterfeit, Fraudulent and Suspect Items |
| CIS | Components Important to Safety |
| CMSP | Combustible Material Safety Permits |
| CNEP | Consolidated Nuclear Emergency Plan |
| CNO | Chief Nuclear Officer |
| CNSC | Canadian Nuclear Safety Commission |
| COG | CANDU Owners Group |
| CRE | Collective Radiation Exposure |
| CRO | Control Room Operator |
| CRSS | Control Room Shift Supervisor |
| CSA | Canadian Standards Association |
| CSIs | CANDU Safety Issues |
| CSP | Critical Safety Parameter |
| D4F | Darlington for the Future |
| DBE | Design Basis Earthquake |
| DBT | Design Basis Threat |
| DFO | Department of Fisheries and Oceans |
| DIQ | Design Information Questionnaire |
| D-ISR | Darlington Integrated Safety Review |
| DLA | Dynamic Learning Activity |
| D-PSR | Darlington PSR |
| DPZ | Detailed Planning Zone |
| DRL | Derived Release Limit |
| DSA | Deterministic Safety Analysis |
| DWMF | Darlington Waste Management Facility |
| EBP | Electronic Based Procedures |
| ECA | Environmental Compliance Approvals |

| Acronym | Word |
|---|---|
| ECC | Engineering Change Control |
| ECI | Emergency Coolant Injection |
| ED&I | Equity, Diversity, and Inclusion |
| EEM | Enterprise Emergency Management |
| EFDR | Event Free Day Reset |
| EITER | Equipment Important to Emergency Response |
| EME | Emergency Mitigating Equipment |
| EMO | Emergency Management Ontario |
| EMP | Environmental Monitoring Program |
| EMS | Environmental Management System |
| 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) |
| EPG | Emergency Power Generator |
| EQ | Environmental Qualification |
| ER | Equipment Reliability |
| ERA | Environmental Risk Assessment |
| ERI | Equipment Reliability Index |
| ERM | Emergency Response Maintainers |
| ERO | Emergency Response Organization |
| ERT | Emergency Response Team |
| ESL | Equipment Status Log |
| ESM | Equipment Status Monitoring |
| ESW | Emergency Service Water |
| ETE | Evacuation Time Estimates |
| GSS | Guaranteed Shutdown State |
| HLW | High Level Waste |
| HoW | Hours of Work |
| HSMS | Health and Safety Management System |
| HTS-AMS | Heat Transport System Aging Management Strategy |
| HWMB | Heavy Water Management Building |
| IAEA | International Atomic Energy Agency |
| IAM | Integrated Aging Management |
| IHSA | Infrastructure Health & Safety Association |
| IIP | Integrated Implementation Plan |
| ILW | Intermediate Level Waste |
| INPO | Institute of Nuclear Power Operations |
| ION | Indigenous Opportunities Network |
| IPZ | Ingestion Planning Zone |
| IRIS | Industry Reporting and Information System |
| ISAR | Industrial Safety Accident Rate |

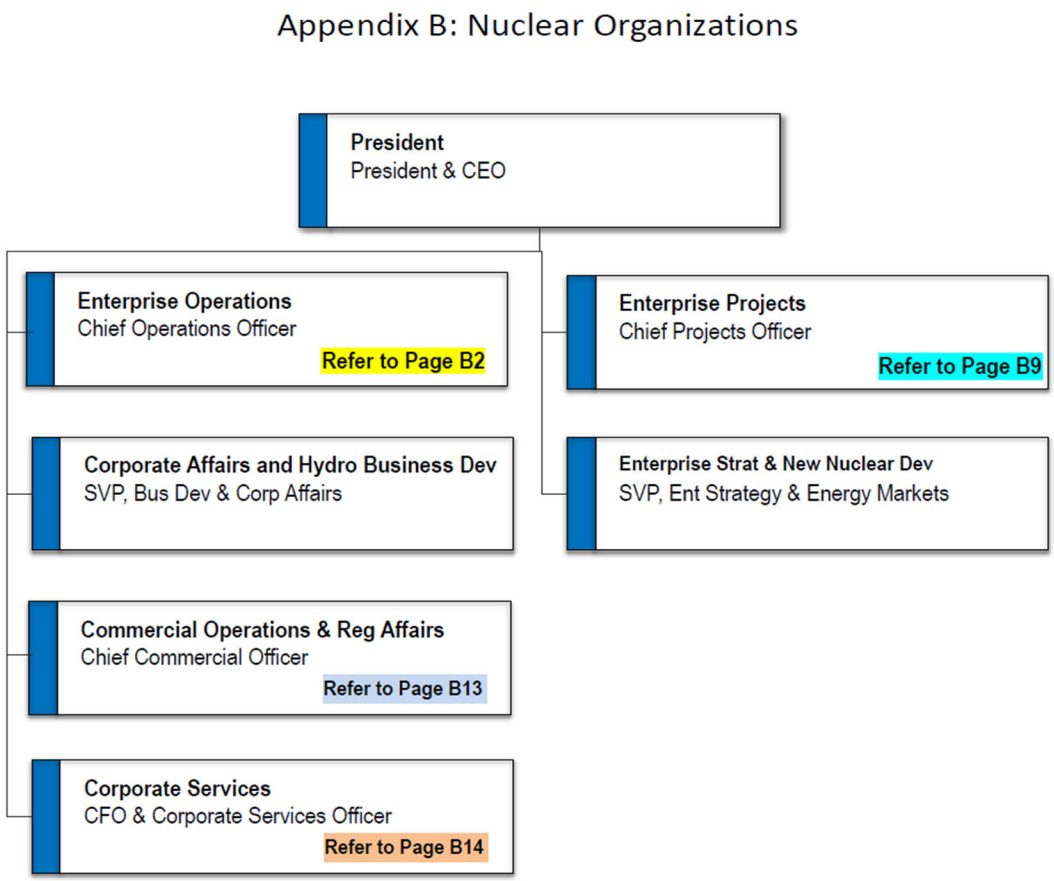
| Acronym | Word |
|---|---|
| ISO | International Standards Association |
| ISP | Ignition Source Permits |
| ISRW | Integrated Strategy for Radioactive Waste |
| IUCs | Instrument Uncertainty Calculations |
| JHSC | Joint Health and Safety Committee |
| JIT | Just-in-Time |
| KI | Potassium Iodide |
| KPI | Key Performance Indicators |
| LBLOCA | Large Break Loss of Coolant Accident |
| LCMP | Life Cycle Management Plan |
| LLW | Low Level Waste |
| LOCA | Loss of Coolant Accident |
| LRF | Large Release Frequency |
| LWPRB | Local Work Protection Review Board |
| M&D | Monitoring & Diagnostics |
| MCQ | Multiple Choice Question |
| MCR | Main Control Room |
| MDE | Margin Design Earthquake |
| MIV | Mispositioning Index Value |
| MOT | Main Output Transformer |
| NGS | Nuclear Generating Station |
| NPCS | Negative Pressure Containment System |
| NPP | Nuclear Power Plant |
| NSCA | Nuclear Safety and Control Act |
| NSO | Nuclear Security Officers |
| NSRB | Nuclear Safety and Review Board |
| NSSCMP | Nuclear Safety and Security Culture Monitoring Panel |
| NWMO | Nuclear Waste Management Organization |
| O&C | Observation and Coaching |
| OHSA | Occupational Health and Safety Act |
| OPEX | Operating Experience |
| OPG | Ontario Power Generation Inc. |
| OSRs | Operational Safety Requirements |
| PA | Public Address |
| PB | Pressure Boundary |
| PCB | Polychlorinated Biphenyl |
| PDP | Preliminary Decommissioning Plan |
| PHT | Primary Heat Transport |
| PIP | Periodic Inspection Program |
| PM | Preventative Maintenance |
| PMMR | Preventative Maintenance Modification Request |

| Acronym | Word |
|---|---|
| PNERP | Provincial Nuclear Emergency Response Plan |
| PROL | Power Reactor Operating Licence |
| PSA | Probabilistic Safety Assessment |
| PSR | Periodic Safety Review |
| R&D | Research and Development |
| RAP | Reconciliation Action Plan |
| RHP | Regulatory Hold Point |
| RMI | Reactivity Management Index |
| RMT | Radioactive Material Transportation |
| RP | Radiation Protection |
| RTS | Return-to-Service |
| SA | Severe Accident |
| SAA | Severe Accident Analysis |
| SAMGs | Severe Accident Management Guidelines |
| SAT | Systematic Approach to Training |
| SCAs | Safety and Control Areas |
| SCDF | Severe Core Damage Frequency |
| SCR | Station Condition Record |
| SDC | Shutdown Cooling |
| SDS | Shutdown System |
| SG | Steam Generator |
| SIIR | Serious Injury Incidence Rate |
| SIS | Systems Important to Safety |
| SM | Shift Manager |
| SMRs | Small Modular Reactors |
| SOE | Safe Operating Envelope |
| SOT | Staying on Top |
| SPI | Safety Performance Indicators |
| SPOC | Single Point of Contact |
| SSC | Systems, Structures, and Components |
| SSCs | Structures, Systems, and Components |
| TCSCA | Timely Completion of Safety Corrective Actions |
| TDS | Target Delivery System |
| TDG | Transportation of Dangerous Goods Regulations |
| TIMS | Training Information Management System |
| TPAR | Technical Procedure Action Request |
| 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 |

| Acronym | Word |
|---|---|
| UST | Unit Service Transformer |
| WANO | World Association of Nuclear Operators |
| WHMIS | Workplace Hazardous Materials Information System |
| WPPI | Work Protection Performance Index |

# Appendix B: Darlington Nuclear Organizational Structure

(Current as of December 5, 2024)



# Appendix B: Nuclear Organizations

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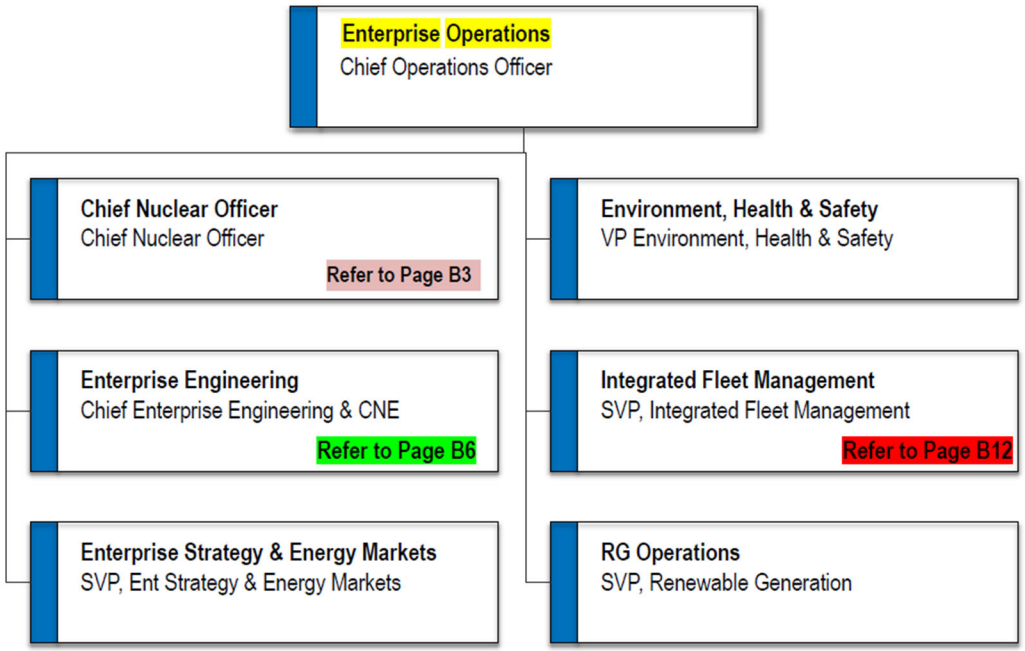

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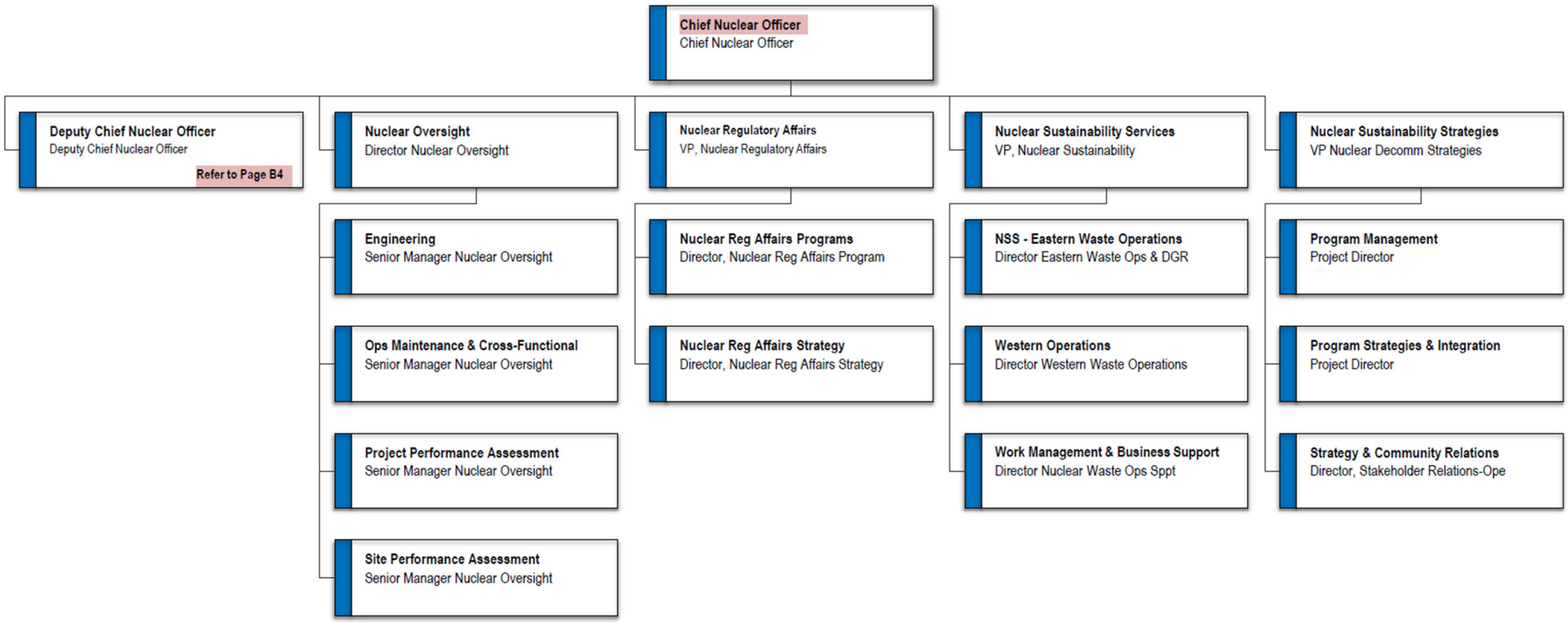

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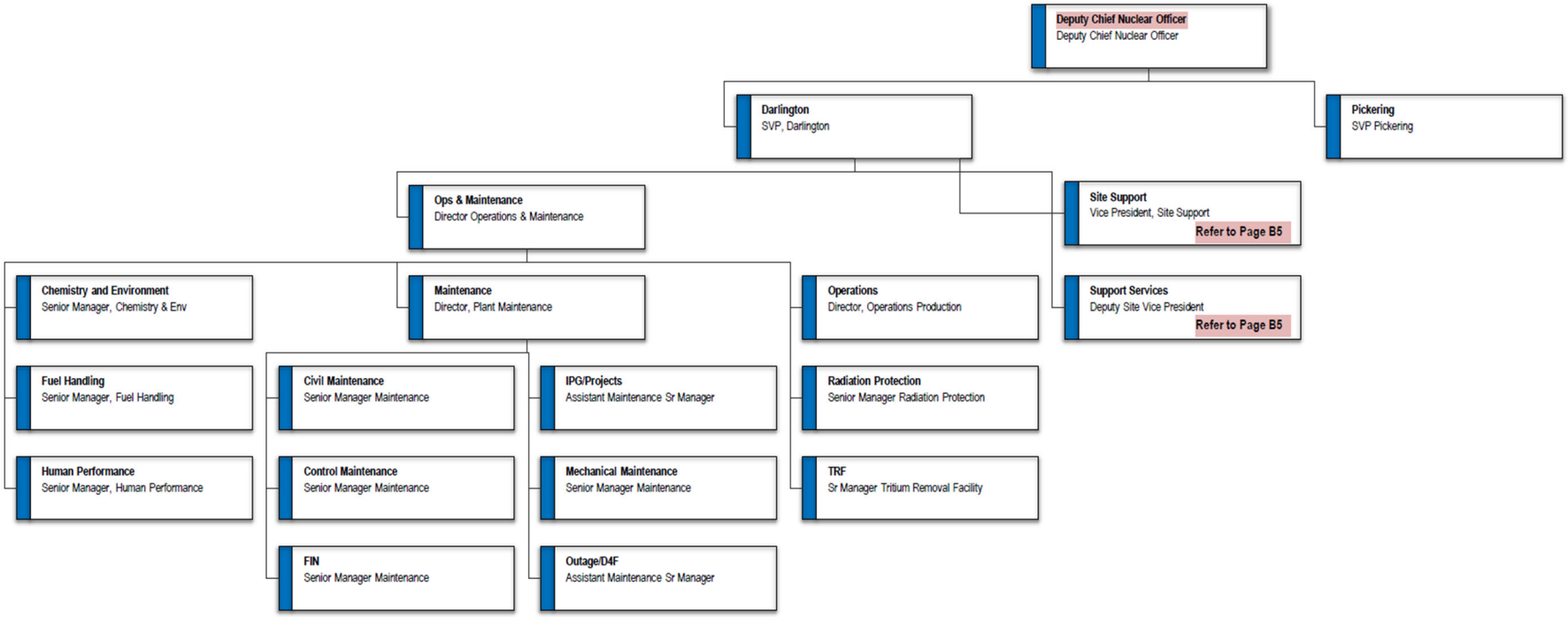

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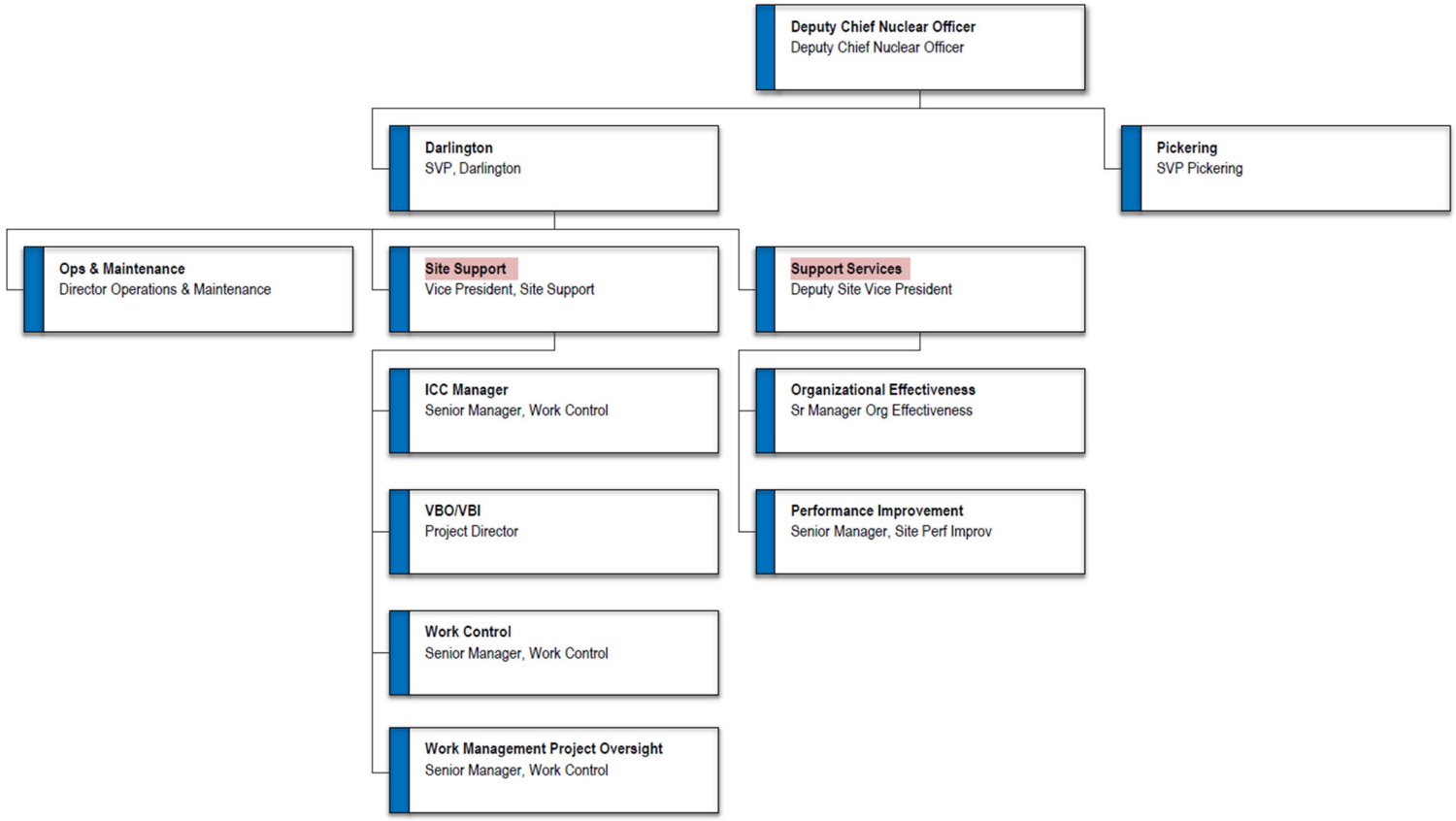

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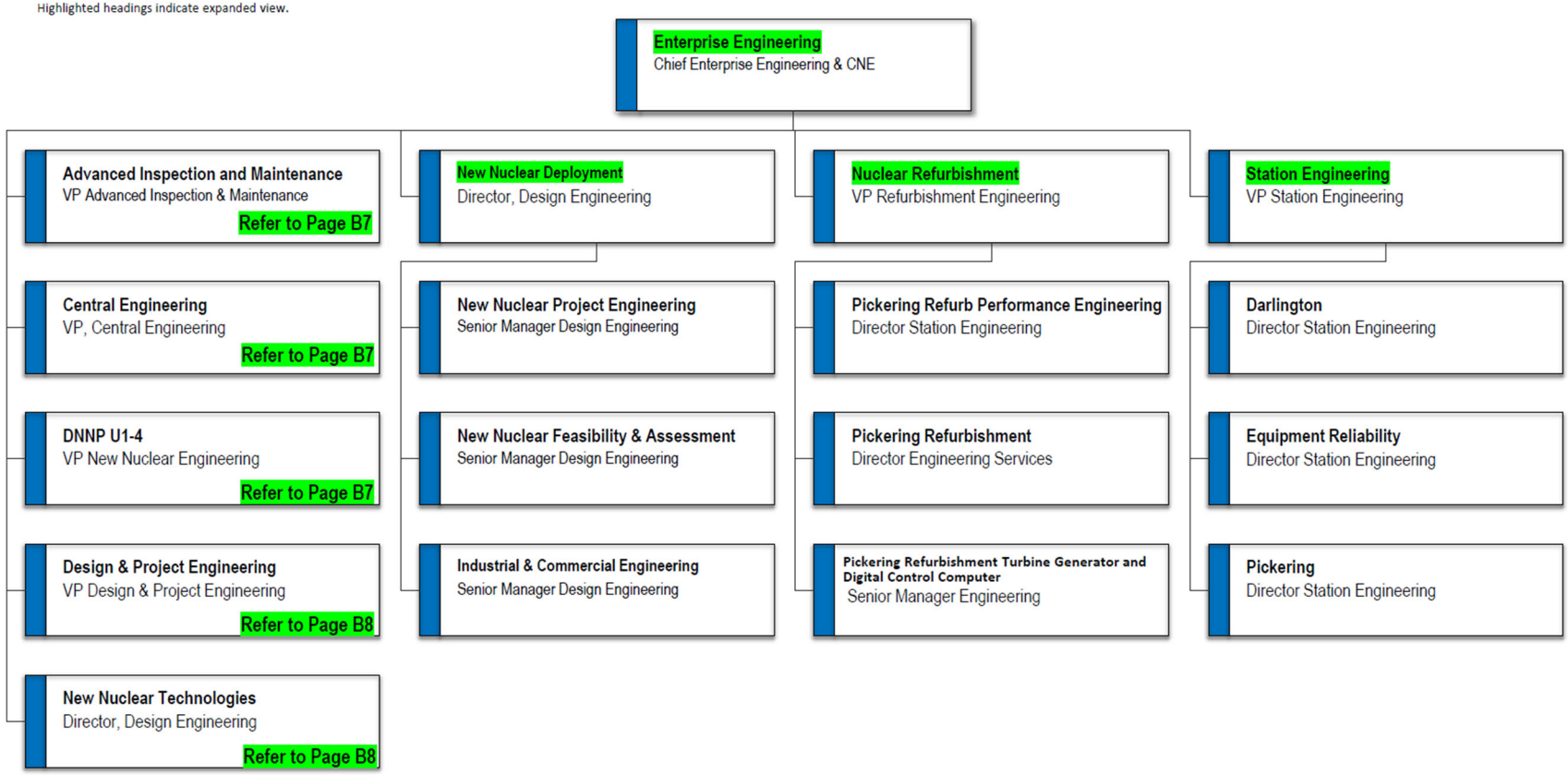

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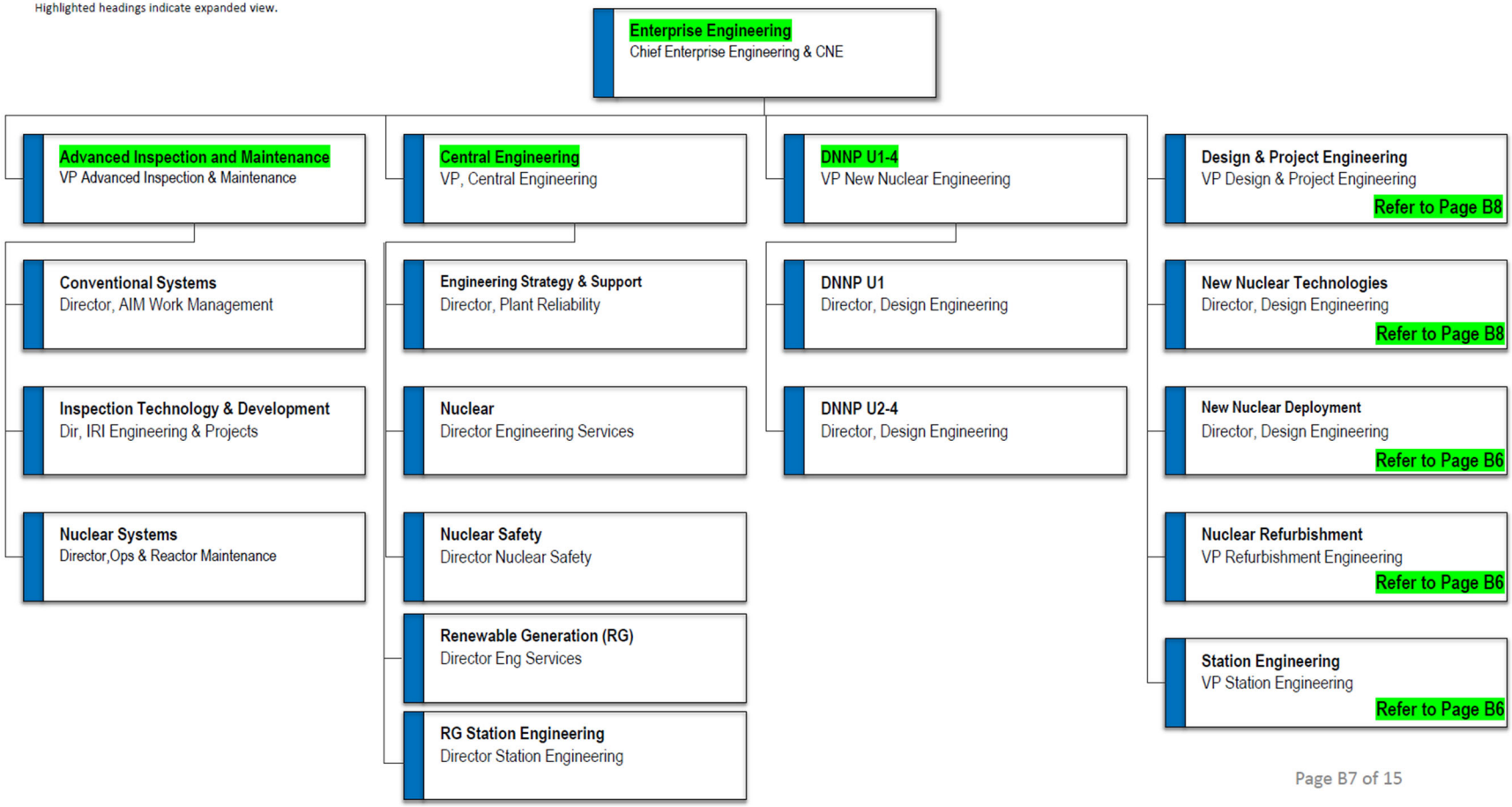


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# Appendix B: Nuclear Organizations

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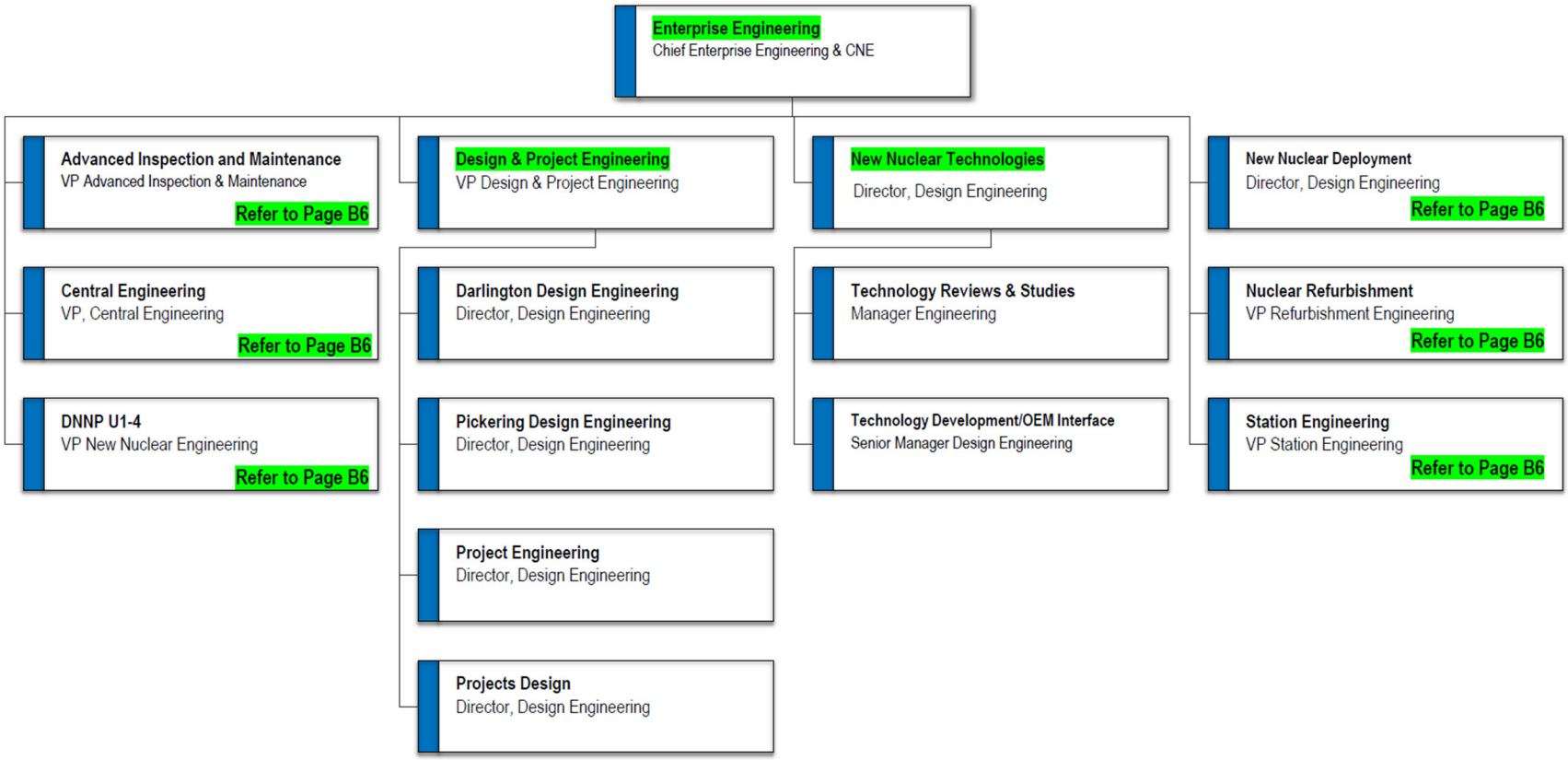

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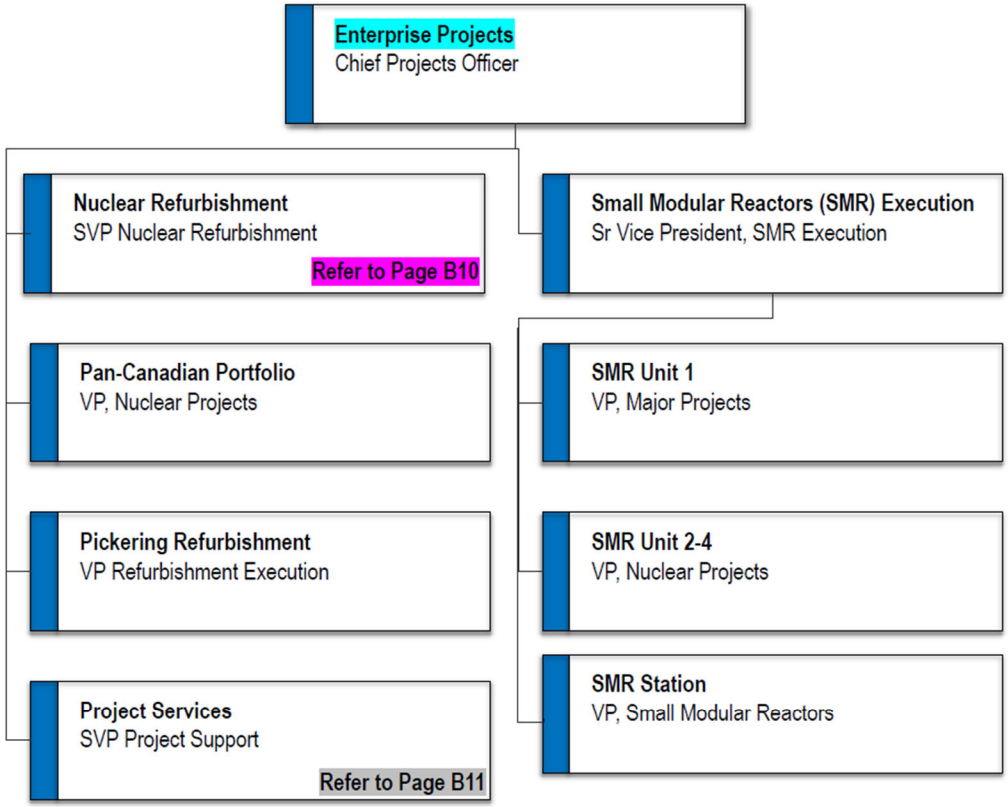

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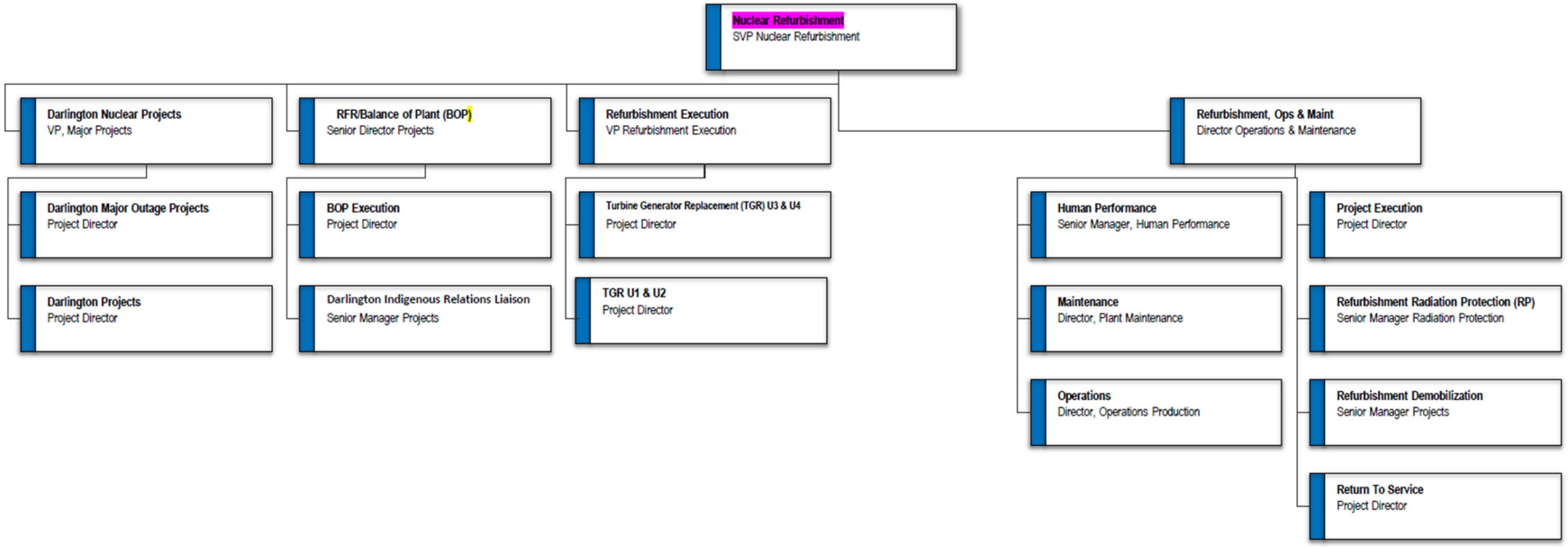

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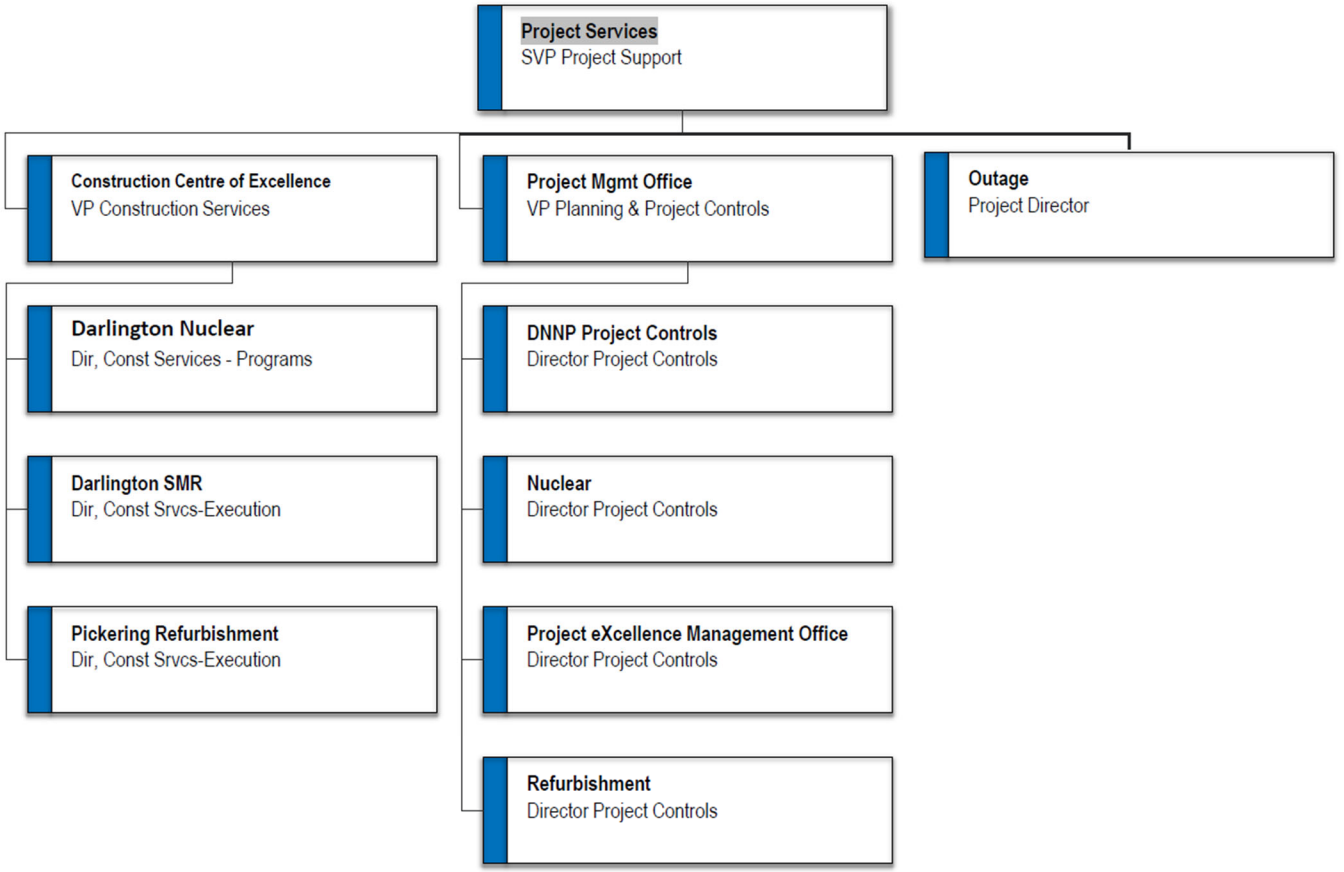

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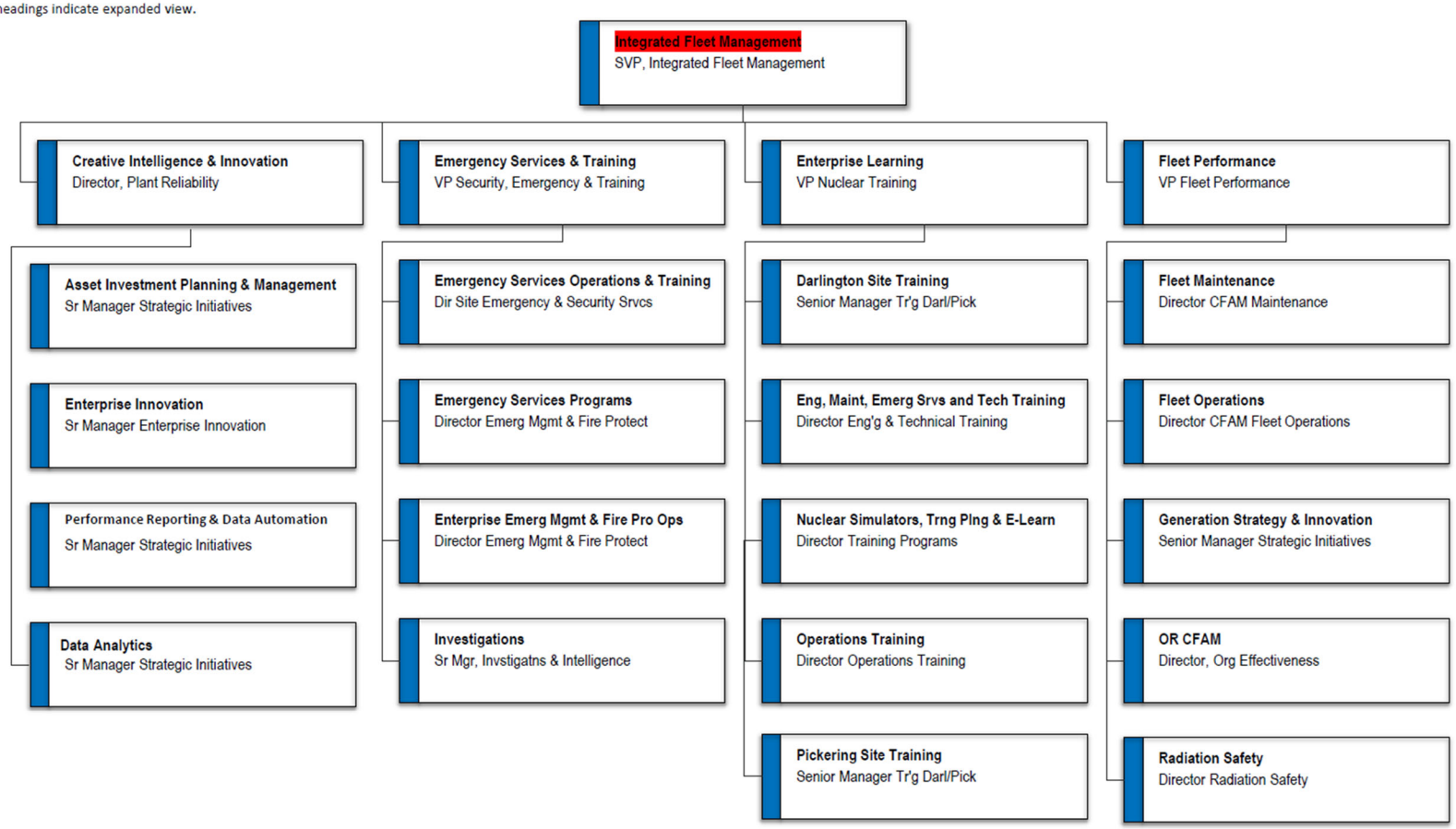
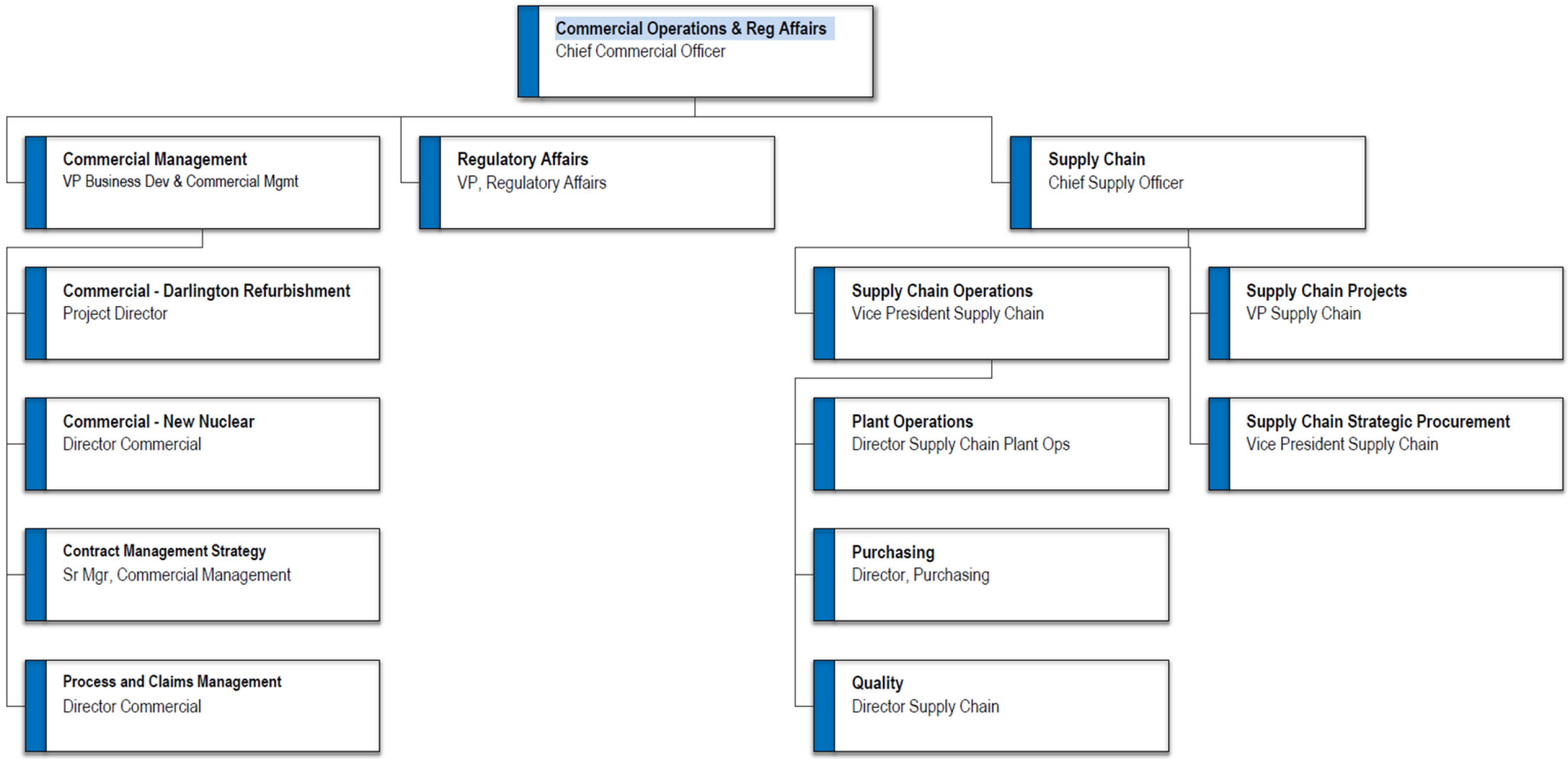


# Appendix B: Nuclear Interfacing Organizations

Highlighted headings indicate expanded view.



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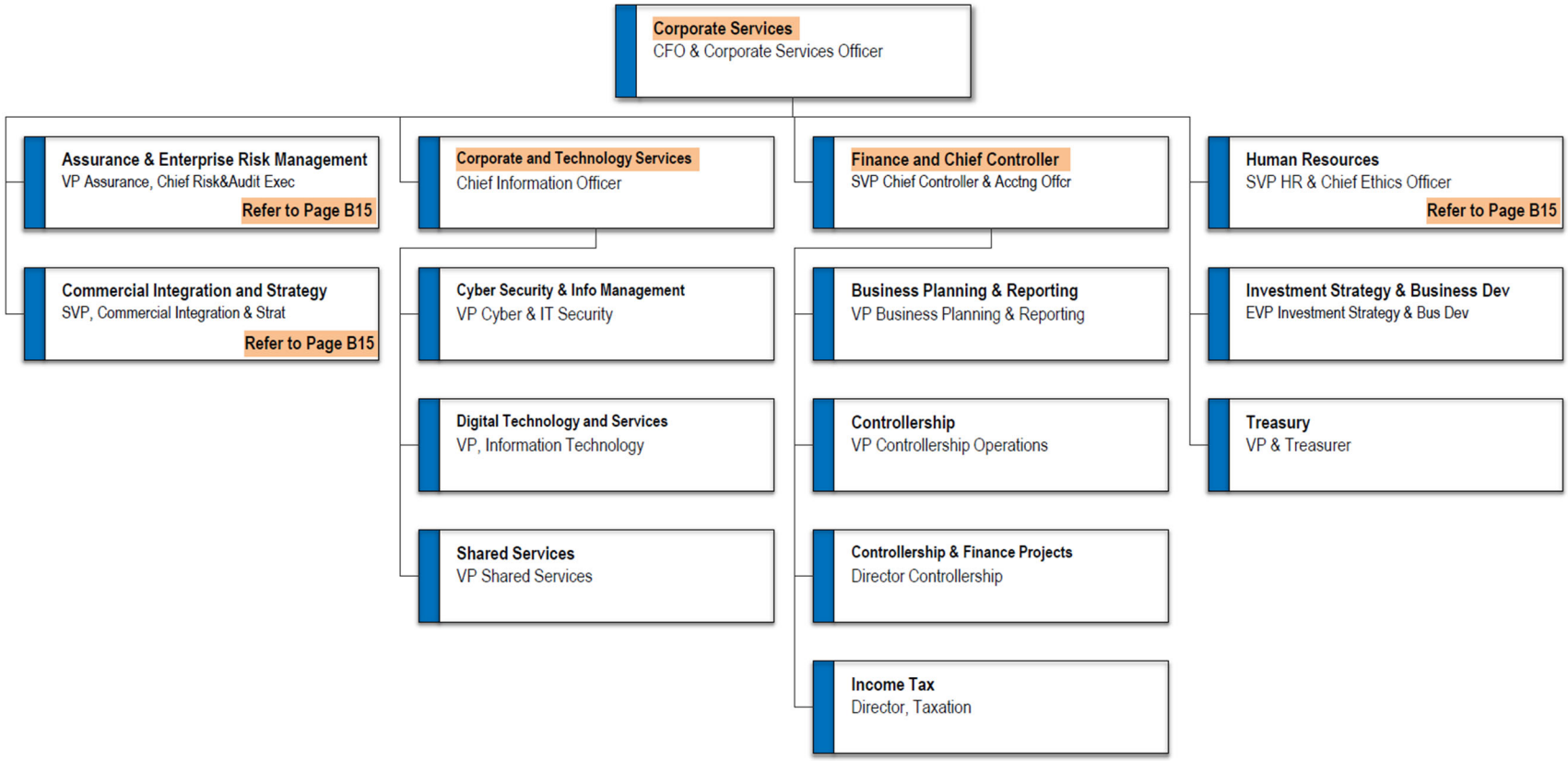
Highlighted headings indicate expanded view.



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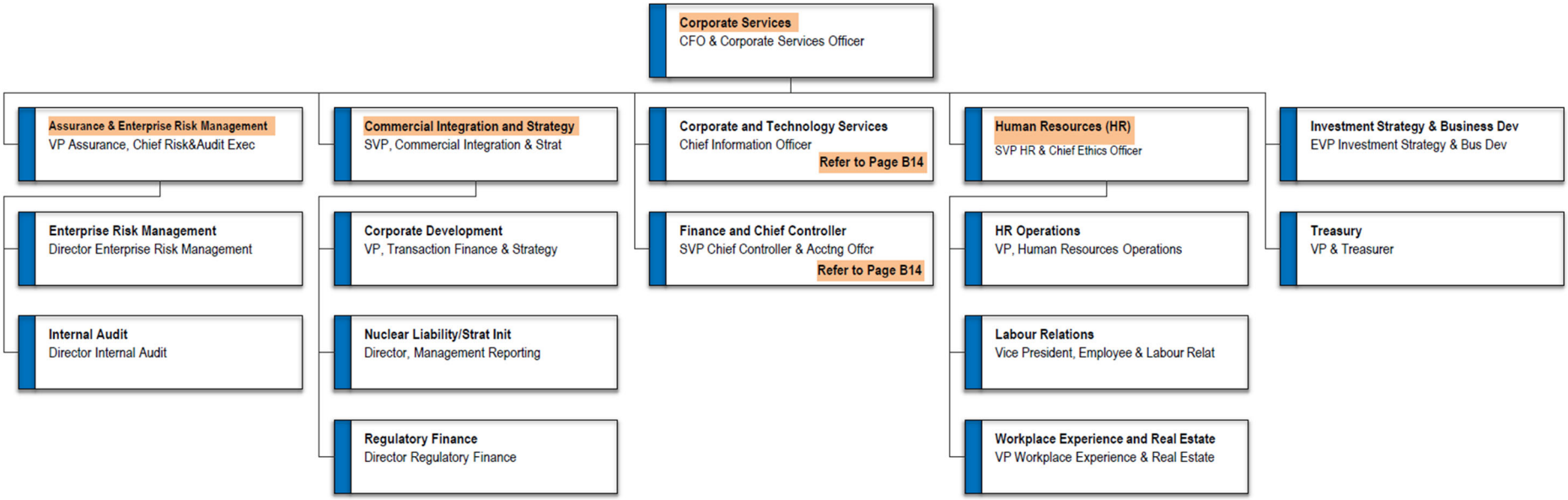

**Summary of Regulatory Commitments, Regulatory Obligations and Regulatory Management Actions Made/Concurrence Requested**

**CD# NK38-CORR-00531-25966 P**

**Submission Title:** **Darlington NGS – Notice of Participation at CNSC Public Hearing 2025-H-02 and Written Submission in support of the renewal of the Darlington Nuclear Generating Station Power Reactor Operating Licence**

**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.