OPG

Written Submission

In support of the Darlington New Nuclear Project's Application for a

Power Reactor Construction Licence

ONTARIO POWER GENERATION

Electrifying life in one generation.

CMD 24-H3.1 PUBLIC HEARING June 28, 2024

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LAND ACKNOWLEDGMENT

The lands and waters on which the Darlington Nuclear Generating Station (DNGS) and Darlington New Nuclear Project (DNNP) are situated on are the Treaty and traditional territory of the Michi Saagiig and Chippewa Nations, collectively known as the Williams Treaties First Nations.

DNGS and DNNP are within the territory of the Gunshot Treaty and the Williams Treaties of 1923. These Rights were affirmed in 2018 in a settlement with Canada and the Province of Ontario.

To acknowledge traditional territories is to recognize their history, predating the establishment of the earliest European colonies. It is also to acknowledge the significance for the Indigenous people who lived and continue to live upon the land, to acknowledge the people whose practices and spiritualties were tied to the land and water, and continue to develop in relation to the territory and its other inhabitants today.

As a company, Ontario Power Generation remains committed to fostering positive and mutually beneficial relationships with Indigenous people and communities across Ontario.

ALDERVILLE FIRST NATION | BEAUSOLEIL FIRST NATION | CURVE LAKE FIRST NATION | GEORGINA ISLAND FIRST NATION | HIAWATHA FIRST NATION | SCUGOG ISLAND FIRST NATION | RAMA FIRST NATION

Executive Summary

Ontario Power Generation Inc. has applied to the Canadian Nuclear Safety Commission for a Licence to Construct the first of four BWRX-300 units at the Darlington Nuclear site under the Darlington New Nuclear Project.

This Commission Member Document (CMD) summarizes the evidence that demonstrates OPG meets all the legal requirements of the Nuclear Safety and Control Act (NSCA) and the applicable Regulations. Within this CMD, Ontario Power Generation (OPG) demonstrates that it continues to be qualified to carry on the licensed activities and will make adequate provision for the protection of the environment, the health and safety of persons and the maintenance of national security and measures required to implement international obligations to which Canada has agreed.

Canadian Nuclear Safety Commission (CNSC) approval to construct a reactor facility would support OPG's mandate to add nuclear generation capacity at the Darlington site and would help to ensure reliable nuclear energy remains an important part of Ontario's low-carbon energy mix in the future, in alignment with OPG's Climate Change Action Plan. OPG has committed to be a net-zero carbon company by 2040, in support of Canada's commitment to be a net-zero carbon economy by 2050. According to the Independent Electricity System Operator (IESO) Pathways to Decarbonization Report [R-1], demand for energy is projected to increase across Ontario and clean energy solutions that do not release significant greenhouse gases are required in attaining greenhouse gases emission reduction targets. For nuclear power to play a significant role in helping decarbonization efforts, it must be deployed safely, efficiently, cost effectively and with the appropriate nuclear regulatory and safety oversight.

Small Modular Reactors (SMRs), like the BWRX-300, support the decarbonization objective using technology that is safe, easy to operate, and efficient to construct and maintain. OPG undertook an extensive and rigorous selection process and selected the General Electric Hitachi (GEH) BWRX-300 as the Darlington New Nuclear Project (DNNP) technology for deployment at OPG's existing Darlington Nuclear (DN) site.

Nuclear Safety

Safety was a critical consideration in OPG's technology selection, and the BWRX-300 meets or exceeds regulatory requirements. The BWRX-300 is the tenth generation of the Boiling Water Reactor (BWR) that incorporates the lessons learned in design, construction, operations, and maintenance from over 100 previous BWRs that have been built, operated, and in some cases, decommissioned. The simplified BWRX-300 design incorporates passive safety features and optimizes safety, operability, and maintainability.

Project and Operating Excellence

OPG is recognized for exceptional performance in nuclear operations within the nuclear industry. As a world leader in nuclear operations, OPG is well positioned to lead a skilled workforce in the operation of new nuclear technology. OPG has a 50-year history of strong safety and operational performance at its two nuclear generating stations. This positive track record is a testament to the diligence and passion for excellence that all OPG personnel are committed to each day, supporting the safe and reliable operation of our facilities.

OPG also has a history of excellent project management success. With the expertise and commitment of qualified partners and vendors, OPG has demonstrated world-class project performance with the successful and safe refurbishment of Darlington units 2 and 3. Success in large projects such as the Darlington Refurbishment, as well as completion of the Lower Mattagami Hydroelectric Project and the Hydro Tunnel at Sir Adam Beck, demonstrate OPG's readiness and capability to undertake the construction of a BWRX-300 unit at the Darlington Site. OPG will continue to ensure the protection of workers, public and environment during the construction phase that will support future safe operations.

Indigenous Relations

OPG acknowledges the Aboriginal and Treaty Rights of Indigenous People as recognized in the Constitution Act, 1982. OPG is committed to its relationship with Indigenous Nations and Communities. OPG's Indigenous Relations policy provides a framework for engagement with Indigenous peoples and communities to advance its reconciliation efforts. OPG regularly reports on the company's activities and progress in achieving the goals found in its Reconciliation Action Plan.

Public Engagement and Communication

OPG has been engaging with the local community for more than 50 years since the construction of our existing nuclear facilities. OPG's relationship with the local community in the vicinity of DN site remains strong due to ongoing open engagement and sustainable partnerships with community stakeholders, including government, media, business leaders, educational institutions, interest groups, and community organizations.

Since 2006, OPG has kept the public and stakeholders informed about DNNP as part of the existing engagement and communications activities for the Darlington Nuclear Generating

Station (DNGS). Topics such as station operations, environmental performance, and the status of projects (including DNNP) are communicated through various methods and forums with the goal of ensuring transparent disclosure of our activities. Specific to DNNP, OPG has kept Indigenous Nations and Communities, the public and stakeholders updated on the status of the project since its inception and continues to make publicly available the relevant documents associated with the DNNP licensing process.

This CMD contains a summary of the information documented in the Licence to Construct (LTC) application [R-2] and associated documents, and the information necessary for the Commission to make its decision associated with the application. This material will also support members of Indigenous Nations and Communities, stakeholders and the public in understanding the proposed activities and the work undertaken to support the LTC application.

In summary, OPG's application for a Licence to Construct a reactor facility demonstrates that OPG has met or exceeded the applicable requirements and has a history of safe and successful operations and project management, all of which demonstrate that OPG is qualified to undertake the construction of a BWRX-300 unit and ancillary facilities at the Darlington Nuclear site.

OPG respectfully requests the Commission approve OPG's Darlington New Nuclear Project Power Reactor Construction Licence for one BWRX-300 unit. OPG also requests that the Commission accepts OPG's proposed Financial Guarantee for DNNP as part of the requested Power Reactor Construction Licence.

The Licence Application and supplementary information to the Application are available to the public on OPG's website, www.opg.com/newnuclear.

1.0 OVERVIEW

1.1 Introduction

Ontario Power Generation Inc. is the leading supplier of electricity to the power grid in the province of Ontario. We provide safe, reliable, and low-cost power through our nuclear stations at Pickering and Darlington; our hydro-electric facilities; a solar generating station; a biomass generating station; and several natural gas plants. We have safely provided for the electricity needs of the people of Ontario for decades and look forward to doing so for many decades to come. Building on OPG's extensive experience and in partnership with its key contract partners, OPG is proposing to construct the first of four General Electric Hitachi (GEH) BWRX-300 units and ancillary facilities at the DNNP site.

As the largest nuclear power plant operator in Canada, OPG has demonstrated a history of safe operations and project management success which include 100 years of electricity production and more than 50 years of nuclear operating experience.

OPG's capabilities as an industry leader in safe nuclear operations at both its Darlington and Pickering Nuclear Generating Stations continue to be demonstrated by achievements and recognition both at home and internationally.

OPG has showcased its ability to deliver on large scale nuclear projects. In June 2020, after more than three years of safe, quality work, OPG completed the Darlington Unit 2 refurbishment and successfully returned the unit to the grid. This world-class project performance is a testament to the detailed preparations and planning, as well as the expertise and commitment of OPG and its partners to deliver projects on time. The OPG Project Management Office was the recipient of the PMO of the Year: The Americas award in 2023.

The successes and learnings of Unit 2 were further demonstrated in July 2023, when Unit 3 was safely returned to the grid, well ahead of schedule. OPG remains on track and committed to return all four Darlington units to the grid, safely and on time. OPG is demonstrating that with detailed planning and preparation, large nuclear projects can be completed safely, on time and budget, and with quality.

OPG believes operating in an environmentally sustainable manner is directly connected to business success and is essential for maintaining our social licence to operate. Our commitment to operating in an environmentally sustainable manner has garnered recognition from several authorities, including 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.

1.2 Purpose

OPG has submitted to the CNSC the "Application for a Licence to Construct a Reactor Facility" for the DNNP [R-2]. This Commission Member Document (CMD) is being submitted to support the public hearing where the Commission will consider OPG's request for a licence to construct the first of four BWRX-300 reactors, and ancillary facilities, at the DNNP site.

This CMD summarizes OPG's application which demonstrates that OPG is qualified to carry out the proposed licensed activities and that OPG will make adequate provisions for the protection of the environment, the health and safety of persons and the maintenance of national security and measures required to implement international obligations to which Canada has agreed.

1.3 Scope

OPG is requesting a 10-year Power Reactor Construction Licence to construct a Class 1A nuclear facility at OPG's DNNP site located in the Municipality of Clarington, in the Regional Municipality of Durham. The proposed activities include:

- the completion of any remaining activities under the existing site preparation licence;
- the construction of one BWRX-300 power block, which includes the Structures, Systems and Components (SSCs) associated with the Reactor Building (RB), control building, turbine building, radioactive waste building and auxiliaries;
- the construction of the support structures for up to four BWRX-300 units;
- the inspection and testing of equipment; and
- the conduct of fuel-out commissioning (i.e. the commissioning of systems prior to loading fuel in the reactor).

1.4 Darlington New Nuclear Project History

Work on the Darlington New Nuclear Project began in the early 2000's with plans to build a large-scale nuclear power plant of up to four units with a total capacity of up to 4800 MWe. On this basis, an Environmental Assessment (EA) was initiated for the project under the 1992 Canadian Environmental Assessment Act (CEAA) [R-3]. The scope for the assessment included the site preparation, construction, operation, and decommissioning of four nuclear power reactors to produce up to 4,800 megawatts of electrical generating capacity. At the time, a reactor technology had not been selected and the Plant Parameter Envelope method was used as a means of bounding potential impacts on the environment.

In 2012, after extensive public regulatory hearings on the Environmental Assessment, the Darlington New Nuclear Project Environmental Assessment was approved by the Government of Canada and subsequently, the Canadian Nuclear Safety Commission granted OPG a Power Reactor Site Preparation Licence to prepare the site for up to four units.

In 2020, OPG submitted an application for the renewal of the Power Reactor Site Preparation Licence (PRSL). The renewed 10-year licence, PRSL 18.00/2031 [R-4], was granted in October 2021.

In December of 2021, OPG announced its partnership with GEH to develop and deploy the BWRX-300 Small Modular Reactor (SMR) design.

In 2022, site preparation activities in support of the project began and in October, OPG submitted an application for a Licence to Construct for the first unit.

In January 2024, a Commission Public Hearing was held for Determination of Applicability of Darlington New Nuclear Project Environmental Assessment to OPG's Chosen Reactor Technology. In April 2024, the Commission determined that the 2012 Environmental Assessment remains valid for the deployment of four GEH BWRX-300 units at the Darlington Site.

Pending regulatory approvals, construction activities are targeted to start in 2025 and to be completed by the end of 2028.

OPG further plans to submit a Licence to Operate application in 2026. Pending regulatory approvals, the commercial operation of the first unit is anticipated for 2029.

1.5 Existing Site Preparation Licence

The existing Power Reactor Site Preparation Licence, PRSL 18.00/2031 [R-4], allows OPG to conduct the site preparation activities for the future construction and operation of a new Nuclear Generating Station.

These activities include:

- Construction of access control measures;
- Clearing and grubbing vegetation;
- Excavation and grading of the site to an elevation of approximately +78 masl (metres above sea level);
- Installation of services and utilities;
- Construction of administrative and physical support facilities outside of the (future) protected area;
- Construction of environmental monitoring and mitigation systems;
- Construction of flood protection and erosion control measures; and
- Construction of temporary shoring systems.

Completed activities under the PRSL included clearing, grubbing and site grading activities to support Unit 1 construction activities. Power and communication sources were also established. Site preparation activities that are in progress include the distribution of services across the site to service future support structures such as the administration building, warehouse and fabrication building, as well as construction trailers including water, power, communications and sewage. Site grading activities are also continuing in support of preparing the site for future units (Units 2, 3 and 4). Installation of temporary shoring systems to support excavation work is also in progress.

Excess soils resulting from site grading activities have been placed in a mound on the northern portion of the DNNP site. Similar to what was done at the Darlington Nuclear Generating Station, after the final completion of all grading activities the mound will be contoured, seeded and planted for long term stability and to blend into the natural landscape.

1.6 Licence to Construct Application

In October 2022, OPG submitted an LTC application [R-2] to the CNSC. Following OPG's LTC Application Plan [R-5], supporting packages were submitted per the requirements of CNSC REGDOC-1.1.2 [R-6]and other associated regulatory documents, codes and standards. The packages covered the Safety and Control Areas (SCAs) Identified in CNSC REGDOC-1.1.2 and included the Preliminary Safety Analysis Report (PSAR), which demonstrated the sufficiency of the safety and control measures underlying the design of the BWRX-300.

The submitted licence application and supporting documents underwent detailed review by CNSC staff. In response to CNSC staff information requests OPG provided additional information and clarifications. This supplementary information further supported CNSC staff's detailed technical reviews of the application.

1.7 Licence to Construct Commitments and Regulatory Actions

OPG has met its commitments with respect to DNNP and reports on the status of the project as part of the DNNP annual report. OPG uses the DNNP Commitments Report [R-7] to track OPG commitments and actions arising from the DNNP EA. These include activities, and deliverables associated with the construction phase.

In addition, any other formal regulatory commitments made by OPG as part of the CNSC LTC application review process are captured and tracked as regulatory actions. OPG continues to meet its commitments on the project and reports on their status to CNSC staff on a regular basis.

1.8 Description of Site

As shown on Figure 1, the Darlington Nuclear (DN) site is located on the north shore of Lake Ontario, about 65km east of the City of Toronto, in the Municipality of Clarington, Region of Durham in the province of Ontario, Canada, and is within the Gunshot Treaty and the Williams Treaties of 1923.

The DN site is home to the four-unit Darlington Nuclear Generating Station (DNGS) and the Darlington Waste Management Facility.

As per Figure 1, immediately east of the DNGS on the DN site is the Darlington New Nuclear Project (DNNP) site that is currently undergoing site preparation work in advance of the future construction of the BWRX-300.

The portion of the DN site for the DNNP is the easterly one third (approximately) of the overall DN site. The DNNP site comprises approximately 180 hectares of land which is bisected by the CN railway. The DNNP site is bounded to the north by Energy Drive, to the south by Lake Ontario, to the west by Holt Road and to the east by the St. Mary's Cement Plant. Figure 2 illustrates the DNNP site boundary.

The proposed site layout for DNNP construction is shown in Figure 3, with a detailed view depicted in Figure 4.

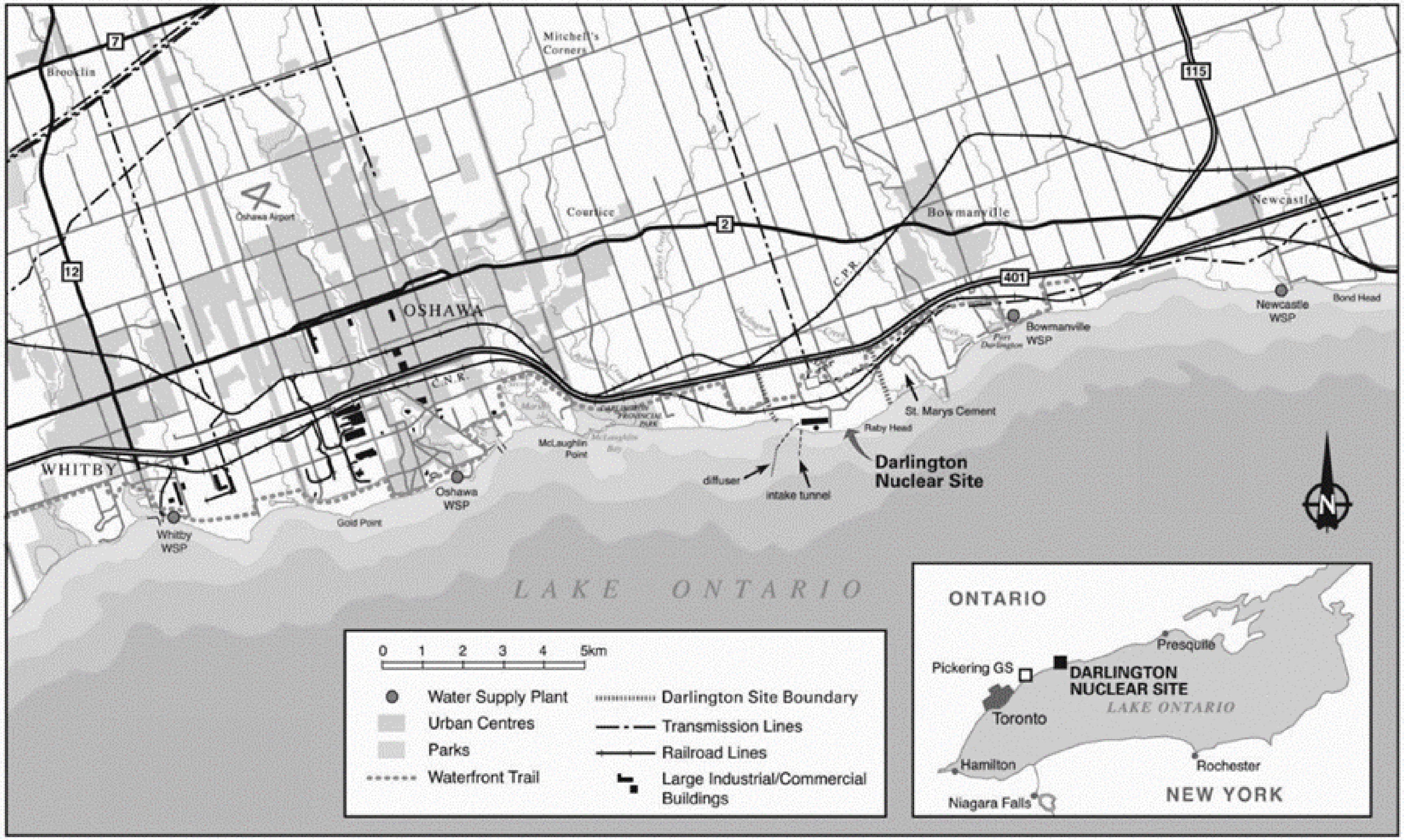


Figure 1: Location of Darlington Nuclear Site

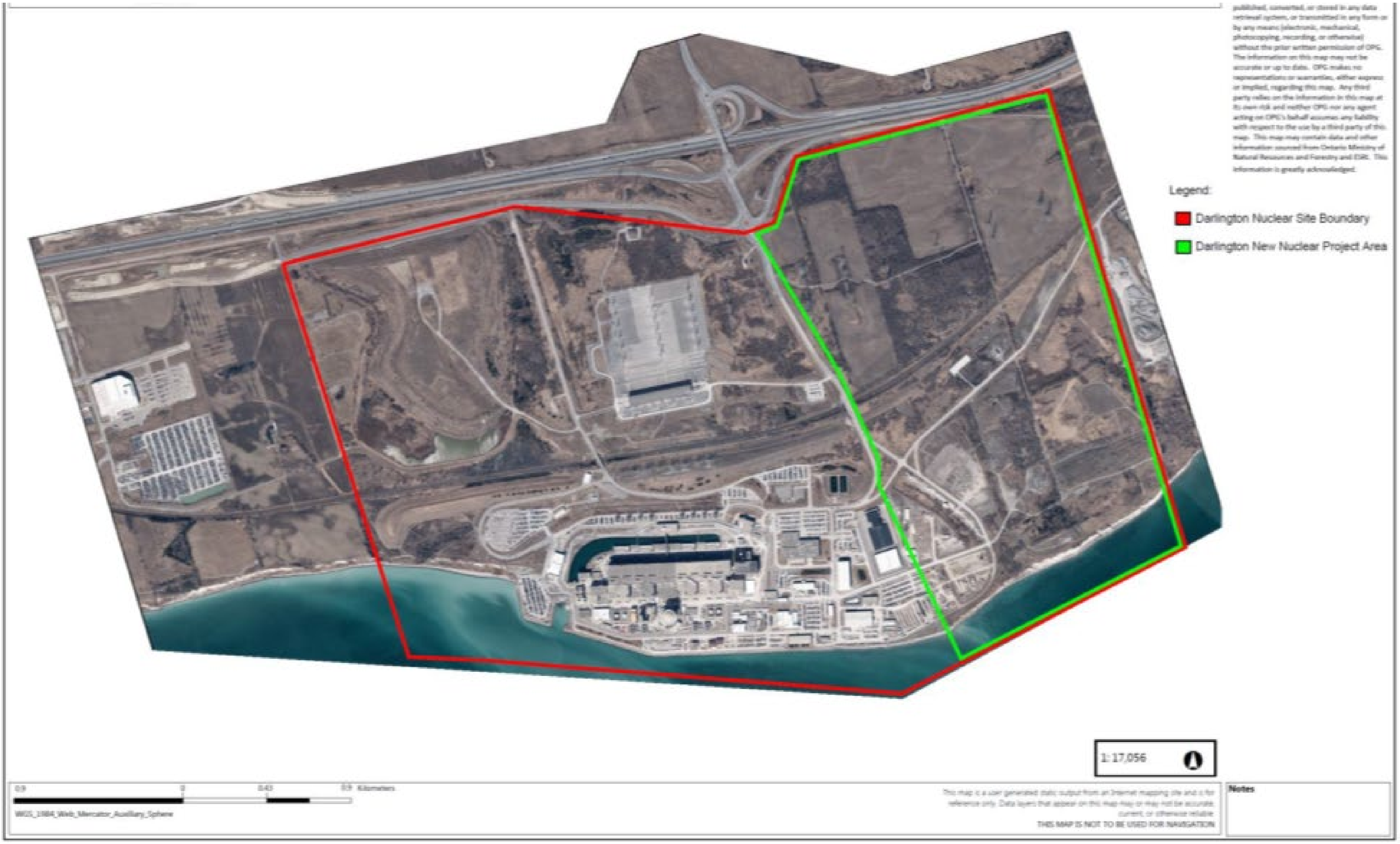


Figure 2: Photograph of DN Site Illustrating DNNP Site Boundary

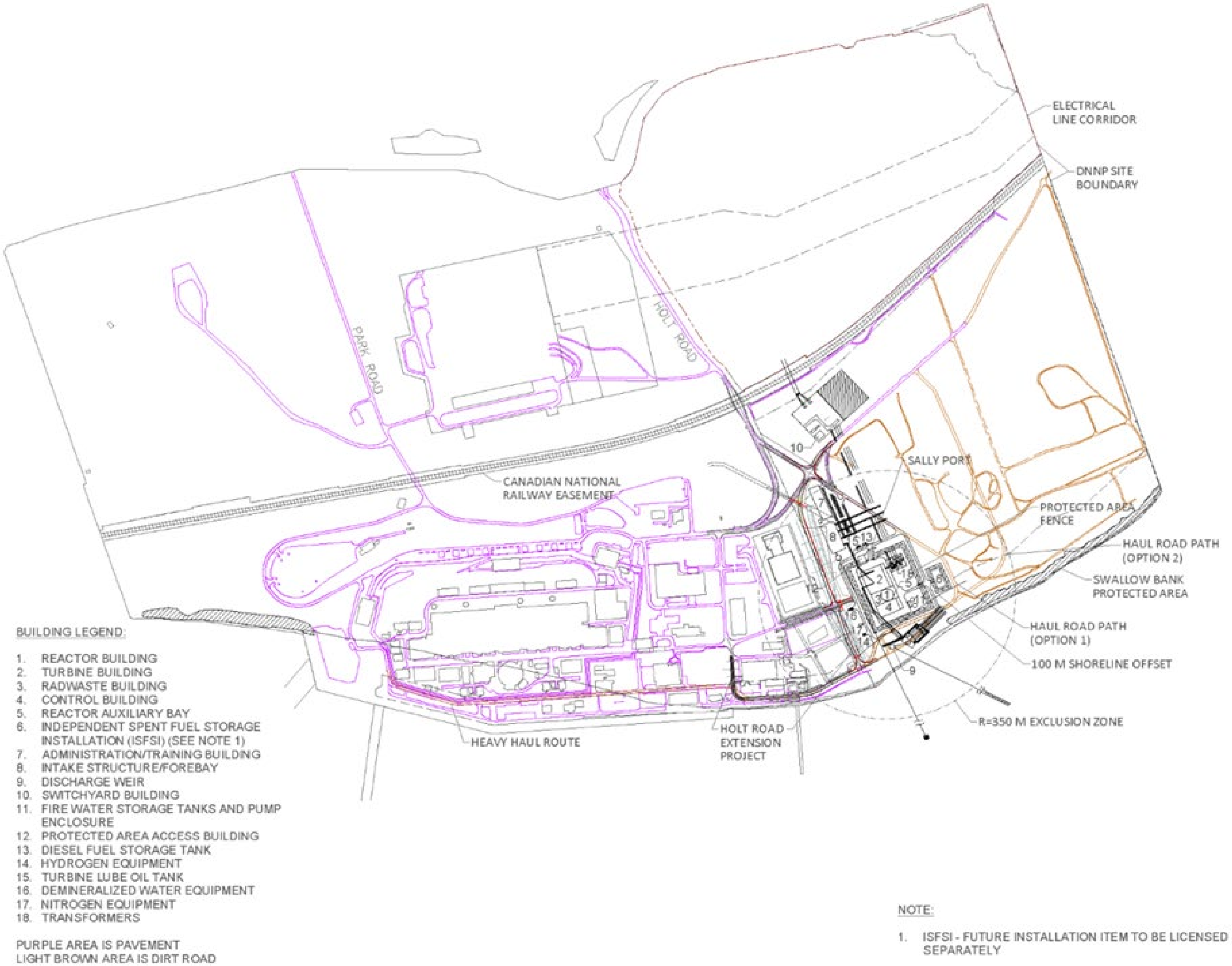
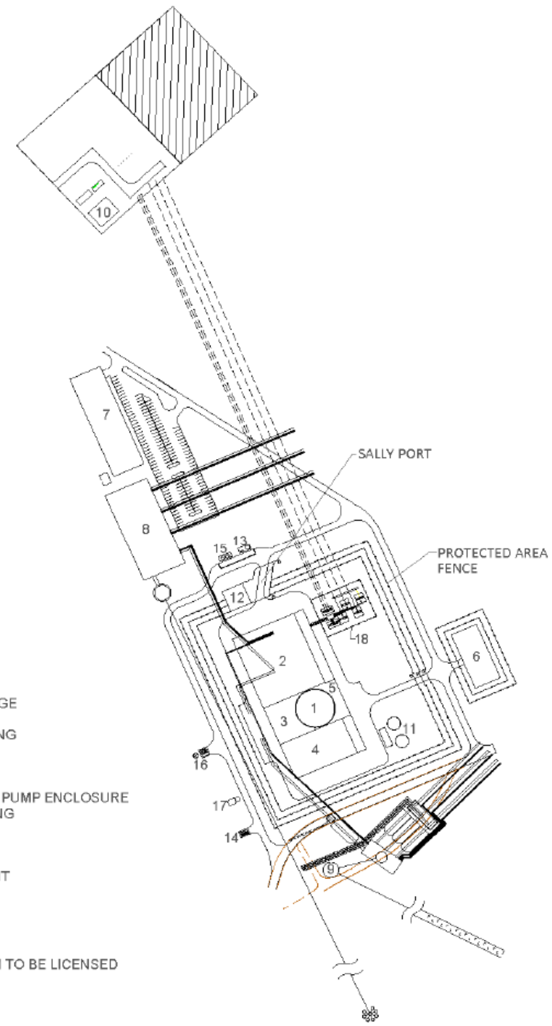


Figure 3: Preliminary Proposed Site Layout for Construction at DNNP Site



BUILDING LEGEND:

1. REACTOR BUILDING
2. TURBINE BUILDING
3. RADWASTE BUILDING
4. CONTROL BUILDING
5. REACTOR AUXILIARY BAY
6. INDEPENDENT SPENT FUEL STORAGE INSTALLATION (ISFSI) (SEE NOTE 1)
7. ADMINISTRATION/TRAINING BUILDING
8. INTAKE STRUCTURE/FOREBAY
9. DISCHARGE WEIR
10. SWITCHYARD BUILDING
11. FIRE WATER STORAGE TANKS AND PUMP ENCLOSURE
12. PROTECTED AREA ACCESS BUILDING
13. DIESEL FUEL STORAGE TANK
14. HYDROGEN EQUIPMENT
15. TURBINE LUBE OIL TANK
16. DEMINERALIZED WATER EQUIPMENT
17. NITROGEN EQUIPMENT
18. TRANSFORMERS

NOTE:

1. ISFSI - FUTURE INSTALLATION ITEM TO BE LICENSED SEPARATELY

Figure 4: Detailed view of Preliminary Layout of Single BWRX 300 Unit

1.9 Facilities to be Constructed Under Current Licence Application

The facilities to be constructed at the DNNP site under the current licence application include the following:

DNNP BWRX-300 Powerblock

Reactor Building (RB) - A shear wall building made of reinforced concrete, steel or steel-plate composite floors and walls. Fuel handling equipment and pools containing water needed for the BWRX-300 passive cooling systems are in the above-grade portion of the RB. A portion of the RB extends below grade where the Steel-Plate Composite Containment Vessel (SCCV) and the Reactor Pressure Vessel (RPV) mostly reside. The below-grade portion also houses reactor support and safety class systems and most essential power supplies and equipment. The Secondary Control Room (SCR) located in the RB provides safe shutdown capability as a backup to the Main Control Room (MCR).

Control Building - Houses the MCR and electrical, control and instrumentation equipment. It is also the entrance and exit for the BWRX-300 powerblock during normal operations.

Turbine Building – Houses the steam turbine generator, main condenser, condensate and feedwater systems, condensate purification system, turbine-generator support systems, bridge crane, and parts of the off-gas system.

Radwaste Building (RWB) – Houses equipment associated with the handling, processing, and packaging of solid and liquid radioactive waste generated by the nuclear facility. The RWB is used to house equipment and processes that package waste into approved containers.

Facilities/Buildings Outside Powerblock

Plant Service Area – A warehouse that runs alongside the length of the nuclear facility, providing an area for maintenance and storage.

Security Building – Controls access to the Protected Area and includes a vehicle inspection area.

Lake Water Intake/Discharge Structures - The BWRX-300 at DNNP will use a once-through lake water cooling system. The water intake will be supplied from Lake Ontario to circulate through the condenser and then discharge to the lake through a discharge duct and outfall structure. Additionally, the shoreline of the lake will include shoreline protection to control erosion. Note that these structures are sized adequately to support up to four BWRX-300 units.

Cooling Water System Pump House – Contains the cooling water system pumps and auxiliary equipment needed to cool the nuclear facility.

Switchyard – Hydro one will be building a new temporary switchyard on the north side of the nuclear facility for electrical transmission of the first unit to the Ontario grid. In a future state, all units at DNNP will be directly connected to an expansion of the existing switchyard. The DNNP site may share some infrastructure with the existing DNGS site such as the meteorological tower, sewage lift station, roads and infrastructure to connect the facility to provincial electrical distribution system.

2.0 BWRX-300 GENERAL DESCRIPTION

The BWRX-300 is a 327 MWe (approximately) water-cooled, natural circulation SMR. As denoted by the X in BWRX-300, it is a tenth-generation evolution of GEH's Boiling Water Reactor (BWR) design and builds upon lessons learned and improvements from previous generations. The BWRX-300 is an evolution of the 1,520 MWe Economic Simplified Boiling Water Reactor (ESBWR), which has received design certification by the US Nuclear Regulatory Commission (NRC). The expected commercial life of the reactor facility is 60 years.

Figure 5 provides an illustrative view of the BWRX-300 facility at the DNNP site. Figure 6 shows the general layout of the powerblock, and Figure 7 provides a simplified cross section of the powerblock.

Figure 5: An Artist Rendition of a Potential BWRX-300 Layout

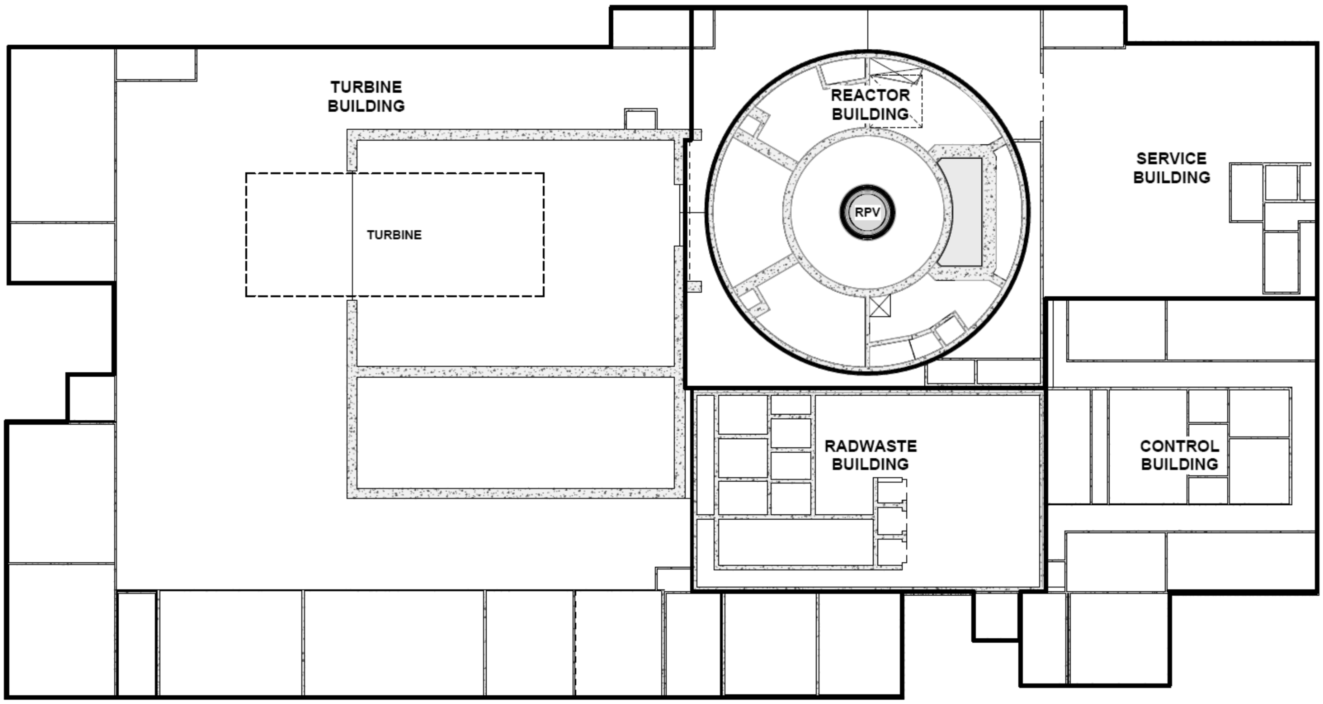


Figure 6: Preliminary DNNP BWRX-300 Powerblock Layout

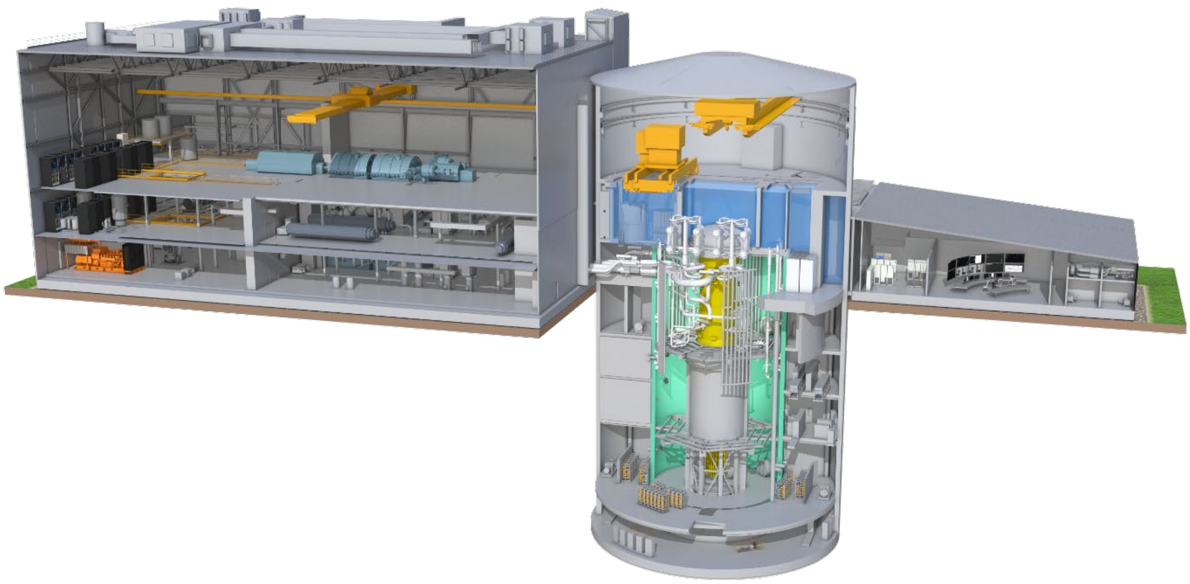


Figure 7: DNNP BWRX-300 Powerblock Conceptual Cross Section

The BWRX-300 uses proven fuel, materials, components, and a combination of established and innovative manufacturing techniques. It implements a safety strategy aligned with international standards and industry best practices to achieve a design with a high level of safety. Its safety is achieved by deliberate design decisions informed by iterative safety analyses.

Though mostly traditional in BWR design, the BWRX-300 incorporates several innovative design features that include:

1. Integral Reactor Pressure Vessel (RPV) isolation valves: The BWRX-300 RPV is equipped with isolation valves that are integral to the RPV that rapidly isolate a ruptured pipe to help mitigate the effects of a Loss of Coolant Accident (LOCA). All large fluid pipes with RPV penetrations are equipped with double isolation valves that are integral to the RPV.

2. Large Capacity Isolation Condenser System: Safety relief valves have been eliminated from the BWRX-300 design, eliminating this as a source of LOCAThe large capacity Isolation Condenser System in conjunction with the large steam volume in the RPV provides overpressure protection.

3. Dry containment: The BWRX-300 has a dry containment. This has been proven to effectively contain the releases of steam, water, and fission products after a LOCA.

4. Standardized equipment as well as in-factory modular construction: Due to its smaller size and inherent safety, the BWRX-300 has been designed to use more standardized equipment than previous BWRs. Where possible, the BWRX-300 design allows for in-factory modular construction. These design decisions help to increase quality of construction and reduce overall cost and time.

The BWRX-300 reactor is designed with negative coefficients of reactivity and thermal hydraulic stability as inherent safety features of the BWRX-300 that provide core reactivity protection. For a loss of coolant accident that results in increased presence of voids in the moderator, the resulting negative reactivity feedback will reduce the reactor power, and thus help mitigate the event.

Simplicity attributes are incorporated throughout the BWRX-300 design, beginning with a simplified system layout that requires fewer systems and components. An example of simplicity in the BWRX-300 design is the reduction in the number of required components which improves not only safety and reliability, but also operability and maintainability. Simplicity is predominantly achieved by incorporating passive safety features. While simplicity has been incorporated to the extent reasonable, where necessary additional features are added to ensure systems are designed to meet reliability requirements, reduce potential for human error and to ensure defence in depth.

Figure 8 shows a conceptual overview of the BWRX-300 Plant Systems and Table 1 below summarizes some of the basic design parameters for the BWRX-300.

Table 1: Basic BWRX-300 Design Parameters

Parameter Description	Value
Current/Intended Purpose	Commercial – Electric
Main Intended Application (once commercial)	Baseload
Output Power (gross)	327 MWe, 870 MWth
Reactor Type	BWR
Core Coolant	H_2O
Neutron Moderator	H_2O
Steam Supply System	Direct-cycle
Primary Circulation	Natural
Thermodynamic Cycle	Rankine
Secondary Side Fluid	n/a (No secondary side since it is direct-cycle)
Fuel Lattice Shape	Square
Fuel Bundles	GNF2 (240-bundle core configuration)
Rods per Fuel Bundle	92
Fuel Material	UO_2 with 3.81/4.95% (avg./max. enrichment)
Refuelling Cycle	12-24 months

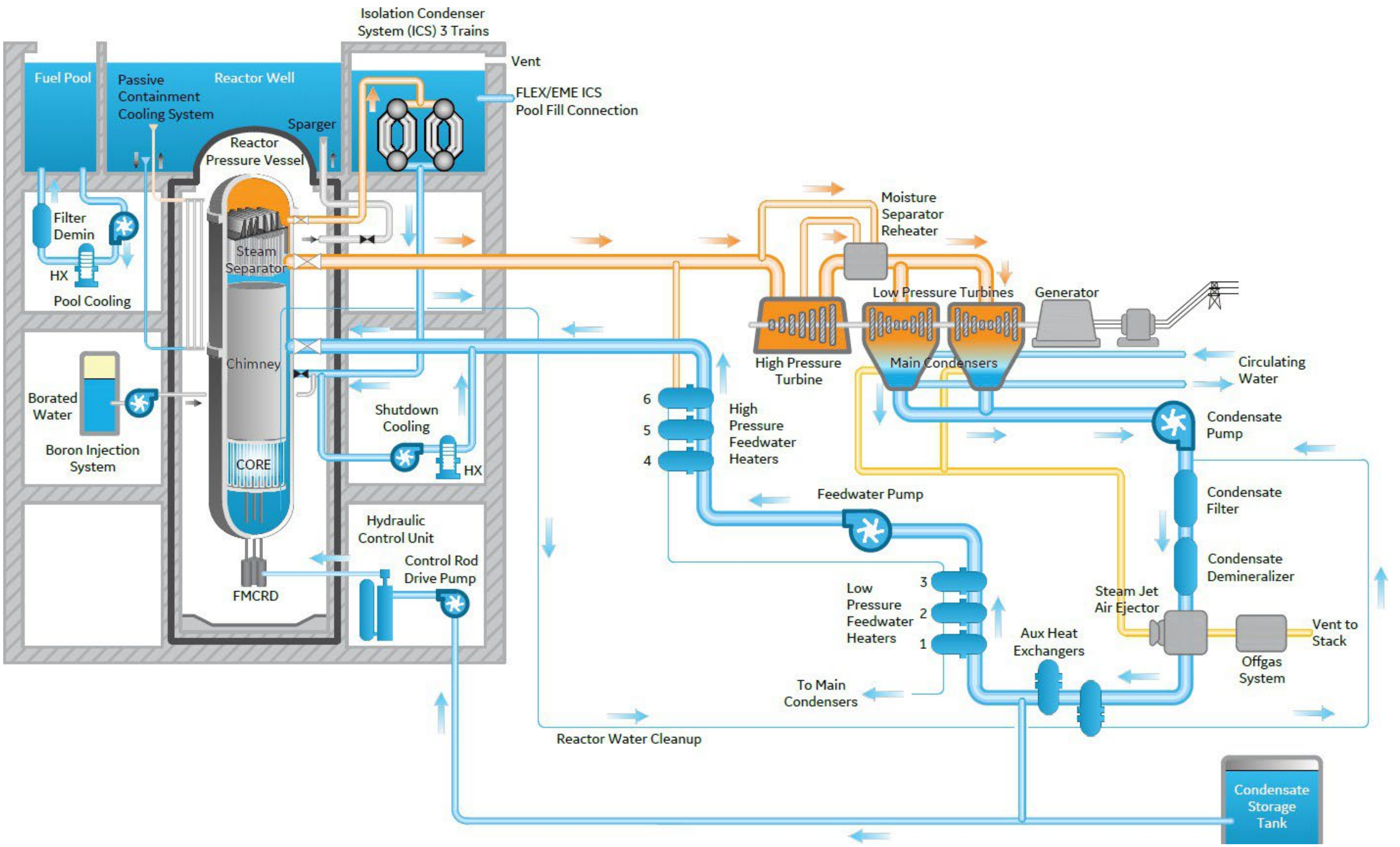


Figure 8: Conceptual Overview of the BWRX-300 Plant Systems

2.1 Nuclear Steam Supply Systems and Components

2.1.1 Nuclear Boiler System

The BWRX-300 primary circuit or Nuclear Boiler System (NBS) consists of three subsystems: Reactor Pressure Vessel (RPV) and internals, Main Steam, and RPV Instrumentation.

The primary functions of the NBS are to:

- Deliver steam from the RPV to the turbine Main Steam System;
- Receive feedwater from the Condensate and Feedwater System to the RPV;
- Provide overpressure protection of the reactor coolant pressure boundary;
- Provide core support structure to enable the control rods to stop the nuclear reaction when driven in the core by their respective hydraulic control units; and
- Provide the flow path to enable the core coolant to keep the core cooled using natural circulation.

Reactor Pressure Vessel

The BWRX-300 RPV assembly is shown in Figure 9.

The RPV forms a major part of the reactor coolant pressure boundary, contains the path for reactor coolant flow through the fuel, and generates steam to drive the high pressure and low-pressure turbines. Flow through the core is by natural circulation; pumps are not required to force reactor coolant through the RPV, which removes the reliance on AC power to support reactor cooling.

Natural circulation is enabled by a tall chimney between the top of the core at the top guide to the bottom of the steam separators. The RPV design is such that the level of all nozzles is located significantly above the top of active fuel, which helps mitigate loss of coolant accidents by preserving inventory for core cooling The large RPV volume, along with the tall chimney region, provides a substantial reservoir of water above the core to preserve reactor coolant inventory, ensure adequate core cooling is maintained and enhance safety by reducing the rate at which reactor pressurization occurs if the reactor is suddenly isolated from its normal heat sink.

The RPV instrumentation monitors the conditions within the RPV over the full range of reactor power operation and shutdown conditions. The RPV, together with its internals, provides guidance and support for the fine motion control rod drives.

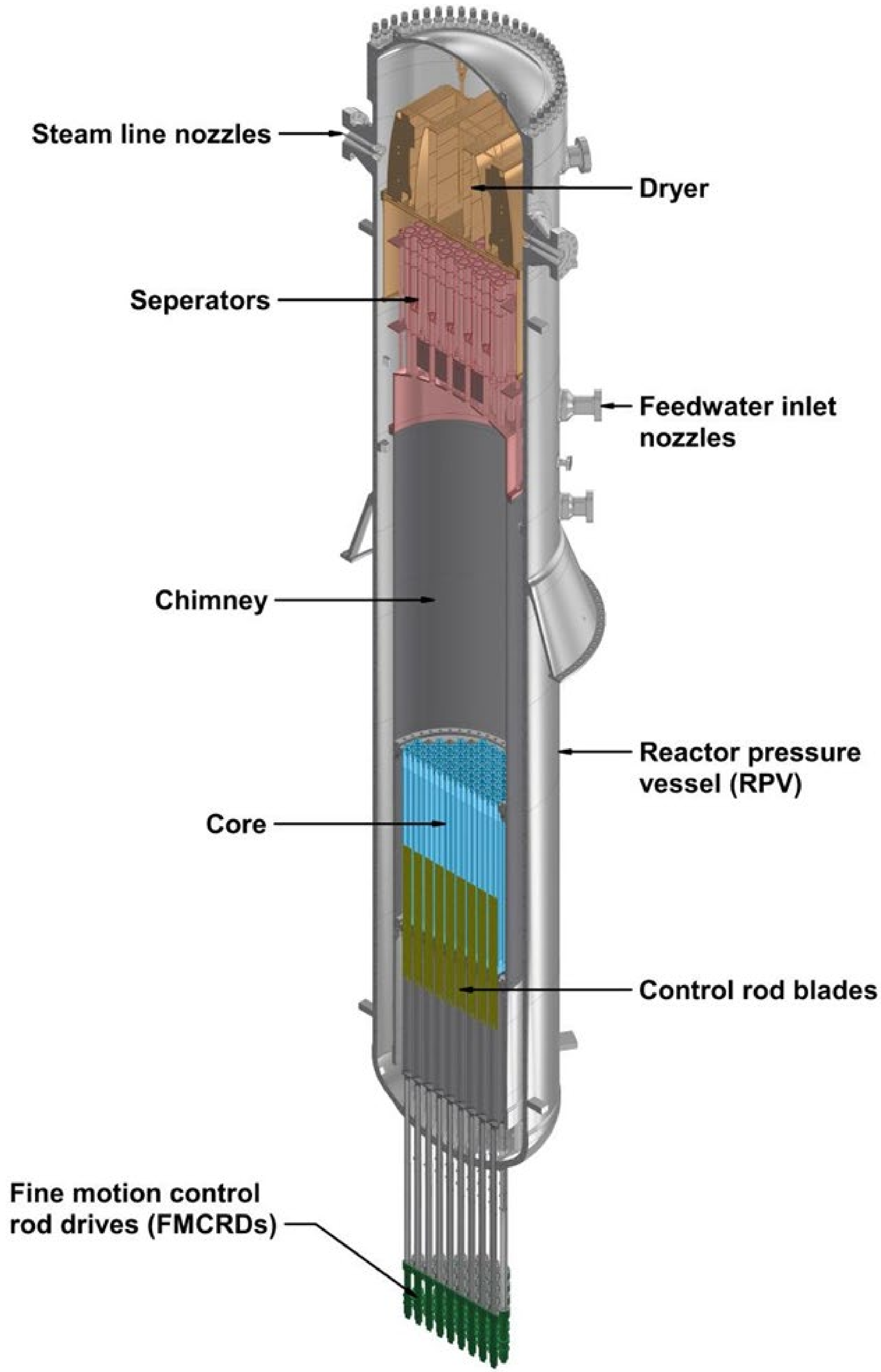


Figure 9: BWRX-300 Reactor Pressure Vessel and Internals

Reactor Internals

The major reactor internal components include:

- Core (control rods and nuclear instrumentation);
- Core support and alignment structures (shroud, shroud support, top guide, core plate, control rod guide tube, and orificed fuel support);
- Chimney;
- Chimney head and steam separator assembly; and
- Steam dryer assembly.

The fuel assemblies (including fuel rods and channels), control rods, chimney head, steam separators, steam dryer, and in-core instrumentation assemblies are removable when the reactor vessel is opened for refueling or maintenance.

Reactor Isolation Valves (RIV)

The BWRX-300 design eliminates the traditional non-isolable large break LOCA by utilizing reactor isolation valves (RIVs) integral to the RPV. This feature allows the reactor vessel to be isolated automatically, quickly stopping leakage from the vessel following a downstream pipe break.

The RIV consists of two valves, each independently able to isolate the line. The RIVs are attached to the RPV nozzles for the main steam subsystem, the reactor water cleanup system, the supply and return lines of the isolation condenser system, the head vent, and the feedwater system.

Nuclear Instrumentation

The nuclear core instrumentation consists of the Local Power Range Monitors (LPRMs), Gamma Thermometers (GTs), and Wide Range Neutron Monitors (WRNMs).

LPRMs are arranged radially throughout the BWRX-300 core to measure neutrons. GTs are in-core devices that convert local gamma flux to an electrical signal; gamma flux is representative of core thermal power. It represents a completely diverse technology to the neutron detecting LPRMs. The GTs are co-located in the instrument tubes with the LPRMs.

The WRNM detectors are distributed radially in the core at fixed heights. Each detector is sensitive to neutrons from fluxes below criticality to greater than 100% thermal power levels.

2.1.2 Control Rod Drive System

The BWRX-300 employs two effective means of shutdown that are separate, independent and diverse with the exception of control rods that are shared; there is a single set of control rods for both control of normal reactivity and reactor shutdown. The means of shutdown are designed to function with a high degree of reliability.

The BWRX-300 shutdown system is effective and highly reliable, providing large margins to the probability of failure to shutdown on demand and for contribution of a shutdown failure to the Large Release Frequency safety goal. In case of the highly unlikely scenario that both means of shutdown are unsuccessful (design extension condition), the BWRX-300 design includes complementary design features such as Ultimate Pressure Regulation (UPR) devices and the Boron Injection System (BIS). The UPR devices ensure that, in a design extension condition in the unlikely case that neither means of shutdown are successful, the reactor core pressure boundary integrity is maintained, while the BIS provides an additional means to inject negative reactivity in the core to allow shutdown for beyond design basis events.

The Control Rod Drive System includes three major elements: Fine Motion Control Rod Drive (FMCRD) mechanisms, hydraulic control unit assemblies, and the Control Rod Drive Hydraulic (CRDH) subsystem.

In addition to hydraulic powered scram, the FMCRD motors also provide continuous electric motor- driven run-in of all control rods as a path to rod insertion that is diverse from the hydraulic powered scram. (For clarity, a scram is the sudden shutting down of the reactor by rapid insertion of the control rods). If a rapid reactor shutdown is required, and in the highly unlikely event that the hydraulic reactor scram does not perform as intended, then the reactor is shut down by the independent electric motor run-in of FMCRDs function.

The CRDH subsystem provides clean, demineralized water that is regulated and distributed to provide charging of the scram accumulators and purge water flow to the FMCRDs during normal operation. The CRDH subsystem is also the source of pressurized water for purging the Shutdown Cooling System pump seals and the NBS reactor water level reference leg instrument lines.

2.1.3 Isolation Condenser System (ICS)

The Isolation Condenser System (ICS) consists of redundant independent trains, each containing a heat exchanger or isolation condenser that is submerged in a dedicated pool of water and is connected to the RPV by steam supply and condensate return piping. The complex of ICS pools represents the ultimate heat sink for protecting the reactor core if the main condenser is not available, and the RPV becomes isolated.

When in operation, the ICS removes heat from the reactor coolant. The ICS also minimizes increases in steam pressure and maintains the RPV pressure at an acceptable level through decay heat removal. This is accomplished by condensing reactor coolant supplied as steam from the RPV and returning the condensate back to the RPV in a closed loop. Heat removed from the steam is transferred by the isolation condenser to the water in the pool. The isolation condensers are placed at an elevation above the steam source, causing natural circulation that is driven passively by gravitational force. The arrangement of the isolation condensers is shown in Figure 10.

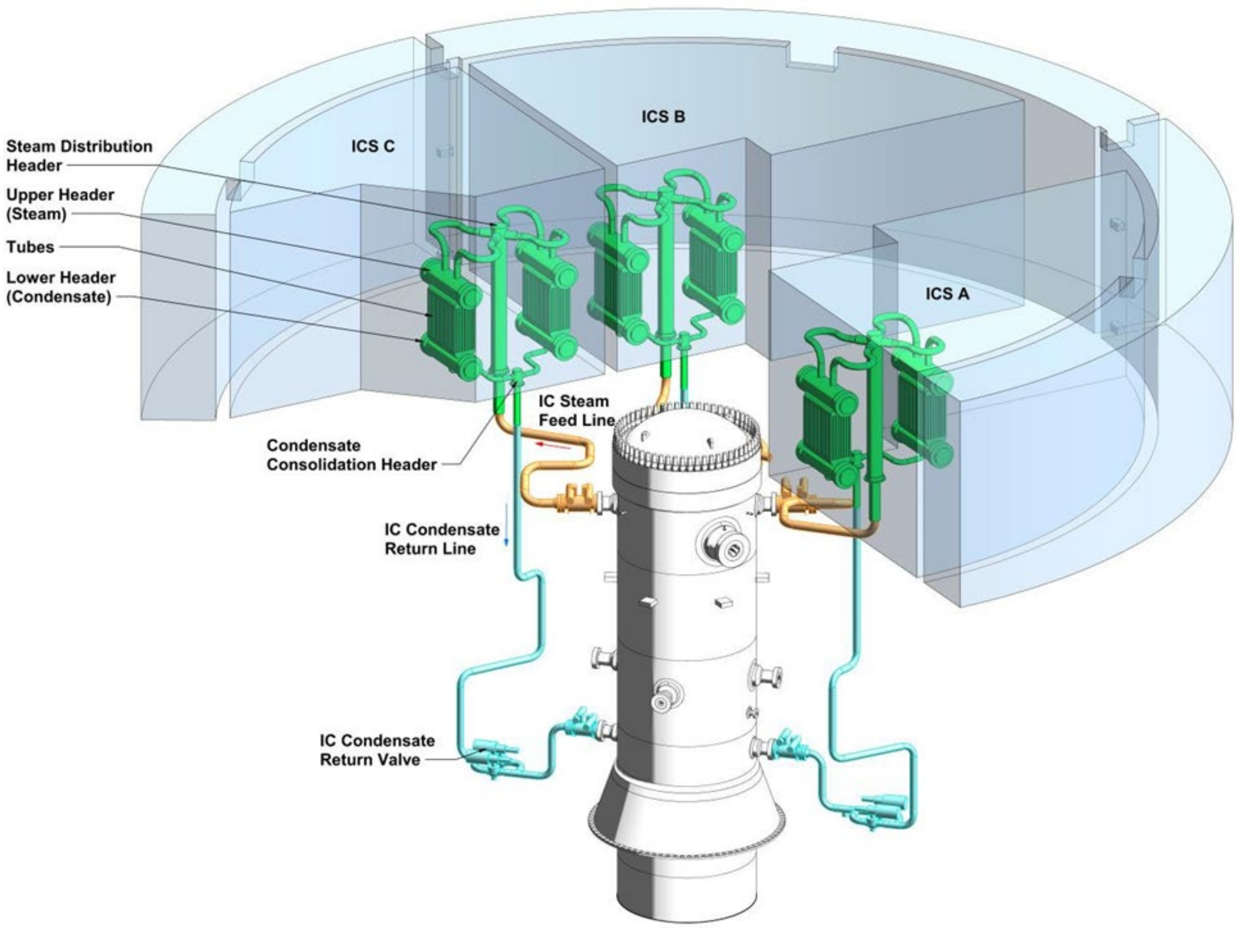


Figure 10: Isolation Condenser System

The ICS capacity is designed such that decay heat removal can be sustained for up to 7 days with no reliance on significant operator action. The ICS pools are located above ground and are not pressurized. Clean makeup water can be added directly to the ICS pools using readily available transportable sources such as a fire truck, enabling fuel cooling to be maintained indefinitely.

The ICS may be placed in service manually from the Main Control Room (MCR), automatically by the protection systems signal or by passive means if a loss of DC power occurs (fail-safe).

2.1.4 Primary Containment System

The BWRX-300 Primary Containment System (PCS) encloses the RPV and some of its related systems and components, provides radiation shielding, and acts as a boundary for radioactive contamination released from the NBS or from portions of systems connected to the NBS inside the containment system.

Figure 11 shows a cross-section of the containment system. The BWRX-300 comprises a Steel-Plate Composite Containment Vessel (SCCV), consisting of steel-plate composite cylindrical wall, base mat, and top slab, and a steel containment closure head. The containment structure is completely enclosed within the deeply embedded RB and includes personnel/equipment hatches, containment penetrations, and other safety components. The SCCV is also integrated with the RB and the integrated structure is supported by a common steel-plate composite base mat.

The PCS design uses a nitrogen-inerted containment atmosphere during most operating modes. Atmosphere control is provided by the Containment Inerting System. The inert atmosphere provides dilution of hydrogen and oxygen gases that can be released in a post-accident condition by radiolytic decomposition of water and the released hydrogen from water and fuel cladding (zirconium) reaction during a severe accident condition. The dilution provides protection to the PCS and its internal components from hydrogen combustion or detonation. The inert atmosphere design has the additional benefit of minimizing long-term corrosion and degradation of the SCCV and the contained components by limiting the exposure to oxygen during plant operating service life.

The PCS has provisions for personnel access and for habitability during plant outages to perform maintenance, inspections, and tests required for assuring SCCV integrity and reliability, and the integrity and performance reliability of interfacing SSCs contained inside the PCS boundary.

The PCS is designed for a design life of 60 years of operation plus an assumed 10 years for decommissioning.

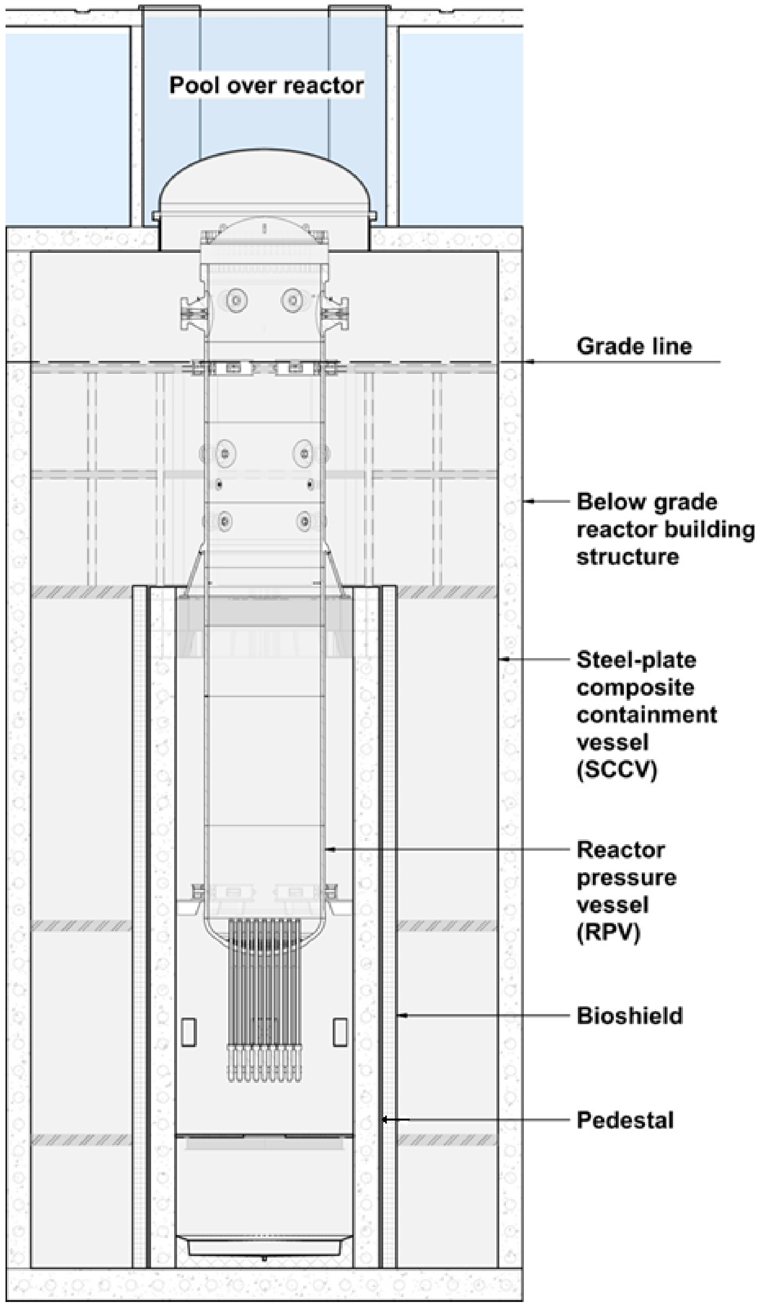


Figure 11: BWRX-300 Dry Containment

2.1.5 Containment Cooling System

The Containment Cooling System (CCS) is used to ensure the containment bulk average temperature is maintained according to technical specifications. It is a closed loop recirculating cooling system with no outside air introduced into the system except during outages. The CCS is comprised of two fully redundant air handling units. Each air handling unit is cooled by a corresponding chilled water equipment system.

The Steel-Plate Composite Containment Vessel (SCCV) is purged with nitrogen before startup and kept inert during normal plant operation. During outages requiring containment entry, the heating, ventilation, and cooling system supplies filtered, conditioned outside air into the SCCV through piping interface to purge the nitrogen out of the SCCV. In this mode, the SCCV temperature is maintained for personnel comfort by the CCS.

The CCS assists with containment cooldown and limiting containment temperature following a loss of offsite power during the period from hot shutdown to cold shutdown.

2.1.6 Passive Containment Cooling System (PCCS)

The Passive Containment Cooling System (PCCS) relies on natural circulation to transfer heat from the containment to the equipment pool to maintain containment pressure and temperature within the design limits during accident conditions or loss of active containment cooling. Supply and discharge connections from the pool are connected to closed loop piping within containment. Heat transfer occurs from the containment to the PCCS by natural circulation and condensation. The arrangement for the PCCS is shown in Figure 12.

The PCCS consists of three independent trains of low-pressure heat exchangers that transfer heat from the containment to the equipment pool, which is located above the primary containment system and is filled with water during normal operation.

PCCS operation requires no sensing, control, logic, or power actuated devices for operation. The PCCS condensers are closed loop, and the fluid inside does not contact the containment atmosphere. Since there are no containment isolation valves between the heat exchangers and the containment, the mode is always in "ready standby". The PCCS is in service during normal operation. However, the PCCS does not contribute to the heat removal significantly during normal operation since the containment temperature is maintained by the containment cooling system.

The PCCS becomes effective when steam is discharged into the containment following a pipe break. The steam discharge to containment raises containment temperature and increases the steam content for condensation to occur. Heat transferred to the PCCS from the containment is removed by the natural circulation of water in single phase flow and rejected to the equipment pool.

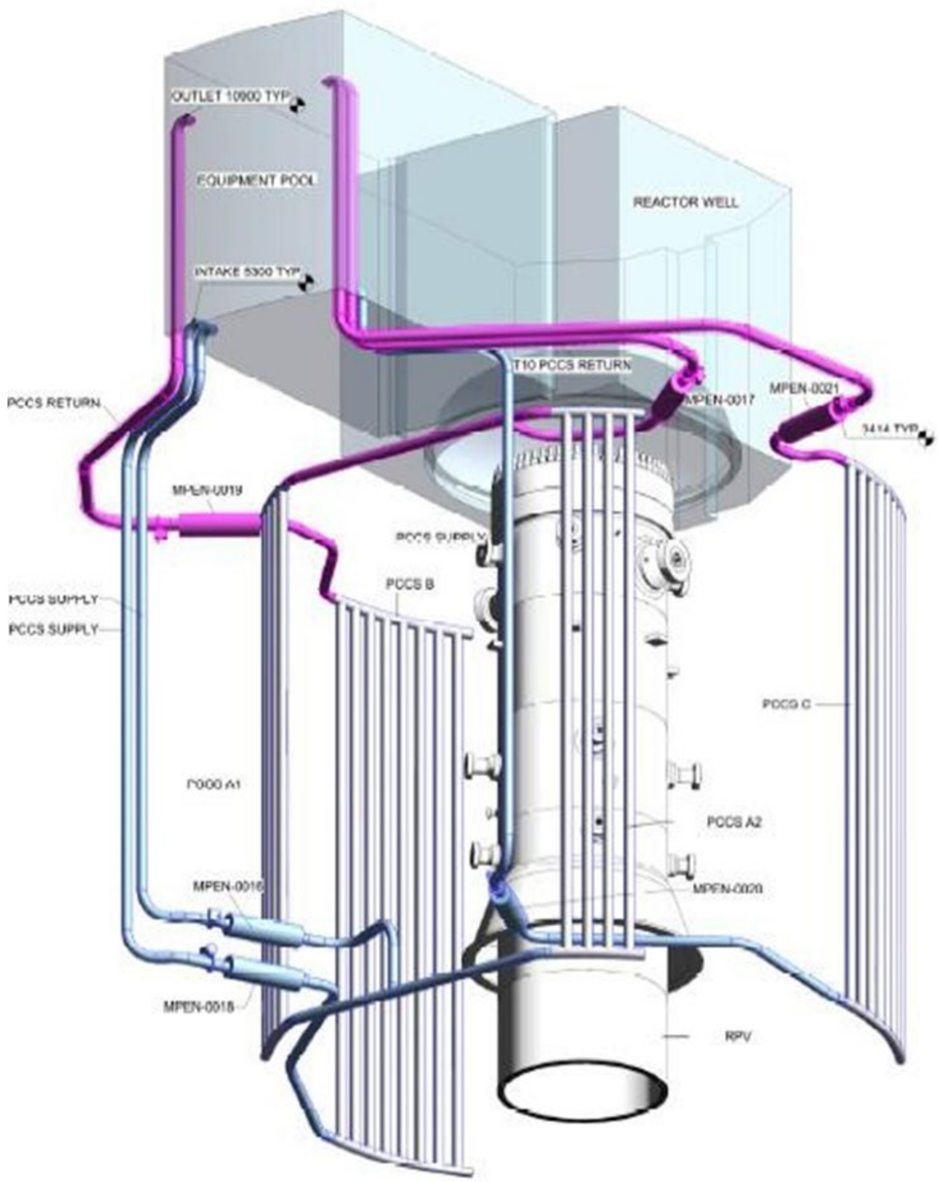


Figure 12: Passive Containment Cooling System

2.1.7 Boron Injection System (BIS)

The Boron Injection System is a complementary design feature that supports the Defence in Depth concept (elaborated on in section 4.4.1.1) by being available for events outside of the BWRX-300's design basis. The BIS is capable of introducing sufficient negative reactivity into the reactor primary system to assure a reactor shutdown from the full power operating condition to the cold subcritical state with no control rod motion. The BIS dispenses the required neutron absorber of natural boron using a Boron-10 solution or equivalent into the core zone to meet the shutdown concentration required throughout the core region while providing reasonable margin for leakage or imperfect core mixing. The system is provided for and only for a situation which causes the normal reactor control system to be unable to shut down the reactor. The BIS acts as an emergency backup to the insertion of control rods to provide a means of making the reactor subcritical in beyond design basis events.

The BIS consists of a storage tank, test tank, injection pump, piping, valves, and instrumentation & control necessary to prepare and inject a neutron absorbing solution into the reactor and to test the system.

2.1.8 Shutdown Cooling System

The Shutdown Cooling System provides for decay heat removal when shutting down the plant for refueling or maintenance. The system is also used to reduce RPV inventory and can be used in conjunction with the reactor water cleanup system piping to reduce RPV thermal stratification.

The Shutdown Cooling System comprises two independent pump and heat exchanger trains. These trains together provide redundant decay heat removal capacity such that each train is designed to remove 100% of decay heat as soon as 4 hours after reactor shutdown. The major components of each train are a pump and heat exchanger, along with valves, piping, instrumentation & control, and power inputs.

2.2 Fuel and Fuel Cycle

The BWRX-300 reactor core includes fuel assemblies, control rods, and nuclear instrumentation.

The BWRX-300 core design includes a 240-bundle configuration. The BWRX-300 fuel uses the well-established and proven GNF2 fuel design which is already widely and safely used within the boiling water reactor fleet in multiple generations of BWR's. The fuel assemblies have low hydraulic resistance that benefits natural circulation.

The reactor core of the BWRX-300 is arranged as an upright cylinder containing fuel assemblies located within the core shroud. The core configuration has equal spacing between the control rod and non-control rod sides of the fuel bundle (N-lattice). This configuration provides more shutdown margin for variations in burnup histories imposed by load following.

A BWR fuel assembly consists of a fuel bundle and a coolant channel. The fuel bundle contains the fuel rods and the hardware necessary to support and maintain spacing between fuel rods.

The channel is a Zircaloy box surrounding the fuel bundle and directing core coolant flow through the bundle; it also serves to guide the movable control rods.

Figure 13 shows the GNF2 fuel bundle design with major components identified. This figure shows the bundle in a horizonal orientation but during storage and operation the bundles are in a vertical position.

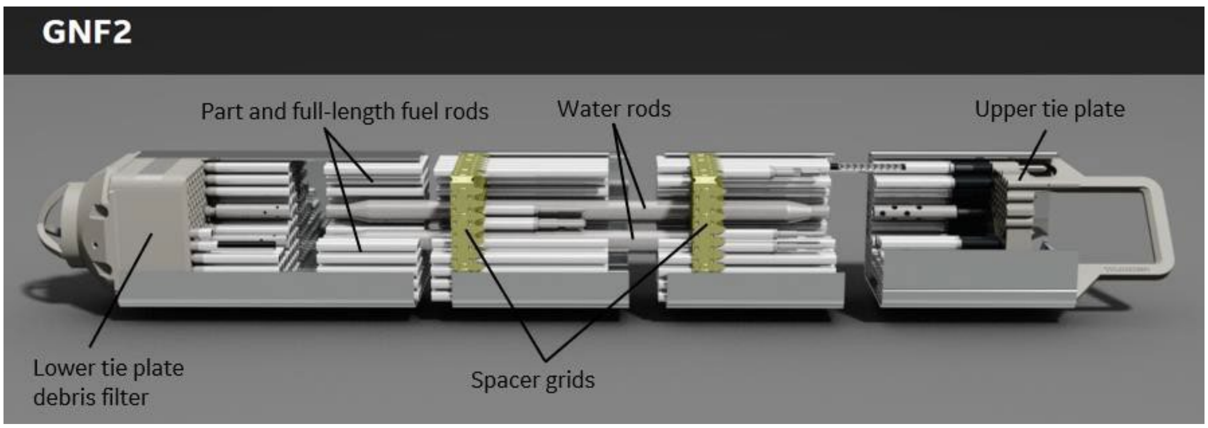


Figure 13: GNF2 Fuel Bundle

2.2.1 Fuel Handling and Refueling Process

The BWRX-300 fuel handling and refueling process takes advantage of historical BWR practices. The refueling process is an intricately scheduled series of tasks to disassemble/assemble the containment head, RPV head, remove/replace the RPV internals to access the fuel assemblies and remove/replace/shuffle the fuel assemblies.

The RB includes a refueling platform (gantry crane) for fuel movement and servicing. The refueling platform spans the reactor vessel and storage pools on tracks in the refueling floor. A telescoping mast and grapple suspended from a trolley system lift and orient fuel assemblies for placement either in the core or in storage racks in the fuel pool.

A position indicating system is provided to locate the grapple over the vessel core and prevent collision with pool obstacles. The mast grapple has redundant features so that no single component failure results in a fuel bundle drop. Multiple interlocks are provided on the refueling machine to prevent mishandling of the fuel assemblies.

Storage racks provide for the short-term and long-term storage of new or used fuel and associated equipment. The fuel storage racks are spaced to prevent inadvertent criticality. Fuel racks are in the fuel pool in the RB. The racks are top loading, with a fuel assembly bail extended above the rack. The rack arrangement prevents accidental insertion of fuel assemblies between adjacent racks and is spaced to allow flow between assemblies for fuel cooling.

2.2.2 Fuel Pool Cooling and Cleanup System

The primary function of the Fuel Pool Cooling and Cleanup System (FPC) is to provide continuous cooling of the water volume in the fuel pool to remove decay energy from spent fuel, and to provide replacement coolant inventory from a variety of sources to ensure spent fuel is kept cool and submerged throughout the life of the plant. In addition, the FPC includes water treatment to maintain coolant quality and to reduce general area dose.

The FPC consists of two trains of equipment, each with a pump, demineralizer, and heat exchanger. A single train is sufficient to prevent boiling in the fuel pool. If both trains are rendered inoperable, the fuel pool is sized such that it can retain sufficient coverage of the fuel for seven days, and the FPC can provide makeup capacity from various sources to ensure pool level during off-normal conditions.

The demineralizer allows for removal of small particulate matter through back-washable filters, with ionic cleanup performed with deep bed demineralization using mixed anion and cation bead resin.

2.3 Main Steam and Power Conversion

The main steam subsystem consists of two steam lines from the discharge of the main steam reactor isolation valves to the turbine stop valves, the turbine bypass valves, the main steam line drains, and other load isolation/maintenance valves. The supply lines to these loads, all connecting branch lines up to and including their respective isolation valves, and all associated piping supports are also part of the main steam subsystem. Figure 14 shows a typical arrangement for main steam piping.

The main steam subsystem also includes a containment isolation valve on each main steam line. The containment isolation valves are fast-closing and fail-closed type valves that provide the isolation of the containment in the event of accidents or other conditions and prevent the unfiltered release of containment contents that exceed appropriate limits.

The main steam flow restrictors are in the RPV main steam nozzles. The function is to limit the overall steam flow through one steam line when the steam flow exceeds preselected operational limits (if a large break of a main steam line is sensed) and the corresponding isolation valves have not closed.

The main steam line drains transfer any condensate from the main steam lines to the main condenser during startup, low power operation, normal power operation, and shutdown. A reduction in power to a low-level, results in the automatic opening of the air-operated drain line valves, thereby establishing drain flow to the main condenser.

The Turbine Bypass Valves are opened by Instrumentation & Control System when the actual steam pressure exceeds the steam pressure needed by the turbine. One or two bypass valves may be modulated as required in response to changes in the bypass demand. Bypass steam is discharged to the main condenser.

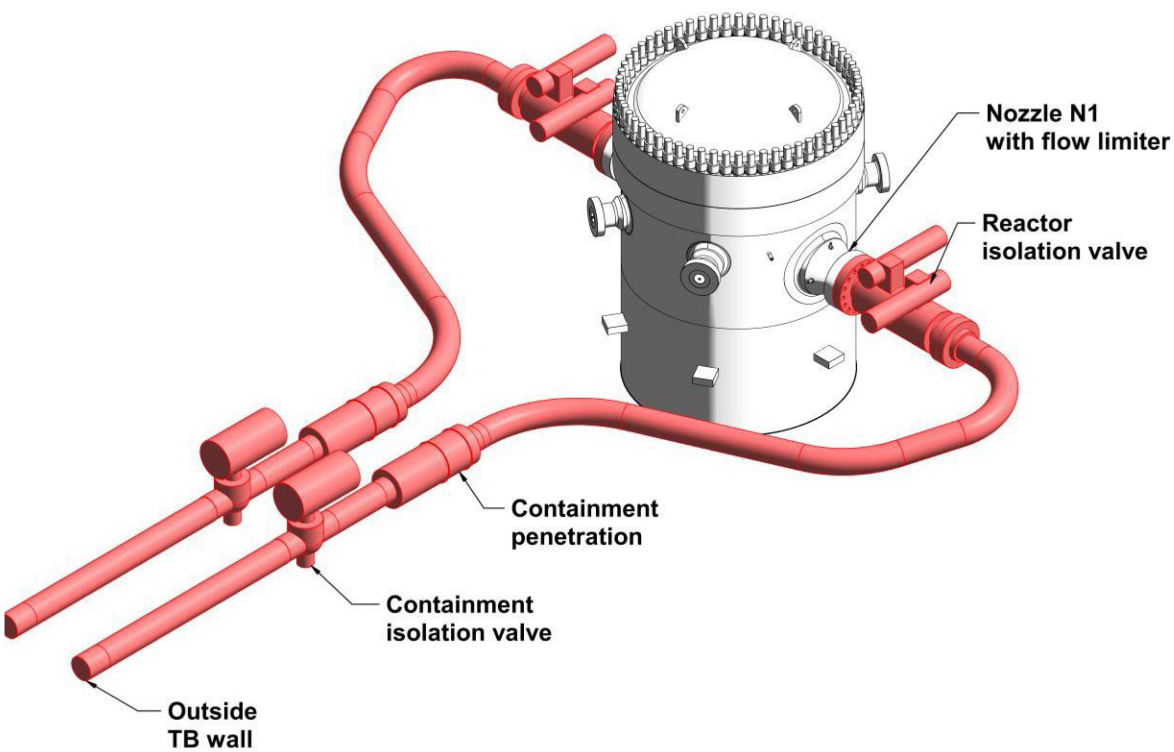


Figure 14: Main Steam Piping

The turbine generator receives steam from the RPV via the main steam lines. High pressure steam enters the HP turbine converting thermal energy into mechanical rotational energy. The exiting low-pressure steam then passes through two low-pressure steam turbines where further mechanical energy is produced. The resulting mechanical energy drives the generator to produce electricity.

2.3.1 Main Condenser

The Main Condenser and Auxiliaries (MCA) System is the heat sink for the power generation and normal reactor cooldown and plant startup activities. The MCA System consists of the main condenser, two steam jet air ejectors, and a condenser vacuum pump as well as associated piping, valves, instrumentation, and controls. The main condenser is a single pressure, two-shell unit. Each shell is located beneath its respective low-pressure turbine. The two condenser shells operate at similar pressures and drain to hotwells that are cross connected. Circulating water flows through each of the two single-pass tube bundles to condense the turbine exhaust steam into the hotwells.

The main condenser receives and condenses turbine exhaust steam and turbine bypass steam during all modes of operation. The main condenser provides hold-up for Nitrogen-16 decay to reduce worker radiation exposure and supplies condensate to the condensate pumps. The main condenser also serves as a collection point for other steam cycle miscellaneous drains, vents, and relief valve discharges. The condenser is cooled by the Circulating Water System configured as an open system (i.e. rejects heat to an appropriately sized body of water).

Two steam jet air ejectors are used to maintain the turbine backpressure and remove non- condensable gases from the main condenser. Non-condensable gases extracted from the condenser are exhausted to the Off-gas System.

2.3.2 Condensate and Feedwater System

The Condensate and Feedwater System contains two condensate pumps, two reactor feedwater pumps, three stages of low-pressure closed feedwater heaters, and three stages of high-pressure feedwater heaters. The two reactor feedwater pumps are used to maintain RPV water level. The three high-pressure feedwater heaters are arranged in series.

The Condensate Filters and Demineralizers System (CFD) purifies the condensate to maintain reactor feedwater purity. The CFD uses filtration to remove suspended solids, including corrosion products, and ion exchange resin to remove dissolved solids from condenser leakage and other impurities. The CFD is a full-flow system that consists of high efficiency backwash type filters followed by mixed bed demineralizers.

2.3.3 Circulating Water System

The Circulating Water System (CWS) provides cooling water to the main condenser and transfers heat from the condenser to the environment through the normal heatsink. The CWS also supplies cooling water to reject the heat loads from the plant cooling water heat exchangers through the normal heatsink.

The CWS has two subsystems: the main condenser supply and the plant cooling water supply. The main condenser supply provides cooling water to the MCA during all modes of condenser heat removal. The plant cooling water system consists of two trains, each containing one pump and one heat exchanger, that address the reactor component and turbine component cooling loads.

2.4 Instrumentation and Control Systems

2.4.1 Instrumentation and Control Design Architecture

The BWRX-300 Instrumentation & Control System, also referred to as the Distributed Control and Information System (DCIS), is an integrated control and monitoring system for the power plant. The DCIS is arranged in three Safety Classified DCIS segments and a Non-Safety Class segment with appropriate levels of hardware and software quality corresponding to the system functions they control and their Defence Line (DL) location. The DCIS provides control, monitoring, alarming, and recording functions. The various segments of the integrated DCIS are designed to operate autonomously and independently.

The various DCIS systems are implemented on different hardware and software platforms appropriate to the functions they are performing. It is desirable to use standardized DCIS equipment such that only BWRX-300 application programming need be added; specifically, platforms whose operating systems and hardware have already been designed and adapted for the BWRX-300 requirements.

The BWRX-300 plant has passive safety systems which are actuated via the various DCIS platforms that provide specific safety functions. In general, the safety functions include reactor shutdown (bringing the reactor subcritical), isolation of the reactor vessel and containment, monitoring of reactor power in the power range, initiation of heat removal and pressure control, and monitoring and control of the plant. The safety systems are automatically initiated upon detection of specific conditions and can be initiated manually by an operator. The safety systems are designed to be fail-safe, so they actuate the safety function upon loss of power. The DCIS also provides for monitoring of post-accident parameters to support emergency procedures and guidelines.

The defined safety functions are provided with high reliability, diversity, independence, and redundancy features. The BWRX-300 has been designed to perform safety functions even with single (and sometimes multiple) failures. The analysis for software-based systems considers common cause failure of the hardware/software platforms to demonstrate that the safety functions can be carried out reliably.

2.4.2 Main Control Room

The Main Control Room (MCR) is the primary location for plant monitoring and control during normal, abnormal, and emergency conditions. The MCR includes controls, indications, and alarms that enable operators to perform the defined set of functions during normal operation modes and postulated initiating event conditions. In the event the MCR becomes uninhabitable, or is expected to become unhabitable, or if functionality is unacceptably impaired, personnel are to move to the Secondary Control Room (SCR). Egress from the MCR and access to the SCR is designed such that required minimum operations staffing can safely transition from the MCR to the SCR.

The MCR is designed with Human-System Interface (HSI) to support tasks such as:

- Assessing the overall status and performance of the plant in any condition and providing necessary information to support operator actions;
- Monitoring the status and trends of key plant parameters (such as reactor power and rates of power change);
- Operating the plant safely during all operational states, automatically or manually;
- Taking measures to maintain the plant in a safe state or to bring it back into a safe state after design basis events and Design Extension Condition (DEC);
- Maintaining the plant within the specified limits and conditions for the parameters associated with plant systems and equipment;
- Monitoring for failure of critical instrumentation and equipment;

- Confirming safety actions for the actuation of safety systems are automatically initiated when needed and that the relevant systems perform as intended;
- Determining the need and the time for manual initiation or intervention of specified safety actions; and
- Implementing emergency operating procedures, Emergency Mitigating Equipment guidelines, and severe accident management guidelines.

The design provides the ability for user selectable display screens and user-defined trending and parameter value monitoring. A robust visual and audible alarming system is provided to alert operators when value thresholds are exceeded. Considering the control technology, the design supports query of control input status (e.g. interlocks, start permissive, auto-start signals) at the point of operation. The Safety Parameter Display System is integrated in the overall MCR HSI designs.

2.4.3 Secondary Control Room

The Secondary Control Room is in the Reactor Building. The SCR includes the required HSI that enable operators to perform the defined set of functions required for responding to the identified plant events and conditions for which the MCR cannot be used.

The SCR is designed in accordance with current international best practice codes and standards for control room design, integrating results from Human Factors Engineering (HFE) analyses and specified HFE design requirements.

The SCR is utilized to perform the functions required to keep the plant in a safe state when the MCR is unavailable. The required functions are derived from safety and HFE analyses.

2.5 Electrical Systems

The BWRX-300 Electrical Distribution System (EDS) is an integrated power supply and transmission system. The EDS is arranged like the DCIS with three safety classified segments and a non-safety classified segment with appropriate levels of hardware and software quality corresponding to the system functions they control and their safety rating.

Each subsystem has appropriate levels of hardware and software quality (corresponding to the systems they power) to provide power to plant loads and a transmission path for the main generator to the utility switchyard/grid. The EDS is monitored and controlled by plant operators from the MCR. Various segments of the EDS are designed so they can operate independently.

There are two transmission lines of off-site power to the plant, to improve reliability and operational flexibility, that power the plant's auxiliary loads. The BWRX-300 maintains passive safety features that are not reliant on a switchyard off-site AC power source. Passive safety features require no power for the initial 72-hours to maintain a safe state.

3.0 BWRX-300 CONSTRUCTION OVERVIEW

Based on lessons learned from previous nuclear and non-nuclear projects, including the ongoing refurbishment of the Darlington Nuclear Generating Station, OPG understands that detailed front-end planning is critical to the successful completion of new nuclear construction.

OPG continuously seeks opportunities to reduce the carbon footprint during construction of a new reactor facility. During site preparation, approximately 7000 tonnes of greenhouse gas emissions were avoided by storing spoils on site. Additionally, OPG has utilized temporary on-site power in lieu of diesel generators to support construction and is utilizing locally manufactured cement to reduce the transport distances for trucking concrete on site. OPG will continue to review construction best practices including a review of the use of materials to identify and implement opportunities to minimize environmental impact.

3.1 Plans for Component Manufacture and Plant Construction

Many of the components utilized in the BWRX-300 have been used extensively in the nuclear and power industries and have a well-established supply chain. For example, the BWRX-300 high pressure turbine will be factory assembled, a method that has been used effectively in the industry. This approach eliminates the need for open-top or open-ended assembly of tolerance critical equipment in a construction environment, reducing the risk of foreign particle entry, and minimizing exposure of the internal components to the elements. Assembling this equipment in a shop environment by craftspeople that perform these tasks on manufacturer- specific equipment on a daily basis will also improve quality. Such quality improvements are valuable to the safety of the plant. Figure 15 shows a rendering of high and low-pressure turbines for the BWRX-300.

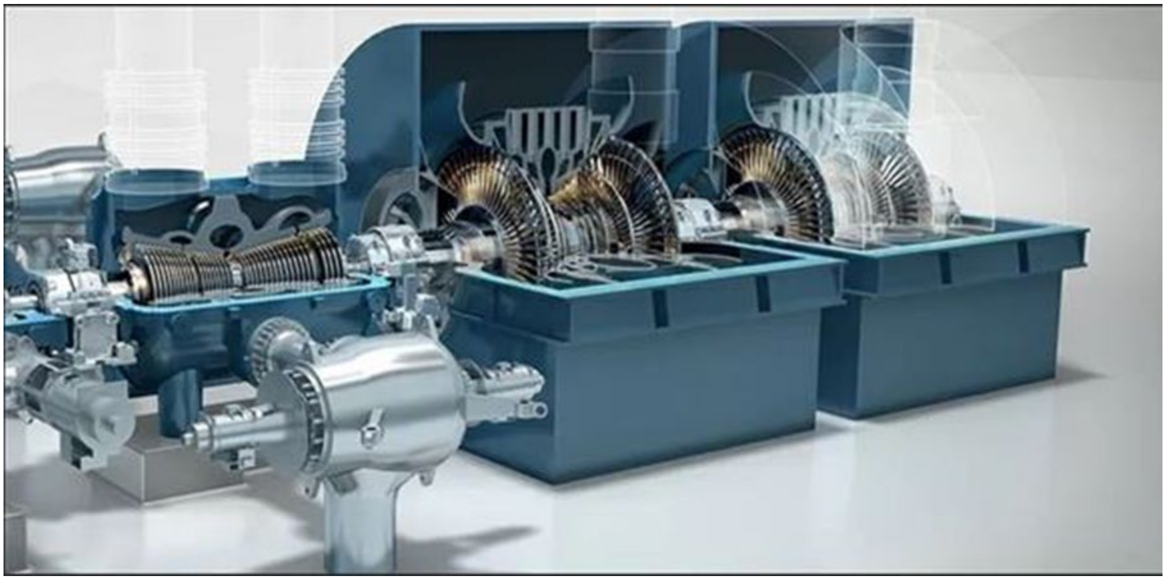


Figure 15: Conceptual illustration of BWRX-300 High and Low-Pressure Turbines

The BWRX-300 also draws from proven construction methods from within and outside of the nuclear construction industry. The design utilizes modularized construction for large components that can be consistently lifted, set, aligned, and fixed in place, resulting in better quality control, efficiency, reliability and construction schedule benefits.

The modularized construction will be conducted in three stages:

- Shop fabrication and pre-assembly of the largest standard shipping load to site;
- Site fabrication to further assemble material to the largest feasible size for setting with equipment available at site; and
- Final in-place assembly.

As part of normal project processes, a construction plan is used to support detailed construction sequencing for determination of travel routes, laydown areas, fabrication and storage facilities, and general construction site layout.

3.2 Material Excavation

The key excavation feature is the reactor shaft development. Straight line shaft excavation will minimize material removal and backfill requirements. Standard techniques used by tunneling and hydraulic industries will be used to accomplish this excavation.

3.3 Diaphragm Plate Steel Composite (DPSC) Construction

The Reactor Building will utilize Diaphragm Plate Steel Composite (DPSC), a material that leverages the combination of strength from concrete and steel interaction while minimizing the use of rebar. The DPSC Structural System will be used for the walls, floors, and specific substructures of the RB. It utilizes steel plates that provide both strength and permanent concrete forming as well as shear studs that provide a composite action between the steel and concrete. It also provides the ability to prefabricate, install, and connect DPSC assemblies into larger modules. The use of rebar is minimized with this type of construction. The DPSC Structural System allows for the construction efficiencies gained from modularization to be realized, while maintaining a proven safe and reliable structure. A visual depiction of the DPSC is shown in figure 16.

While the DPSC Structural System planned for DNNP is a new variation of steel composite design specific for this project, steel composite construction is a proven technology that has been used widely in the construction industry. Steel composite designs have also been used for construction of safety related structures in previous nuclear projects such as the AP1000 reactors constructed at plant Vogtle in Georgia, USA. In order to ensure the robustness of this construction technique, GEH in partnership with the US Department of Energy has undertaken a series of tests utilizing this construction technique. The results of these tests have been summarized and provided with both the CNSC and US NRC.

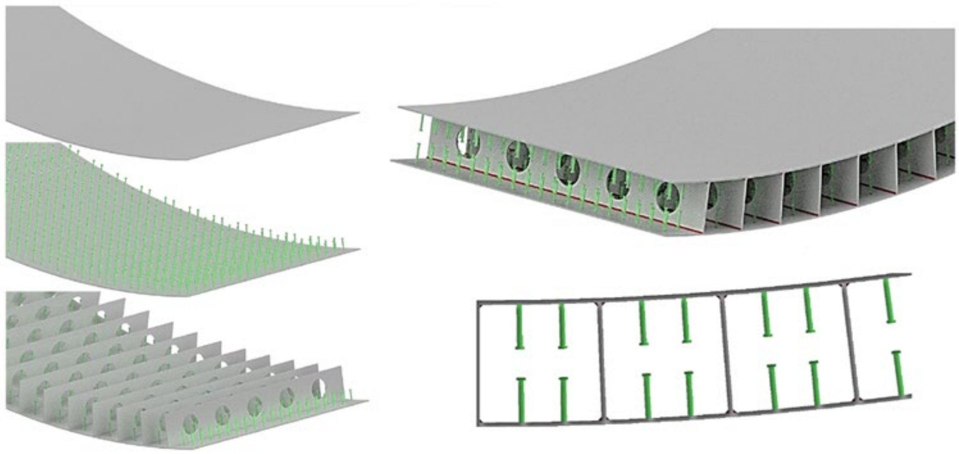


Figure 16: Diaphragm Plate Steel-Plate Composite (DPSC)

4.0 SAFETY AND CONTROL AREAS

4.1 Management System

OPG has a mature and effective Nuclear Management System (NMS) that will ensure the execution of activities performed under a Power Reactor Construction Licence are controlled with quality and safety as the overriding priority.

OPG's NMS is a set of processes and programs that brings together in a planned and integrated manner elements required to ensure OPG achieves its safety and business objectives, continuously monitors its performance against those objectives and fosters a healthy safety and security culture. The NMS framework with its programs, processes, standards and other implementing documents ensures that safety is the foremost consideration in management decisions and actions. Project-specific documents define the details of how DNNP meets CSA N286-12 [R-8] management system requirements.

OPG is the Owner and will be the Licensee accountable for the safe execution of the DNNP licensed activities. DNNP will utilize an Integrated Project Delivery (IPD) contract model that maximizes integration and collaboration between contract partners. OPG will have the accountability to ensure management system requirements are met through ongoing oversight for the construction phase activities following the OPG NMS and associated project specific implementation plan documents.

4.1.1 DNNP Management System Governance

The DNNP will utilize applicable OPG program documents for the construction phase, supplemented by project-implementation documents that ensure compliance with CSA N286-12 clauses related to construction activities. This allows the DNNP to leverage significant experience and expertise to ensure governance utilized by the DNNP maintains the highest levels of quality and safety focus and is suitable for LTC activities.

The generic programs within the NMS applicable to the conduct of licensed activities include nuclear business planning, conduct of regulatory affairs, human performance, performance improvement, training, independent assessment, managing change, information management and cyber security. Existing Project Management and Design Management programs will also be leveraged significantly to execute project specific activities and design oversight.

OPG's management system governance structure to support DNNP LTC activities is described in Figure 17.

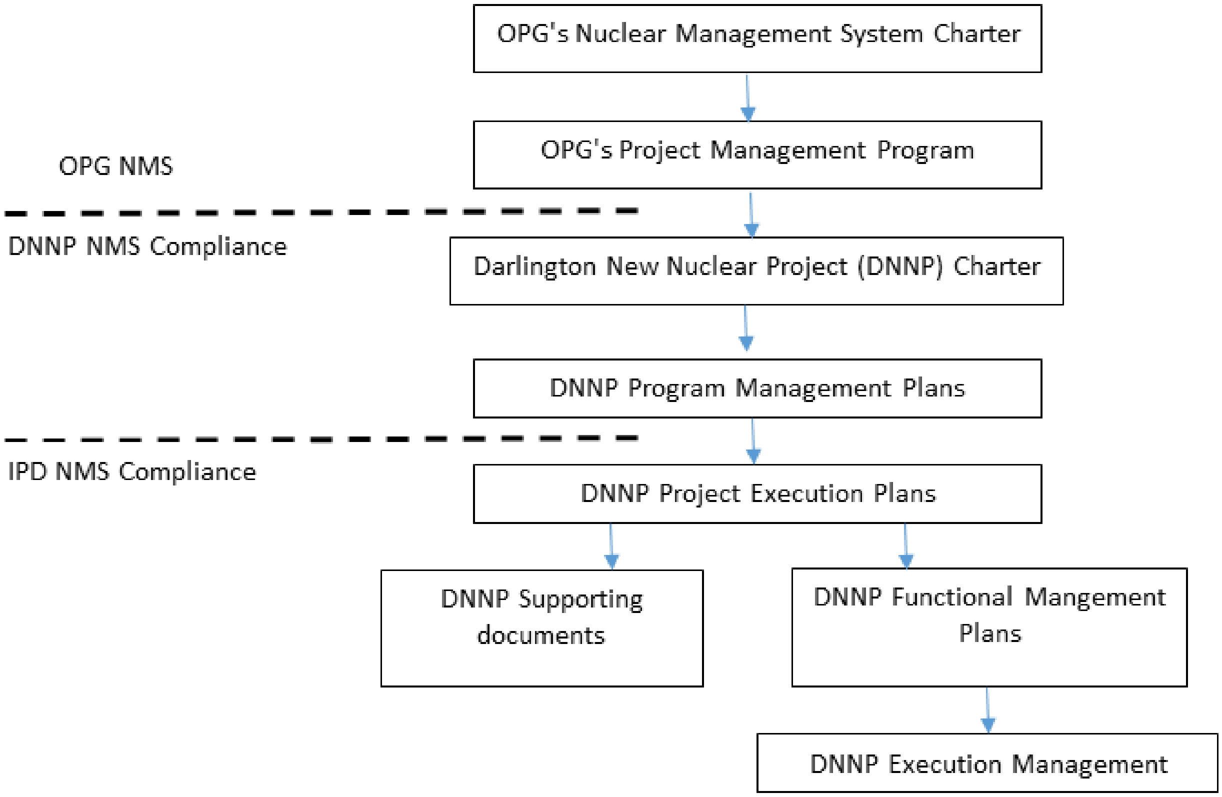


Figure 17: DNNP Management System Governance Document Structure

The OPG NMS Charter provides overall direction regarding administration of nuclear licensing activities and establishes requirements to which all employees shall comply.

The NMS Charter credits the use of the Project Management Program. This program establishes how the requirements, objectives, and commitments for the management of projects across all business areas within OPG are fulfilled.

The Project Management Program requires the creation of a project charter. A project charter typically describes the business vision and scope of the project as defined by the line of business.

The Project Charter gives authority to the DNNP Program Management Plan, which describes the overall programmatic requirements to design, construct and bring a SMR online. The individual subplans are designed to provide the assurance that all aspects of the program will be conducted in accordance with applicable requirements.

The DNNP Project Execution Plan (PEP) receives authority from the DNNP Program Management Plan and provides the overarching framework to execute the project through the Integrated Project Delivery model. The PEP outlines plans, resources, mechanisms and procedures that implement the Management System requirements for the lifecycle activities of the project through to closeout.

Functional Management Plans receive authority from the PEP and set out specific requirements for implementation of the specific functions in the project such as quality, project controls, and engineering.

Execution Management Plans outline how requirements are met for the specifics project bundles such as nuclear island, conventional island and balance of plant.

Each contract partner is required to follow their quality assurance program and management system and is required to meet the applicable requirements of CSA N286-12 for the licensed activities commensurate with the Integrated Project Agreement. OPG has conducted an audit of each contract partner as per the OPG management system to the requirements of CSA N299.1 and N286-12 applicable elements and has qualified them on the OPG Approved Suppliers List. OPG conducts follow-up audits on a regular basis. As the Owner partner and licensee, OPG maintains overall ownership and authority of the DNNP.

4.1.2 DNNP Organization

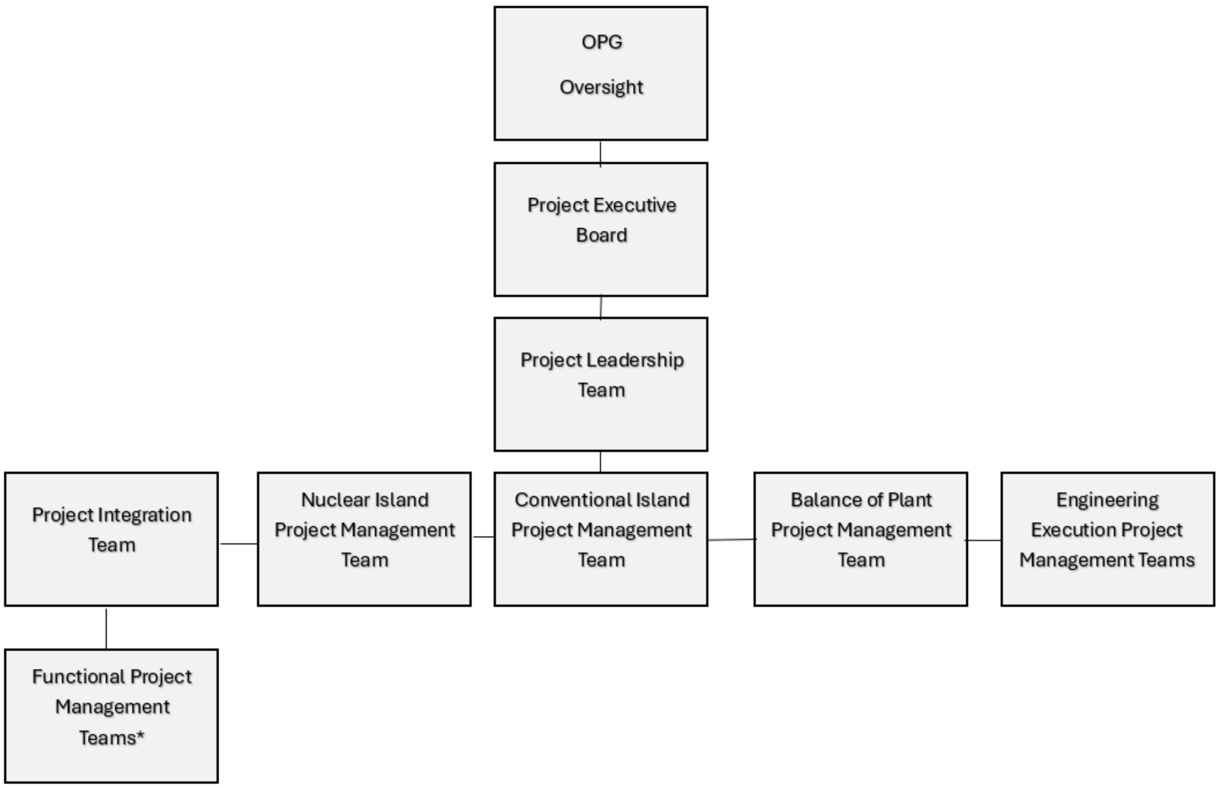
OPG is working with contract partners, General Electric Hitachi, AtkinsRéalis and Aecon to build the DNNP facility under an Integrated Project Delivery model. The project team has a diverse range of expertise and services to develop, engineer and construct a BWRX-300. This includes significant experience with many of the components utilized in the BWRX-300, along with an existing supply chain which minimizes risks for the project.

Each partner will play a specific role on the project:

- OPG: The owner and licence holder; OPG will maintain overall responsibility for the project, including oversight of licensed activities, operator training, commissioning, Indigenous engagement, and stakeholder outreach.
- GEH: The technology developer; provides overall design, procurement of major components and engineering support.
- AtkinsRéalis: The architect engineer; provides design, engineering and procurement support.

- Aecon: The constructor; will provide construction planning and execution.

Figure 18 describes the project organization to ensure oversight and effective project management of the DNNP.



**Functional PMTs consist of: Project Controls, Site Management and Construction, Procurement, Engineering, Health Safety and Environment, Operations and Maintenance, Start-up and Commissioning, Communications, Indigenous Engagement, Security and Emergency Management, Regulatory Affairs, Digital Project Delivery, Waste and Decommissioning, Field Coordination*

Figure 18: DNNP IPD Organization

The Executive Board is composed of one executive from each of OPG, AtkinsRéalis, Aecon, and GEH. The Executive Board is responsible for strategic oversight of the project and provides executive-level collaborative guidance for the Project to achieve the project objectives. While decisions are made by the Executive Board, OPG as licensee and owner retains the authority to issue directives to the project.

Owner oversight consists of OPG representatives that are separate from the integrated teams to maintain independence and accountability for the licensed activities.

The Project Leadership Team (PLT) includes one leader from each party. The PLT is responsible for providing project oversight, strategic project decisions, staffing, and overall accountability for DNNP IPD model. The PLT provides management-level collaborative guidance for the project to achieve the project objectives. The PLT provides direction to the Parties and to the Project Management Teams (PMTs). The PLT creates, organizes, manages, and mentors the PMTs. The PLT is responsible for monitoring all project progress and for developing benchmarks, metrics, and standards for progress evaluation.

Project Integration Team (PIT) – This team is composed of one representative from each contract partner. The PIT is tasked with establishing the overall integration of the project execution and functional teams. This includes integration between bundles and functions to ensure consistency in approach, managing organizational structure and governance, and providing oversight on functions and supporting activities.

Functional PMTs – Reporting to the PIT, the functional groups may be comprised of representatives from all four organizations or have a single leadership as appropriate. They ensure project processes are efficient and support the execution of the project, comply with the contract and owner requirements, and will provide resource and strategic direction for their associated functions.

Execution PMTs - Reporting to the PLT, the execution PMTs are the delegated authority for budget, schedule, and risk management. They are accountable for their areas, tactical decision making, work processes, schedule development and the overall responsibility for all aspects of project execution within their assigned scope. Execution PMTs are responsible for accurately reporting on area performance and keeping the team informed on project status.

By engaging highly experienced companies across various aspects including engineering, construction, and operations, OPG is ensuring that design, construction, and safety of its DNNP BWRX-300 plant will meet or exceed regulatory requirements incorporating industry-leading best practices.

4.1.3 Configuration Management and Change Control

OPG has an established process that ensures design requirements (including safety analysis), physical and operational configuration, and configuration information (operating procedures or drawing) are consistent throughout all project phases.

The Darlington New Nuclear Project has a Configuration Management Plan that encompasses the DNNP Engineering, Procurement, Construction and Commissioning phases. The elements and activities in this plan apply to any personnel who perform or support licensing, engineering design, procurement, or any other activity that may impact the configuration management of the structures, systems, and components prior to turnover. It establishes a means of configuration change control to maintain consistency and conformity between design requirements, the design, the physical configuration, and configuration information including the inter-relationships and mutual integrity through status and revision control.

The oversight activities performed by OPG are applied using a graded approach such that complex or safety significant activities and deliverables will have more frequent and intrusive oversight. The intent of intrusive oversight is to proactively inquire to assess results and behaviours while ensuring gaps are identified, and drivers are understood, actions are taken and results are verified to achieve desired performance. The oversight is intended to ensure ongoing conformance of the engineering products or deliverables in accordance with the applicable management system.

4.1.4 Safety Culture

OPG and contract partners foster a healthy nuclear safety and security culture among all employees throughout all phases of the facility's lifecycle to ensure the protection of workers, the public and the environment.

A healthy nuclear safety and security culture is integrated and promoted through the management system polices, programs, and procedures.

All employees are accountable to conduct themselves in a manner consistent with the "INPO Traits of a Healthy Nuclear Safety Culture" [R-9] and to maintain vigilance such that:

- Nuclear Safety and Security are the overriding priority in all activities performed in support of the DNNP.
- Nuclear Safety has clear priority over schedule, cost, and production.

The DNNP Nuclear Safety and Security Culture Program establishes a framework to ensure the ongoing monitoring of safety culture including the execution of comprehensive, systematic and rigorous safety and security culture assessments. The cyclical assessment of safety and security culture allows for continuous focus to maintain a healthy safety and security culture throughout the project.

4.2 Human Performance Management

OPG's 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. OPG ensures its projects partners also have human performance programs in place.

The principles of human performance will apply to the lifecycle of the DNNP facility throughout all stages of design, construction, operation, and decommissioning with a graded approach that is commensurate with the level of risk.

OPG ensures that its workers, as well as project partner staff are qualified, and possess the necessary competencies to perform their work safely, meeting established standards and expectations set by OPG management. Workers rely on OPG procedures or equivalent, which encompass a wealth of industry operating experience to execute tasks event-free. Human performance is monitored using established processes and metrics.

OPG fosters a culture of open reporting of events following established processes for human performance event communications and analysis. The fundamental principles of human performance are included in training for all levels of the organization. The training program employs a systematic approach that promotes excellence in worker performance that is based on an understanding how individuals, the environment, organization, and technology interact.

OPG expects that all workers apply themselves to exhibit the behaviours of a nuclear professional. OPG will ensure human and organizational factors are considered throughout the design, planning and construction activities.

4.2.1 Personnel Training

OPG's training program provides the structure, processes, and tools for defining, developing, implementing, documenting, assessing and improving the training required to ensure staff have the appropriate knowledge, skill and behaviours for safe and efficient plant operations.

Training and development at OPG are prioritized to build and maintain in-house capabilities to be an informed customer. Knowledge development, transfer and retention plans are put in place to ensure independent oversight and increased technical knowledge. Where identified, third-party reviews are done in parallel with OPG reviews to ensure work is done with high quality.

While OPG is a highly experienced, qualified, competent nuclear operator, it recognizes the value of learning from others. To this end, OPG has established a Memorandum of Understanding with a highly qualified and competent nuclear operator in the US, the Tennessee Valley Authority, operator of three BWRs at Brown's Ferry. Through this partnership, OPG is gaining valuable knowledge and operating experience that will inform OPG's work throughout the project planning, construction, and future operations.

Training for personnel engaged in activities during the construction and fuel-out commissioning phases of the DNNP includes:

- Training for staff, supervisors, contractors and sub-contractors;
- Training specific to commissioning activities;
- Initial Training and Qualification programs for certified staff (including Simulator Training), field operations personnel, control maintenance and mechanical maintenance, and associated OPG instructors;
- Where applicable, use of existing Nuclear Training Programs including revisions as a result of DNNP technology; and
- Scheduling and timing of training program delivery.

The initial training and qualification programs will also support the certification of staff, which will be completed as part of an application to operate the reactor and prior to fuel-in commissioning.

Contract partners are responsible for the training and qualification of their staff, supervisors, contractors and sub-contractors under their respective management systems.

OPG provides personnel with site specific information where needed. Skilled trades staff are required to hold journeyperson status and certificate of qualification as appropriate. Apprentices work under the accountability of a journeyperson when performing tasks associated with the skilled trade.

Additionally, contract partners maintain records of staff certifications, licences, professional designations, training and qualification (applicable to activities conducted on the project) and make them available for OPG review upon request.

Any workers who require access to the DNGS protected area and/or tie-ins to existing DNGS station systems or equipment, will undergo training and qualification under the DNGS training program as required prior to commencement of the work.

The revision, development and delivery of training for staff who will commission, operate and maintain the new station will follow OPG's applicable Nuclear Training Programs, and all applicable standards and procedures taking authority from the program.

Development and delivery of DNNP specific initial training and qualification for workers, including certified staff, will follow a Systematic Approach to Training (SAT) that focuses on BWR technology and the DNNP management system. This includes the identification of performance requirements and definition of worker training through analysis, the design and development of training to support proper job performance and individual development, implementation of training and examination processes, as well as examination security, development, and approval processes.

4.2.2 Personnel Certification

As part of future operations, OPG will develop programs that ensure persons seeking a certification or renewal of a certification issued by the CNSC for a designated position referred to in the DNNP operating licence are qualified to carry out the duties of that position in accordance with the NSCA and the regulations made under the Act.

The certification of personnel will be included as part of the next licensing phase. The sections below provide an overview of the current programs and processes for certifying personnel. These will be adapted to support certification of personnel for the future operations at DNNP.

Personnel certification is governed under OPG's certification program. The program is mature and robust and conforms with applicable CNSC regulatory documents.

As discussed in the previous section, required skills and competencies for certified positions are identified through OPG's Systematic Approach to Training. The objective of the SAT is to guide the development of performance-based training to support job performance requirements and individual development.

Personnel involved in development and conduct of certification training programs are required to be qualified. All qualifications are developed, implemented, approved and revised following established processes and documented in Training and Qualification Descriptions (TQDs) and guides.

TQDs define the initial training and qualification requirements for each of the positions requiring certification, and for each of the certification training program instructors and examiners. These TQDs describe each phase of the initial training programs. Upon successful completion of the training phases, including required certification examinations, candidates are eligible to receive a CNSC certification.

TQDs will be developed for each of the positions requiring certification at the DNNP. A qualification guide will be developed that describes the initial and continuing training for DNNP operations certification training instructors and examiners.

Positions requiring regulatory certification will be based on the technology needs and safety significance. The roles and responsibilities for each designated position will be described in a series of role documents that will be developed as operating documentation becomes available.

The training program for certified staff will be developed as design and operating documentation becomes available. Based on simplification of the design and the advanced safety features incorporated in the BWRX-300, it is anticipated that the SAT-based certification training programs will be less complex than the current programs at other OPG facilities.

Training for certification of staff required under a future operating licence will include the use of a full-scope simulator. The full scope simulator will be a replica of the BWRX-300 Main Control Room hardware panels and instrumentation, telephone and communications systems, radiation and fire emergency tones and public address system. It will include the simulation computers and servers required to provide plant system modeling, simulator operation and Instructor Station functionality.

All operator-related actions normally performed in the BWRX-300 MCR identified by the training analysis will be incorporated into the simulator capability. The simulator will be based on the final iteration of the plant design and the simulator and simulation models will support the training of certified staff.

The DNNP initial certification training program is planned to begin in 2026, with the program completed and CNSC certified staff in place prior to the initial fuel load.

OPG has mature and effective programs in place for initial and continuing training in compliance with applicable regulatory requirements that will apply under the proposed construction licence.

In support of a future application for a Licence to Operate, OPG will demonstrate its capability to administer initial training for certified staff and ensure sufficient certified staff are available for the safe and reliable operation of the DNNP. This includes having sufficient trained and qualified staff available to deliver the examination and testing programs throughout the station’s continued operation.

4.3 Operating Performance

Operating performance for the Licence to Construct application refers to the licensed activities taking place during the construction and fuel-out commissioning phases. Construction activities will be executed by the constructor with oversight from OPG. Development and execution of commissioning instructions will be completed in collaboration with contract partners.

OPG will have the primary responsibility for the safety and security of construction and commissioning activities, including the work carried out on its behalf by contractors. OPG will use its independent oversight to ensure compliance with both OPG's management system and the constructor's management system, which will meet applicable standards. The construction activities to be completed by the contract partners will leverage leading construction expertise to ensure construction is executed in a safe manner and deliver nuclear grade quality that meets or exceeds OPG expectations and regulatory requirements.

4.3.1 Construction Oversight

OPG is actively engaged in the oversight of site construction to ensure project success. OPG plays a multifaceted role in ensuring quality, adherence to regulations, and effective communication with project partners and vendors. Independent quality surveillance, observations and periodic checks will be conducted to ensure work and construction activities meet the design quality standards and regulations, and to monitor work progress and deadlines. Site walkdowns are conducted periodically and as required, upon site and construction islands turnovers, prior to work commencement, after work completion, or in response to emergent issues, emergencies, or any adverse scenarios. OPG also plays a pivotal role in reviewing construction work packages, work plans and design drawings.

OPG is also responsible for Memorandums of Understanding and addendums, facilitating smooth transitions and construction islands turnovers, and ensuring clear communication and agreement terms between vendors. Additionally, OPG acts as a Single Point of Contact between regulators and the constructor Aecon, enhancing communication efficiency and work coordination.

4.3.2 Procedures

The BWRX-300 design philosophy of "simplicity" and "designed for constructability" enables it to be efficiently constructed and commissioned per OPG's Construction and Quality Program Management Plan, in compliance with regulatory requirements.

Procurement and Receipt of Materials

Established processes and procedures will ensure equipment supplied is manufactured per the requirements of the Quality Assurance program. The level of inspection requirements during manufacturing will be prescribed considering the consequence of equipment failure (including safety considerations, operational significance, economic significance). Procurement packages consisting of commercial and technical sections will be assembled in accordance with approved procurement processes, with technical specifications established with the specific product requirements.

Components will receive an initial onsite "receipt inspection" to ensure the components are as ordered, have not been damaged, and that the components are not counterfeit, fraudulent or suspect. Ongoing maintenance, surveillance, and in-service testing of components and systems will be conducted with OPG oversight.

Protection of Structures, Systems, and Components

The requirements associated with maintenance of SSCs during fabrication, storage, installation, and fuel out commissioning will be documented and reviewed by contract partners. Measures will be established to protect SSC and will include controls to address environmental conditions, ensure foreign material exclusion, protection from personnel traffic, and adjacent construction activities.

Requirements for cleanliness and housekeeping, fire protection, and security against theft or vandalism will further ensure system construction quality. Additionally, specific requirements will be established for shelf life, preventative maintenance, and for maintaining cleanliness, including assurance of compatibility of cleaning methods and materials. Chemistry requirements for layup, cleaning, flushing and conditioning of piping systems and components will be established.

Testing

Rules and procedures will be established for testing to ensure that applicable codes and standards are met. The specifics of construction testing will be defined in the installation specifications or in the documentation provided by the major equipment suppliers and used to demonstrate that components are ready for pre-operational testing and the introduction of energy. Process and procedures will be established to control and coordinate the turnover of work, structures, equipment and systems.

Turnover

Turnover of SSC from one organization to another will include walkdowns to ensure that they are in the state defined in the turnover documentation. Incomplete items, exceptions and completion schedules will be identified and listed for resolution prior to final acceptance. Transfer of responsibility for the maintenance and protection of equipment will occur as per the turnover process. At all times boundaries and system status will be documented. During the construction phase, there will be intrusive and non-intrusive tests performed by contract partners for which OPG will perform oversight, such non-destructive evaluation on welds via radiography.

Commissioning Program

Commissioning is the process during which the Structures, Systems and Components of a facility, having been constructed, are made operational and verified to be in accordance with design requirements. Lessons learned and experience from other projects, including OPG's successful Darlington Refurbishment, will be incorporated into the DNNP commissioning program. DNNP will have one commissioning program that spans testing prior to fuel load, as part of the construction license, and post fuel load as part of an operating license.;.

The DNNP commissioning program will be developed in detail in the commissioning plan and associated documents. The commissioning plan will address the regulatory requirements of Part B: Commissioning of Reactor Facilities of CNSC REGDOC-2.3.1 [R-10] and will include:

- Information on the commissioning organizational structure, including roles and responsibilities;
- The administrative processes that support commissioning such as turnover from construction; system acceptance by operations and the approval to move past the current test phase to the next test phase; and
- An initial list of required safety tests to be completed for each commissioning phase.

OPG has committed to providing the DNNP Commissioning Plan in advance of the start of commissioning activities.

4.4 Safety Analysis

The general nuclear safety objective, which is common within the international community, is that the plant is designed and will be operated in a manner that is protective of the public and environment.

To achieve this objective, the BWRX-300 is designed to comply with the three complementary safety objectives: Radiation Protection, Technical Safety, and Environmental Protection, as identified in CNSC REGDOC-2.5.2 [R-11]. These safety objectives are not independent; their overlap ensures completeness and adds emphasis on their intent.

Radiation Protection Objective

The BWRX-300 is designed to account for the Radiation Protection objective through a comprehensive identification of radiation sources and an appropriately conservative radiological source term. The safety analysis confirms that comprehensive safety features and measures are provided to prevent unplanned exposures and limit occupational exposure during plant operation, maintenance and decommissioning.

Technical Safety Objective

The BWRX-300 is designed to account for the Technical Safety Objective by ensuring that potential radiation doses to the public from Anticipated Operational Occurrences (AOOs) and Design Basis Accidents (DBAs) will not exceed dose acceptance criteria as per CNSC REGDOC-2.5.2. The safety analysis confirms that in the 30-day period after an AOO or DBA, doses would be less than or equal to the following dose limits:

- 0.5 mSv for any AOOs, and
- 20 mSv for any DBAs.

Environmental Protection Objective

The BWRX-300 is designed to account for the Environmental Protection Objective by ensuring that reasonably practical measures are taken to protect the environment during the construction and operation of the reactor facility and to mitigate the consequences of an event. The safety analysis confirms that the design includes effective provisions to limit, control, treat and monitor releases to the environment and minimize the generation of radioactive and hazardous wastes.

The safety analyses are documented in the Preliminary Safety Analysis Report (PSAR) that was submitted as part of the licence to construct application. These analyses will be updated to support a future application for an operating licence.

4.4.1 Safety Strategy

The BWRX-300 is designed for international deployment and, therefore, utilizes standards published by the International Atomic Energy Agency (IAEA) in its safety methodology. The IAEA Safety Standards represent an international consensus on what measures constitute a high level of protection and safety and utilize Defence-in-Depth as the primary means of preventing accidents in a Nuclear Power Plant and mitigating the consequences of accidents if they do occur.

The concept of Defence-in-Depth involves the provision of multiple layers of defence against some undesirable outcome rather than a single, strong defensive layer. In the case of a Nuclear Power Plant, the undesirable outcome is the exposure of workers or the public to radioactivity that exceeds a safe level.

The BWRX-300 Safety Strategy relies on five Defence Lines (DLs) consistent with the IAEA Defence-in-Depth concept and the CNSC REGDOC-2.5.2, 2.4.1 and 2.4.2 requirements.

The objective of the BWRX-300 Safety Strategy is to achieve a design with a high level of safety consistent with the complementary safety objectives. The design is implemented to meet defined safety limits and margins confirmed by performing safety analyses. Results of safety analyses provide feedback regarding the design, and the process is repeated as necessary.

To achieve this, a comprehensive safety assessment is carried out throughout the BWRX-300 design process to ensure that all safety requirements on the design are met throughout all stages of the lifetime of the reactor and to confirm that the design - as delivered, built, operated, and modified - meets requirements for manufacturing and for construction. The safety assessment consists of two main parts:

- The safety analyses which are performed use two complementary methods:
    - Deterministic as per REGDOC 2.4.1 to predict response to postulated initiating events (PIEs) and to verify fulfillment of acceptance criteria; and
    - Probabilistic as per REGDOC 2.4.2 to combine the likelihood of PIEs and potential scenarios and their consequences into estimation of probabilistic safety goals, source terms and risks.

- The assessment of design principles such as the single failure criterion, effectiveness of defence in depth, integrity of multiple barriers, safety classification, protection against internal and external hazards and human factors.

The results of the safety analyses provide feedback to the BWRX-300 design which may be modified until all safety objectives and regulatory requirements are met. The scope and detail of the safety analyses increase as the design matures.

The initial safety analysis is documented in the Preliminary Safety Analysis Report that was submitted as part of the licence to construct application.

The PSAR and associated safety analyses support the following goals:

- Achieving the design intent in the as-built BWRX-300 facility.
- Demonstrating the effectiveness of defence lines
- Achieving a balanced design such that no particular design feature or an event make a disproportionate contribution to the overall risk.
- Meeting the applicable safety goals and regulatory requirements, including public dose limits.

The level of detail of the BWRX-300 design and the safety analysis are progressing in parallel and iteratively, as per guidance of CNSC REGDOC-1.1.2. As they progress further to the completion of the design phased milestones, additional information will be provided to CNSC staff.

4.4.1.1 Defence-in-Depth and Plant States

To achieve a high level of safety, the BWRX-300 design is based on the concept of Defence-in-Depth to compensate for potential human and component failures, and to maintain the effectiveness of the fission product barriers.

The Defence-in-Depth provides a conceptual platform for the effective implementation of the BWRX-300 Fundamental Safety Functions (FSFs):

- Control of reactivity;
- Removal of heat from the fuel (in the reactor, during fuel storage and handling, and including long-term heat removal); and

- Confinement of radioactive materials by shielding against radiation, controlling planned radioactive releases, and limiting accidental radioactive releases.

There are five levels of Defence-in-Depth called Defence Lines (DLs):

- DL1 includes quality measures in the design taken to minimize potential for failures and for initiating events to occur (Note: DL1 does not include plant functions).
- DL2 includes functions to detect and mitigate PIEs to prevent escalation to accident conditions.
- DL3 includes plant functions that detect and mitigate design basis accident frequency PIEs and event sequences, by preventing fuel damage, when possible. Assuring the integrity of the release barriers are maintained, and the plant is maintained in a safe state until normal operations are resumed.
- DL4 is comprised of DL4a and DL4b:
    - DL4a functions detect and mitigate DECs that occur without core damage.
    - DL4b functions detect and mitigate DECs to prevent or mitigate the consequences of severe accidents.
- DL5 involves off-site emergency preparedness measures to protect the public in case a substantial radioactive release occurs (Note: DL5 does not include plant functions).

The safety analysis of the BWRX design evaluates and assesses the challenges to safety of all categories of plant states which are included in the plant design envelope. The BWRX-300 plant states, illustrated by Figure 19, are associated with DLs and are grouped into a limited number of categories primarily on the basis of their frequency of occurrence:

- Anticipated Operational Occurrences (AOOs): A frequency category applied to Postulated Initiating Events (PIE) or event sequences that are expected to occur (frequency greater than 1E-02 per reactor-year).
- Design Basis Accidents (DBAs): The range of conditions and events taken explicitly into account in the design of a nuclear facility, according to

established criteria, such that the facility can withstand this range without exceeding authorized limits (frequency of 1E-02 to 1E-05 per reactor-year).

- Design Extension Conditions: Beyond Design Basis Accidents (BDBAs) and represent the BDBA event sequences that are not practically eliminated (less frequent than 1E-05 per reactor-year).
- Severe Accidents (SAs): involve core damage (are also BDBAs); most of the severe accidents are practically eliminated; however, some DEC severe accidents are considered.

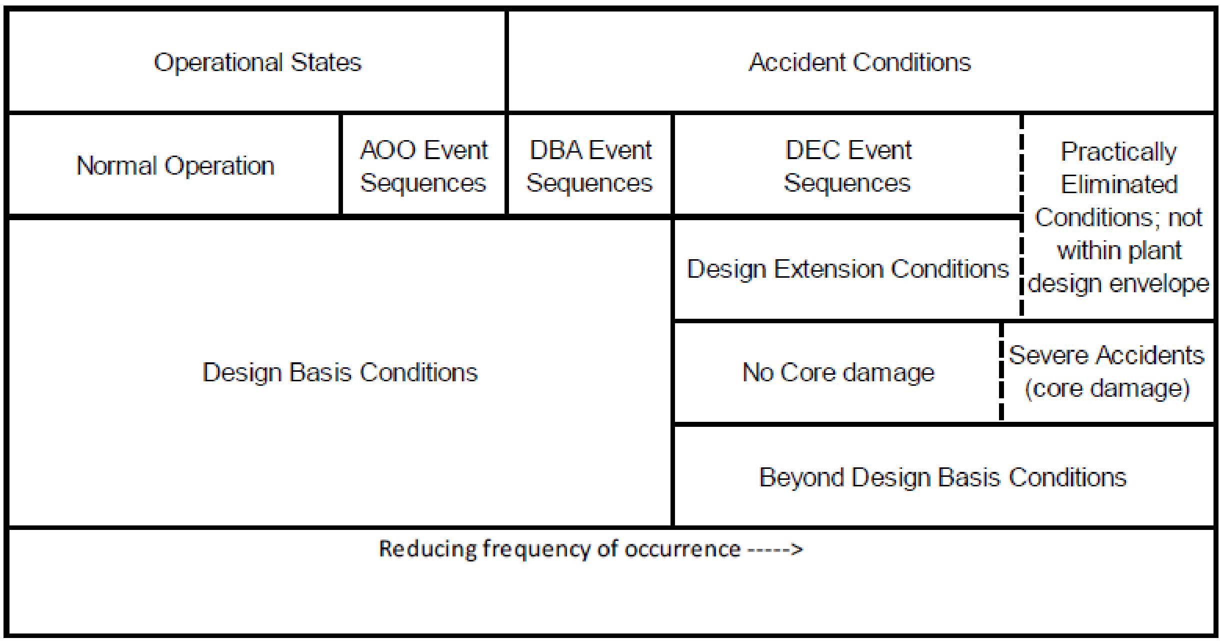


Figure 19: BWRX-300 Plant States

The safety analysis of the BWRX-300 design uses both deterministic and probabilistic assessments to enable the challenges to safety in the various categories of plant states to be evaluated and assessed.

4.4.1.2 Postulated Initiating Events

The design of the BWRX-300 is supported by analysis of a comprehensive set of Postulated Initiating Events (PIEs), and associated failures, such that all foreseeable events identified by either frequency or consequence are anticipated and considered in the design. They include foreseeable failures of the SSCs of the plant, as well as operating errors and possible failures arising from internal and external hazards.

The PIEs are identified based on a combination of deterministic and probabilistic assessments and engineering judgment. Deterministic assessments identify and assess foreseeable events whereas probabilistic assessments predict the frequency and potential consequence of events.

The PIEs are evaluated, categorized, and grouped during the event evaluation in the deterministic selection stage. Event sequences are allocated to three types of deterministic assessment: Baseline, Conservative and Extended. A bounding set of PIEs and event sequences, which result in the most significant challenge to the FSFs, are selected for deterministic evaluation. Both the PIEs and event sequences, which are relevant to core damage and radionuclide releases outside containment, are examined in the Probabilistic Safety Assessment (PSA).

4.4.1.3 Deterministic Safety Analysis

The Deterministic Safety Analysis (DSA) is a structured review of the safety performance of the plant, including its Structures, Systems (safety and operating), and Components, and its personnel and management under a wide spectrum of postulated event sequences.

The DSA is intended to demonstrate the effectiveness of Defence-in-Depth to provide assurance that barriers to the release of radioactive material will maintain their integrity to the extent required. The DSA is also performed to demonstrate that the complementary design features are capable of coping with DECs. Supplemented by further specific information and assessments (e.g., fabrication, testing, inspection, and operating experience) and the probabilistic assessment, the DSA contributes to demonstrating that the potential radiological consequences of different plant states are acceptable.

As described in the LTC application, the BWRX-300 DSA is performed for the Baseline, Conservative and Extended assessment categories. The primary objectives are:

- Baseline - demonstrates the effectiveness of the DL2 functions to mitigate AOOs and prevent progression to accident conditions without relying on DL3 functions. The assessment is performed to demonstrate that an event meets established acceptance criteria, including the public dose limits. The endpoint of the analysis is a controlled stable state with no damage to Structures, Systems, and Components.

- Conservative - demonstrates the effectiveness of DL3 functions without relying on any other level of defence. The assessment is performed using conservative initial plant conditions with established acceptance criteria, including the public dose limits. The endpoint of the analysis is a controlled stable state and preservation of integrity of fission product barriers.

- Extended - assesses the effectiveness of DL4a functions for DECs to demonstrate conformance to safety goals. The endpoint of the analysis is to demonstrate achievable stable shutdown conditions for the event sequence.

Acceptance criteria are used to evaluate the capability of the BWRX-300 design to prevent a more serious plant condition following an event, and to prevent consequential loss of function of the safety systems needed to mitigate the consequences of an accident.

Acceptance criteria include:

- A set of safety limits that relates directly to the radiological consequences of operational states or accident conditions, or to the integrity of barriers.

- A set of design limits consistent with the key physical parameters for each item important to safety (preconditions for meeting the safety criteria).

Acceptance Criteria have two components: qualitative and quantitative. Qualitative acceptance criteria are defined as safety goals while quantitative acceptance criteria are based on direct physical evidence and well-understood phenomena.

The DSA of the BWRX-300 design is conducted in accordance with the requirements of CNSC REGDOC-2.4.1 [R-12]. The predicted doses meet the dose acceptance criteria for AOOs and DBAs, which are specified in CNSC REGDOC-2.5.2, and the corresponding derived acceptance criteria specified in CNSC REGDOC-2.4.1.

Compliance with these requirements shows that physical barriers are assessed to be effective in limiting the release of radioactive material and preventing unacceptable radiological releases following AOOs or DBAs. DECs do not have specific radiological acceptance criteria (the effects of DEC events are considered in the probabilistic safety assessment).

4.4.1.4 Hazard Analysis

The primary objective of the BWRX-300 hazard analysis is to identify hazards with potential challenge to one or more FSFs and to identify where PSAs are required. There are four types of hazard evaluations that are performed for the BWRX-300 design: functional failure of plant systems or equipment, external hazard evaluation, internal hazard evaluation, and erroneous decisions or human action(s) that lead to an unplanned plant transient. Additionally, credible potential combinations of the external hazards and the potential interaction of external and internal hazards are considered.

Functional failures of plant systems or equipment with potential to cause a challenge to a FSF are considered in the Hazard Evaluation. These hazards are identified in Failure Modes and Effects Analyses (FMEAs) performed on the plant's systems as part of the design process and serve as input to the Functional Failure Hazards Evaluation (FFHE). Unlike the other three types of hazards discussed below, functional failure (i.e., equipment failures) are generally PIEs, rather than hazards that lead to PIEs. The FFHE is limited to random single failures and to common cause failures. The system FMEAs are reviewed to identify such failures that cause challenges to FSFs, and a consolidated list of such failures from all system FMEAs is generated and organized.

External Hazards

External Hazards originate from a source that is not under control of the nuclear power plant licence holder (the hazard source is not a part of the licensed nuclear plant site). External hazards include both natural and human induced hazards. The External Hazards Evaluation addresses both individual hazard sources and combinations of sources. Examples of natural external hazards include earthquakes, droughts, floods, high winds, tornadoes, tsunami, and extreme meteorological conditions. Examples of human induced external hazards include potential release of toxic gases from adjacent facilities, aircraft crashes and ship collisions.

Internal Hazards

Internal Hazards originate within the boundaries of the site and with potential to indirectly lead to an unplanned plant transient. The following types of internal hazards are typically considered: fires, explosions, projectiles from rotating or pressurized equipment, collapse of structures/falling objects, pipe whip, jet effects, flooding, electromagnetic interference and human operational hazards.

The internal hazard condition does not directly challenge an FSF, but the effects of the hazard may cause equipment failures that do. For example, a break in fire water piping near a plant electrical equipment room is considered an internal hazard. The broken pipe or the depletion of the fire water supply does not directly challenge an FSF; the reactor could continue operating undisturbed even if the fire water tank was empty. However, the water released into the electrical equipment room could cause short circuits or other failures of the electrical equipment. These electrical failures could then cause a pump trip or reposition a valve that might initiate a challenge to an FSF.

The example above contrasts with a broken pipe in a system directly involved in the plant's nuclear or power generation processes. In this case, depletion of a fluid through the break may directly cause a challenge to an FSF. This sequence represents a functional failure hazard not an internal hazard.

Human Operation Hazards

Human Operation Hazards include failures that involve an erroneous decision or action taken by a human that can lead to an unplanned plant transient. These primarily involve erroneous decisions or actions by operators to change the state of plant equipment from a designated control location; and erroneous decisions or actions by maintenance personnel during a planned maintenance activity resulting in an unintended state-change of plant equipment. Because human hazards manifest as improper state-changes of plant equipment, many human operation hazards produce the same effects as a failure of the corresponding equipment and the effects of such failures are already included in the FFHE.

Qualitative and quantitative criteria are applied to screen out potential hazards that pose no credible adverse consequence to the safe operation. The hazard analysis considers all plant states to establish a comprehensive set of PIEs.

4.4.1.5 Probabilistic Safety Assessment

The Probabilistic Safety Assessment (PSA) provides an integrated review of the plant design operational safety and complements the results of the deterministic analyses. The PSA assesses design vulnerabilities and optimizes the design using a graded approach consistent with REGDCO 2.4.2. The PSA starts with a comprehensive hazard identification and assessment and involves the identification of initiating events, strategies for prevention and mitigation measures.

The PSA is divided into two levels, depending on the scope of the analysis:

- Level 1 provides an assessment of plant design and operation and calculates the probabilities of sequences that could lead to core damage.
- Level 2 provides an assessment of core damage accidents and calculates the probabilities and magnitude of accidental radioactive releases.

The corresponding quantitative safety goals established in CNSC REGDOC-2.5.2 are:

- Core Damage Frequency (CDF): The sum of frequencies of all event sequences that can lead to significant core degradation shall be less than 10^{-5} per reactor year.
- Small Release Frequency (SRF): The sum of frequencies of all event sequences that can lead to any release to the environment that requires temporary evacuation of the local population or a release to the environment of more than 10^{15} becquerels of iodine-131 shall be less than 10^{-5} per reactor year.
- Large Release Frequency (LRF): The sum of frequencies of all event sequences that can lead to any release to the environment that requires long-term relocation of the population or a release to the environment of more than 10^{14} becquerels of cesium-137 shall be less than 10^{-6} per reactor year.

The PSA results demonstrate that the BWRX-300 design meets these safety goals with significant margins. The PSA was performed in accordance with the requirements of CNSC REGDOC-2.4.2 [R-13]. The preliminary LRF estimates shown in Figure 20 demonstrate that the LRF is well bounded by the Safety Goals.

The PSA continues to evolve with design by incorporating resultant changes as well as operational insights.

PSA Events	Large Release Frequency (LRF) per year
Internal Events At-Power	1.8E-09
Internal Events Low Power and Shutdown (LPSD)	7.0E-10
Seismic Event	4.8E-08
High Wind Event	4.3E-09 (Straight Wind) 1.3E-10 (Tornado)
Internal Fire	1.3E-08
Internal Flood	5.5E-10
Spent Fuel Pool	1.3E-08
Fuel and Heavy Load Movements	5.7E-09
Fuel Pool Events	1.3E-08
Safety Goal (REGDOC-2.5.2)	**1E-06**

Figure 20: DNNP BWRX-300 Preliminary PSA Results Severe Accident Analysis

Severe Accidents (SA) represent a subset of Beyond Design Basis Accidents (BDBAs) which are less frequent than DBAs. The objective of SA analysis is to identify and characterize accidents that can lead to significant core damage and/or offsite releases of radioactive material and, if reasonably practicable, define measures to mitigate or eliminate the possibility of certain conditions arising that could lead to early or large radioactive releases.

The SA analysis of the BWRX-300 design is performed as part of the PSA and will continue to evolve commensurate with the available design information. This process is iterative and, as the project advances through the detailed design phase, the analysis will be further refined and validated to demonstrate balanced design with very low overall risk.

The SA analysis of the BWRX-300 design is performed in accordance with CNSC REGDOC-2.5.2, REGDOC-2.4.1, and REGDOC-2.4.2.

The SA analysis results will also be used in developing the accident management programs, as per the requirements of CNSC REGDOC-2.3.2 [R-14], and emergency preparedness planning for the BWRX-300 facility.

4.4.1.6 Accident Management

Event mitigation is a set of actions taken during an accident to prevent the escalation of the accident, mitigate the consequences of the accident, transition into event recovery, and to achieve a long-term safe stable state after the accident. In such circumstances, engineered safety features would act to confine any radioactive material released from the core so that discharges to the environment would be minimal. These engineered safety features include physical barriers, some of which have the single purpose of confining radioactive material.

Accident management includes preplanned and ad-hoc operational practices which, in circumstances in which the design specifications of the plant are exceeded, would make optimum use of existing plant equipment to restore control.

OPG's approach to accident management is:

- Preventive accident management integrates actions and measures needed to prevent SAs from progressing to more severe conditions, including core damage. This is usually accomplished by available equipment, procedures and guidelines.
- Mitigative accident management, often referred to as severe accident management, is primarily devoted to maintaining the integrity of the containment and minimizing the release of radioactive materials.

The BWRX-300 DSA examines the event sequences for AOOs and DBAs to ensure that the credited safety functions are effective in stopping the event progression. Event mitigation is also considered in the PSA to identify potential plant vulnerabilities and design improvements to reduce the probability of severe accidents, or should an accident occur, mitigate the consequences.

Commensurate with the current level of design coupled with preplanned and ad-hoc operational practices which would be defined as part of a future operating licence, OPG has concluded that the accident management will effectively achieve a long-term safe stable state of the BWRX-300 following an accident, as per CNSC REGDOC 2.3.2.

4.5 Physical Design

The LTC application includes a general description of the physical design of the BWRX-300 (a conceptual cross view of the Reactor Building is shown in Figure 21), and the design practices informed by the safety strategy and concepts. The application also includes a description of OPG's design program, management, and oversight that are implemented in accordance with the requirements of CSA N286.2 [R-15] and CNSC REGDOC-2.5.2.

As discussed in the previous section, the BWRX-300 is designed to comply with the three complementary safety objectives: Radiation Protection, Technical Safety, and Environmental Protection. The BWRX-300 design strategy is to achieve a high-level of safety, reliability and maintainability.

As detailed in the previous section, comprehensive safety assessment is carried out to evaluate the safety performance and capability of the various plant systems and components under all conditions (i.e. normal, anticipated occurrences and accidents) to demonstrate that the BWRX-300 will meet the required level of safety.

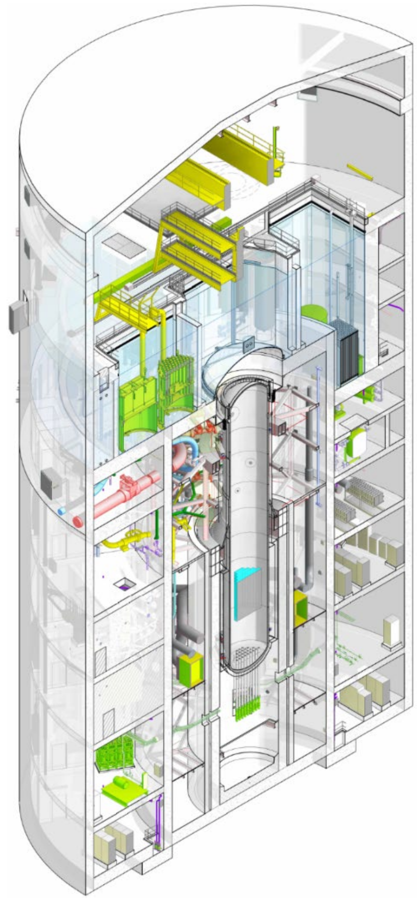


Figure 21: Conceptual Cross-Section of Reactor Building

4.5.1 General Design Approach

The BWRX-300 design is conducted in an iterative phased process. The initial phase starts by establishing design requirements from product, facility owner and regulations. To establish plant level requirements. These plant requirements are used to define system requirements and finally component requirements, with validation at each level to ensure that the specified requirements are satisfied in the design. This approach ensures that issues are identified and addressed early in the design. In parallel with the establishment of design requirements, a high-level conceptual design is generated and forms the basis for the iterative design process. This conceptual design is based on previous BWR design, operating experience, and research and development. Targeted deterministic and probabilistic safety evaluations are performed to provide guidance on the design and to inform the selection of requirements and design concepts.

The next phase of the design focuses on developing the specific design definition of primary structures, systems and components. Technical reviews are conducted to confirm the adequacy of design requirements and objectives. System interfaces are established and an integrated design model and baseline DSA, and PSA are developed with consideration of plant-level requirements, interfacing systems and the overall plant operational concept.

The third phase of design concerns the effort to progress the design in preparation for construction planning, detailed component design, and support for equipment procurement required at this stage of design.

The final design phase focuses on finalization of all remaining system and component design in preparation for construction activities. The remaining equipment specifications are finalized for procurement. Updates may be needed to component specifications and datasheets based on feedback from selected vendors, and these are evaluated for application to the design.

It is important to note that the design of individual systems, and in some cases components, progress through the design phases at different paces. Design control is applied throughout the BWRX-300 engineering design process and complies with GE Hitachi Nuclear Energy Quality Assurance Program Description and GEH implementing procedures. OPG conducts intrusive oversight of the execution of the design process. This process allows some systems to progress to final design and ready for construction while others are still under design. As an example, much of the Civil Structures will be ready for construction in advance of some Instrumentation and Control Systems.

Technical reviews and design document generation are executed throughout each design phase. These technical reviews include all disciplines and, in addition to a review of the system requirements and design, also consider topics such as constructability, reliability, maintainability, and human factors.

The LTC Application, including the PSAR and other supporting documentation demonstrates that the regulatory requirements are satisfied commensurate with the stage of design and continue to be confirmed as part of the design process, some specific design and safety analysis deliverables have been committed to CNSC staff as future deliverables once the detailed design is complete. OPG will ensure that all commitments made during the LTC Application review are completed prior to the start of the relevant construction activities under a Licence to Construct.

Through iterations of both the Plant Integrated Model (including physical, hydraulic, control and electrical models) and the Analyses (consisting of Deterministic Safety Models, Probabilistic Safety analysis Models and validated against ALARA and Human Factors principles), issues such as incompatible systems are identified early in the design process.

As an example, early in the design process the models utilize conservative assumptions related to system design and are used to determine key design parameters, such as instrument setpoints. Later in the design process, the models incorporate final system design and are used to validate plant and system design. Throughout this progression, iterative human factors analyses are performed to both provide input to and review the DSA and PSA, as well as to generate analysis-based Human Factors Engineering (HFE) requirements for input to the design.

The behaviour of the BWRX-300 is analysed under a wide range of conditions that the plant must withstand without unacceptable damage. Consideration is given to accidents beyond the design basis to ensure that early or large releases will be prevented, minimized or mitigated.

This assessment provides information that forms the basis for the decision on whether the overall safety and specific aspects of the physical design are satisfactory. The design and safety assessment are thus a part of the same process which will continue until a desired design solution, meeting all relevant safety requirements, has been reached.

The facility design is based on engineering practices that are proven by testing and experience and comply with applicable codes, standards and other appropriately documented statements.

The BWRX-300 SSCs are conservatively designed, constructed, and tested to quality standards commensurate with the safety objectives. Design and operational safety margins are considered to ensure the overall safety and reliability of the plant. Approved codes and standards are used, whose sufficiency and applicability have been assessed, and which have been supplemented or modified if necessary.

4.5.2 Regulatory Documents, Codes and Standards

Regulatory documents, codes and standards were reviewed and evaluated to determine their applicability to the BWRX-300 technology. The results of this evaluation were reviewed and concurred with by CNSC staff.

Variances, such as codes and standards that differ from those used in Canada, and cases where regulatory documents, codes and standards are not met directly were identified. The safety significance of the variances was assessed to confirm that the intent of requirements are met and the overall level of safety of the BWRX-300 design is preserved.

All code variances are submitted to the CNSC staff for approval. The safety significant variances that have been identified are described below.

Compliance to CSA Pressure Boundary Requirements

Pressure or fluid retaining SSCs are required to comply with the requirements of CSA N285.0 [R-16] which was developed specifically for the CANDU plants. Consequently, certain elements of this standard are not directly applicable to the BWRX-300 design which is addressed through deviations and variances submitted to CNSC for approval.

OPG has submitted to the CNSC the variances for classification of pressure boundary SSCs for the BWRX-300. These variances apply to all pressure retaining systems, components and supports.

Compliance to CSA Requirements for Containment Structures

CSA N287.3 [R-17] permits the use of alternative design methods for the design of concrete containments in Canada. The BWRX-300 Steel-Plate Composite Containment Vessel is constructed using an advanced, innovative Diaphragm Plate Steel Composite system to facilitate modular construction. Current available codes and standards do not include specific provisions for DPSC.

The BWRX-300 containment is designed according to the specifications developed based on analytical and engineering principles and experimental test results which confirm that the design methods are conservative. Aging management requirements for the Reactor Building and DPSC are also defined. These requirements will inform the in-service inspection and testing program that will ensure the RB can fulfill its intended functions throughout its design service life.

The information in the LTC application as well as its supporting documents, submitted to CNSC, demonstrates that the BWRX-300 containment design has a level of safety and performance equivalent to that set by CSA N287.3 and meets or exceeds the relevant requirements in REGDOC-2.5.2.

4.5.3 Safety classification of Structures, Systems and Components

The design principles of independence, diversity, separation, and redundancy are applied to safety systems of the BWRX-300 through the safety classification of SSCs, ensuring high reliability, reduced common cause failures and fail-safe operation, which in turn ensures that any failure places the system or component in a safe state. It also establishes a graded approach in the selection of materials, and application of codes and standards used in design, manufacturing, construction, testing and inspection of individual SSCs.

The BWRX-300 approach to classifying SSCs is consistent with IAEA SSR-2/1 [R-18] and IAEA SSG-30, Safety Classification of Structures, Systems and Components in Nuclear Power Plants [R-19].

The BWRX-300 approach to classifying the safety class of SSCs is based primarily on deterministic methods and is directly traceable to their respective safety functions. This approach addresses:

- The consequences of the SSC's failure to perform its safety functions.
- The expected frequency of the SSC being called upon to perform its safety functions.
- The time following a postulated initial event at which, or the period for which, the SSC may be called upon to perform a safety function.

A fundamental element of the BWRX-300 SSC classification approach is the direct correlation between the DLs in which an SSC performs a function, and the relative safety importance of that function. Functions are categorized into three safety categories, Safety Category 1, Safety Category 2, and Safety Category 3, with Safety Category 1 being the most important.

Primary functions are those that directly perform the FSFs in support of DL2, DL3, DL4a, or DL4b. Safety Categories are applied to the primary functions as follows:

1. Safety Category 1 is assigned to DL3 primary functions. DL3 functions assure the integrity of the barriers to release, provide the ability to place and maintain the plant in a safe state, and provide independence and diversity for all DL2 and DL4a functions caused by a single failure (and many CCFs). Accordingly, DL3 primary functions are the most important from a safety standpoint.
2. Safety Category 2 is assigned to DL4a primary functions. Both DL2 and DL4a provide a redundant means to address PIEs (generally independent of DL3 functions) and are therefore important from a safety standpoint, although less important than DL3 functions. DL4a functions are a backup to DL3 functions, in the unlikely event a DL3 functions fails, and therefore have a higher consequence of failure than DL2 functions and are more important from a safety standpoint than DL2 functions.
3. Safety Category 3 is assigned to DL2 and DL4b primary functions as they are relatively the least important. DL4b functions address severe accidents, which

are extremely unlikely because failure of both DL3 and DL2 or DL4a functions would have to occur. Accordingly, DL4b functions are considered relatively the least important defence line functions, despite the high consequence of failure.

4. Non-Safety Category is assigned to all other functions.

Components that are required to perform multiple functions with different safety categories are assigned to a safety category based on the highest safety category of any of the functions they perform.

4.5.4 Design Considerations

The Concept of Break Exclusion Zone (BEZ)

In accordance with REGDOC 2.5.2, all pressure retaining piping inside and outside containment in the BWRX-300 is designed to limit stresses and deformation during and after PIEs. In addition, piping is designed to minimize flaws in pressure boundary and to facilitate inspections during the entire operational life.

To address these requirements for high energy piping, the concept of the Break Exclusion Zone is applied to high and moderate energy piping penetrating containment, including a short extension up to the seismic interface restraints outside containment. This approach was originally developed to address breaks that could not be isolated in high energy piping in light water reactors.

The methodology of BEZ includes the following:

- Stress and cumulative fatigue usage factor limits are more stringent than usually required by American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section III [R-20].
- Piping is fabricated and installed to higher quality requirements with the objective of minimizing the number of welds.
- The piping and welds are inspected throughout the operational life of the facility.

BEZ methodology, which is applied to all phases of design and fabrication of BWRX-300 pressure retaining piping, combined with augmented in-service inspections significantly reduces the potential for pipe breaks. This eliminates the concern of dynamic effects from high energy line breaks in those sections of piping in containment, thus reducing the likelihood of unisolable breaks.

Human factors

The high-level goal of the BWRX-300 Human Factors Engineering program plan is to specify a proportionate, integrated, and effective Human Factors program for all phases of the reactor lifecycle that reduces the risks and consequences influenced by human interactions, as far as reasonably achievable. The program includes all elements of planning, analyses, design guidance, job design, verification, and validation to ensure that the human factors considerations have been effectively integrated in the design process.

HFE uses a graded approach to provide the appropriate focus for analysis and design with regards to human interactions within the systems. The grading of human actions for the BWRX-300 project is based on three risk categories of nuclear safety, personnel safety, and asset protection.

HFE inputs to the design incorporate considerations for maintenance, inspection, access and egress, labels and signs, and workplace design to address the design of working areas and environments.

Radiation Protection

The objective for BWRX-300 radiation protection is to keep radiation exposures within regulatory limits and As Low As Reasonably Achievable (ALARA), while accounting for social and economic factors.

General design considerations and methods employed to maintain in-plant radiation exposures ALARA include reducing the necessity and amount of time spent in radiation areas for personnel, reducing radiation levels in routinely occupied plant areas, and controlling contamination.

Operating experience and safety research

The design relevant operating experience and research have been, and will be, considered during all phases of the BWRX-300 design, construction, commissioning, operation (including maintenance) and decommissioning.

In developing the BWRX-300 design, over 60 years of operational experience, testing and experimental benchmarking of functional compliance has been applied in choosing the design safety functional features.

As the Design Authority, GEH has established provisions for the incorporation of operating experience through Integrated Management Systems with oversight by OPG.

Industry Incident Reviews

As described in the LTC application, station blackout events have historically been the most demanding for BWRs to withstand and have usually been the dominant sequence for severe accident scenarios.

The BWRX-300 design carries forward the passive ICS and containment cooling concepts from the Economic Simplified Boiling Water Reactor (ESBWR). The systems that support FSF and plant monitoring are designed to operate for a period of 72 hours, without AC power, and without an intake structure that normally provides cooling water.

The ICS capacity is designed such that decay heat removal can be sustained for up to 7 days with no reliance on significant operator action, after which alternate water makeup sources (e.g., flexible mitigation/EME) can be used to refill the pools.

The Passive Containment Cooling System is designed to passively limit containment pressure and temperature by transferring heat to the equipment pool. The demonstration of plant safety functions during a beyond design basis external event such as an earthquake that creates these conditions is typically part of the diverse and flexible coping strategies that form the basis for compliance of regulatory requirements.

In April 2012, the Institute of Nuclear Power Operations (INPO) conducted an independent review of the Fukushima nuclear accident with the purpose of identifying operational and organizational lessons learned from the accident. The BWRX-300 incorporates lessons learned from Fukushima by designing for Design Extension Conditions.

Robustness against malevolent acts

The BWRX-300 design provides physical features to ensure the facility is protected against malevolent acts to prevent potential release of radioactivity or energy to the public and environment.

The BWRX-300 development includes a security by design approach from the early stages of design that uses sound engineering principles to demonstrate that within an acceptable margin of confidence sufficient capabilities are available to perform the above functions over a wide range of threats.

The details of the design relating to security systems and structures are considered Prescribed Information and as such were provided directly to CNSC Staff for review.

Safeguards in plant design

The facility design incorporates all necessary features to comply with Canada's obligations arising from the safeguards agreement between Canada and the IAEA.

These features have been described in the Design Information Questionnaire which was prepared by OPG and has been submitted to the IAEA through the CNSC.

Control of foreign material

Foreign material refers to any objects that are not intended to be present within a system. These objects can be introduced from different sources such as maintenance activities (e.g., tools and materials) or component degradation (e.g., failure of a sub-component such as a gasket that is then spread throughout a system).

The BWRX-300 design will provide for the detection, exclusion, and removal of foreign material and corrosion products that may cause component or system damage or may have an impact on safety. Foreign material will be controlled by measures such as filters and strainers at designated locations and identified via instrumentation to detect changes in system pressure and flow.

Design for reliability

Designing for reliability has been incorporated into the BWRX-300 design in consideration of:

- Reliability assessment methods;
- Design principles and features supporting reliability;
- Common cause failures;
- Single failure criterion;
- Fail-safe design;
- Allowance for equipment outages;
- Shared systems; and
- Aging-related considerations.

The BWRX-300 Reliability Program is used to ensure that all systems important to safety function reliably and in accordance with design and performance criteria.

Through application of this program, OPG assures compliance with applicable requirements of CNSC REGDOC-1.1.2, REGDOC-2.5.2 and REGDOC-2.6.1 [R-21].

Equipment Qualification

Equipment Qualification requirements applied to the BWRX-300 consider all operating and accident conditions in which the safety related SSCs are expected to operate in accordance with the equipment classification. This includes conditions arising from maintenance, testing and internal and external hazards.

The objective of the Equipment Qualification program is to assure that all applicable SSCs, equipment and protective barriers are qualified to perform their safety functions under the environmental conditions defined by design basis accidents.

Seismic Qualification

The design of the BWRX-300 facility protects building structures and the SSCs of the facility from earthquake damage. The seismic qualification also includes the determination of seismic categories of SSCs by safety classifications and the associated methodologies, tests and analyses.

Climate Change

The design of the DNNP facility must be resilient against projected changes in climate that are caused by anthropogenic greenhouse gas emissions and large-scale transformation of land use. Extreme weather events are a focus in the nuclear industry, and as such, understanding how climate change will impact these events is important. Beyond the immediate business needs that drive climate resiliency, external regulatory drivers, project regulatory commitments and internal governance drivers also provide expectations on how climate change should be considered.

One of the project commitments is to perform a systematic climate change risk assessment of the proposed DNNP facility. This work is being completed over two phases, referred to as Phase 1 and Phase 2. In Phase 1 of its assessment, climate change hazards, bounding values, and potentially vulnerable Structures, Systems and Components were identified. OPG completed the Phase 1 scope of work and submitted it to CNSC. Phase 2 of the assessment takes the list of potentially vulnerable SSCs from Phase 1 and develops risk treatments. These risk treatments may include adaptive action where design changes are made. They may also include monitoring plans for instances where immediate adaptive action is not justified.

Operability and maintainability

Operability is a primary consideration in the BWRX-300 safety analysis and design. It provides insights for establishing design criteria and Operating Limits and Conditions (OLCs) that meet applicable codes, standards and regulatory requirements to ensure the ongoing operability of safety critical systems for different plant states.

Maintainability is built into the BWRX-300 design by defining primary requirements for in-service monitoring, tests, maintenance, repairs and inspections to ensure they have been followed. These requirements include accessibility, ALARA, aging management, testing and maintenance.

Operating Limits and Conditions

A set of operational limits and conditions is defined to identify safe boundaries for plant operation. Minimum requirements are also set for the availability of staff and equipment.

Operating Envelope and OLCs ensure compliance with the safety analysis. OLCs include safety analysis and safe operating limits, conditions of operability, actions and action times, and surveillance requirements. This approach is consistent with the relevant requirements in CNSC REGDOC-2.5.2.

4.5.5 Design Management

Design development, technical reviews, design changes and configuration control are executed throughout each design phase, providing a high level of confidence that all relevant safety requirements are met. The design approach includes:

- Comprehensive, collaborative, and iterative design process;
- Conformity to the design basis throughout construction and commissioning;
- Rigorous procedures and requirements;
- Documented and controlled processes and tools;
- Effective change control and configuration management; and
- Evolutionary development process.

In addition, the BWRX-300 design, construction, commissioning and operation are routinely assessed from the perspective of prevailing modern standards and international practice to achieve the highest level of safety as reasonably practicable.

GEH will maintain the Design Authority for the BWRX-300 up to plant start-up. OPG will be an informed customer, providing owner oversight and operator inputs. OPG's role includes reviews and acceptance of design deliverables as well as surveillance and witnessing of engineering activities performed by GEH and the other contract partners in accordance with their respective management systems. This ensures that engineering design deliverables and other work by the contract partners meet all applicable requirements and specifications throughout procurement, construction and commissioning phases, and there is early detection of potential issues so that corrective measures can be taken at the appropriate time.

OPG also ensures that GEH meets the design objective and requirements of CNSC REGDOC-2.5.2 using a graded approach to the design, procurement, construction and commissioning phases. A turnover strategy will describe the transition of the Design Authority to OPG that will occur prior to start up.

4.5.5.1 Design Changes and Configuration Control

The physical design of the BWRX-300 continues to progress following a systematic iterative process using safety analyses to inform the design as it progresses to detailed design. The BWRX-300 design configuration will be maintained throughout the entire plant lifecycle by programmatic configuration and change control processes overseen by the Design Authority. Throughout this process, OPG will act as an informed customer to ensure that design changes are adequately controlled.

Regardless of the scope, all changes that impact the BWRX-300 design basis and/or safety analysis are managed, tracked, and communicated to the CNSC on a quarterly basis. The changes are controlled through the rigorous engineering change control and review process and only authorized once the total impact is considered.

4.6 Fitness for Service

Fitness for Service covers the activities that impact the physical condition of SSC to ensure that they will remain available, reliable, effective and consistent with design, analysis and quality control measures throughout the life of facility. This is accomplished by implementation of processes that establish SSC requirements and practices in the following areas:

- Reliability;
- Maintenance;
- Aging Management;
- Chemistry Control; and
- Periodic and In-Service Inspection.

These areas are addressed through compliance with the applicable laws, regulations, codes and standards. Fitness for Service considerations are incorporated into design as described in section 4.5. The details for the Fitness for Service governance covering these areas during operation will be addressed as part of a future operating licence application.

4.7 Radiation Protection

4.7.1 Radiation Protection during the Construction Phase

The proposed licenced activities do not include the possession and use of nuclear substances, so construction activities covered by this licence are not expected to result in radiation doses to workers or the public. The radiation doses to DNNP workers from the Darlington Nuclear Generating Station and the Darlington Waste Management Facility continue to be well below the regulatory dose limit for members of the public as confirmed by the monitoring programs established for their respective licences.

Radioactive sources, such as those used by contract companies in nuclear gauges and exposure devices, may be required at the DNNP site during the construction phase. These are licensed separately by the CNSC and used in accordance with the respective licensee's CNSC-approved radiation protection program to ensure the safety of workers and the public.

4.7.2 Radiation Protection in the BWRX-300 Design

The BWRX-300 design strategy is intended to ensure that radiation doses are kept below the regulatory limits and ALARA taking into account social and economic factors. ALARA principles are being incorporated into the design based on the regulatory requirements, industry standards and operating experience.

Examples of ALARA design considerations include reducing the amount of personnel time required in radiation areas (e.g. remote operations of plant equipment) and reducing radiation levels in routinely occupied plant areas (e.g. efficient removal of radioactivity from the reactor coolant using filters and demineralizers).

Some of the radiation sources found at other BWRs, such as reactor vessel recirculation pumps, are not present in the relatively simple and passive BWRX-300 design, which is expected to result in less occupational dose during operations and maintenance.

Preliminary radiation zones based on anticipated occupancy times and dose rates during full power operation and shutdown conditions have been established for the BWRX-300 plant layout. These design dose rates have been estimated based on operating experience and are being used as a comparison for the shielding design calculations and to estimate collective occupational exposures.

4.7.3 The Operational Radiation Protection Program

The future radiation protection program for DNNP will provide the necessary oversight and control to ensure occupational and public exposure to radiation during operations remains ALARA, taking into account social and economic factors. Per regulatory requirements, the radiation protection program will also include a set of action levels for radiation doses or other parameters that, if reached, may indicate a loss of control of part of the program and trigger a requirement for specific action to be taken.

The following will be included in the future radiation protection program for DNNP:

- Management control over work practices;
- Personnel qualification and training;
- Control of occupational and public exposure to radiation;
- Planning for unusual situations;
- Organization and administration for radiation protection
- Radiation protection training and qualification
- Classification of radiation zones
- Radiation exposure and dose control
- Worker dose management
- Radiation protection equipment and instrumentation
- Contamination control
- Radiation protection program oversight
- Dose to the public

4.7.4 Projected BWRX-300 Occupational Exposures

Based on the BWRX-300 conceptual design, the annual collective occupational dose during the operations phase is estimated to be approximately 490 person-mSv. This estimate is less than the 1 person-Sv annual collective dose target OPG established for this reactor, due to the design features that support the ALARA principle. It is also relatively low compared to typical annual collective doses at currently operating BWRs and is expected to be further reduced as additional design details are confirmed. Individual doses will be maintained below the regulatory dose limits for Nuclear Energy Workers and will be estimated prior to the operations phase when information such as anticipated staffing levels is established.

4.8 Conventional Health and Safety

OPG applies a rigorous and effective safety management system to protect personnel by managing workplace health and safety and the non-radiological hazards within the workplace.

Under OPG's Health and Safety Management System, workers are expected to adhere to all applicable health and safety legislation and relevant regulations. Additionally, under safety training standards, the Health and Safety Management System incorporates provisions that necessitate contractors to meet all prescribed safety training standards, including those outlined in Occupational Health and Safety Awareness and Training (O. Reg. 297/13). These measures underscore OPG's commitment to ensuring a safe and compliant working environment.

While OPG will maintain overall responsibility for safety under the proposed licence, the lead contractor for construction will assume the role of constructor under the Occupational Health and Safety Act (OHSA)[R-22].

OPG will enable the constructor to determine the means, methods and procedures for project execution, while outlining necessary requirements in the contract specifications. OPG will provide oversight to ensure that the project complies with legislative and regulatory standards. OPG and contractors will manage the health and safety of workers associated with the DNNP as per the DNNP health and safety plan.

The constructor will have a risk management process in place to identify, assess and control associated risks. The constructor is required to have their own Corrective Action Program which will be used to correct adverse conditions and to manage risks effectively. The constructor's management team will provide sufficient oversight to confirm that their corrective action program is rigorously followed. Problems will be identified, documented, and evaluated/corrected based on significance with measures in place to prevent re-occurrence.

OPG, as the owner, will perform field assessments during the contract execution to confirm compliance with contractual terms, conditions and the constructor's project-specific plans. OPG will document and communicate any non-conformance observed to the constructor.

Safety event reporting requirements have been established and communicated to the Constructor. Safety events and non-conformances meeting the defined thresholds will be reported to the CNSC as per CNSC REGDOC 3.1.1 [R-23].

4.9 Environmental Protection

OPG has a robust and mature environmental protection program in place for the DN site to ensure effective oversight and control to minimize environmental releases and promote continued protection of the environment while meeting all regulatory requirements.

The construction activities under the proposed DNNP licence that present potential environmental hazards include heavy equipment operations and groundworks, construction of the water intake/discharge structure for the CWS, construction of shoreline protection, construction of the reactor embedment and management of hazardous wastes. The monitoring and evaluation of environmental parameters such as dust, noise and groundwater impacts and the implementation of mitigation measures and beneficial actions help ensure the protection of terrestrial and aquatic species and their habitat.

The proposed licenced activities do not include the possession and use of nuclear substances, so construction activities covered by this licence are not expected to result in any radiological risks to the environment.

OPG has an established Environmental Management System (EMS), which is certified to the International Organization for Standardization (ISO) 14001 Environmental Management System Standard [R-24]and implements the requirements of OPG's Environmental Policy.

The Environmental Policy states that OPG shall meet compliance obligations, including any environmental commitments that it makes, with the objective of exceeding these compliance obligations where it makes business sense.

The EMS uses a risk-based approach to identify and assess areas of concern with respect to environmental management and ensures that activities are conducted in a manner that prevents or mitigates adverse environmental effects.

DNNP construction phase activities will be executed in a manner that conforms to the requirements of the Environmental Policy and the EMS, by way of the following:

- The Environmental Management and Protection Plan (EMPP);
- The Site-Specific Environmental Management Plan (SSEMP); and
- The Environmental Monitoring and Environmental Assessment Follow-Up (EMEAF) Plan (discussed in the next section).

4.9.1 Environmental Management and Protection Plan & Site-Specific Environmental Management Plan

The EMPP is OPG's overarching plan that implements control measures to eliminate, manage, reduce or mitigate risk associated with DNNP construction. The constructor and subcontractors are required to have site-specific environmental procedures that align with the EMPP. These site-specific procedures will be reviewed on a regular basis and updated, as necessary.

The SSEMP is consistent with the EMPP and is a living document that will be updated to reflect the requirements of the various project phases and activities. Its specific goals are to identify and document environmental risks and appropriate measures for each project activity, including management of noise and dust, spills and hazardous waste; provide direction to project personnel regarding environmental protection measures; provide references to applicable legislation, approvals and guidelines; provide a consolidated reference document for planning and conducting specific work activities or working in specific areas of concern; and communicate any changes to protection measures through a documented revision process.

Topics addressed by the EMPP and SSEMP are shown below with details included in individual site-specific plans.

- Soil management
- Spill management
- Terrestrial, aquatic and wildlife habitat protection
- Air quality, noise and dust control emissions management
- Erosion, sedimentation and surface water control
- Water and effluent management
- Archaeology and cultural heritage management

Some of the key elements of the EMPP and the SSEMP that are relevant to construction are highlighted below.

<u>Spill Management</u>

The constructor's site-specific Spill Management Plan, which aligns with applicable elements of OPG's Spill Management standard, demonstrates the constructor's commitment to spill prevention, preparedness, response, reporting and clean-up in accordance with current standards and regulations.

Terrestrial, Aquatic and Wildlife Habitat Protection

OPG has conducted annual biodiversity monitoring at the DN site for over 20 years and has established a database of natural heritage information. Through this monitoring, the species at risk on site are well understood.

Additionally, OPG has been undertaking studies with respect to hydrology, hydrogeology, noise/dust, and vibration to ensure species at risk will be protected during construction activities.

Bank Swallows

In 2014 and 2017, the Bank Swallow became listed as threatened under the provincial Endangered Species Act (ESA) and the federal Species at Risk Act (SARA), respectively. Both the bird and its habitat are protected under the ESA and SARA.

OPG is making every effort to minimize the effects of construction activities on Bank Swallows. This includes undertaking mitigation measures and beneficial actions that will be captured in an ESA permit for construction. The ESA permit for site preparation activities includes the mitigation measures and beneficial actions listed below. It is anticipated that similar items will be included in the ESA permit for construction.

- Creating woodland, meadow and/or wetland habitat within a specified timeframe;
- Providing species awareness training materials to employees and contractors involved in the completion of site works by a Qualified Professional;
- Conducting vegetation disturbance and removal outside of the active season;
- Undertaking sediment and erosion control measures to prevent the migration of sediment into retained habitats;
- Directing construction lighting down and away from retained habitats.
- Controlling dust to minimize dust emissions;
- Implementing noise abatement strategies;

- Following a spill response plan to avoid or minimize the release of deleterious substances;
- Preventing Bank Swallows from establishing new nests or nesting habitat in stockpiles of soil, overburden, or similar materials; and
- Conducting research and public education.

OPG has also made strides in piloting the design and construction of an artificial nesting habitat structure for Bank Swallows, called a Fixed Face Earthen Embankment (FFEE). The FFEE was constructed at the Pickering Nuclear site in 2021 with the necessary permits to test the structure. Monitoring of the FFEE for Bank Swallow activity commenced in spring 2021. In 2023 and in 2024 the Bank Swallows were observed nesting in the structure. Monitoring of this pilot structure will continue through to 2027.

In addition to the above, OPG coordinates and participates in the Ontario Bank Swallow Working Group, which consists of researchers from Birds Canada, Environment and Climate Change Canada (ECCC), Ministry of Natural Resources and Forestry (MNRF), Ministry of Environment, Conservation and Parks (MECP), Western University, Nature Canada, and other non-governmental organizations. Most recently, the working group also included participation from representatives of the Williams Treaties First Nations.

<u>Bats</u>

OPG has carried out extensive bat monitoring since the completion of the Environmental Impact Statement (EIS), and these surveys have documented eight species of bats on the DNNP site where habitats are being used for roosting and foraging activities. These species include Big Brown Bat, Silver-haired Bat, Hoary Bat, Eastern Red Bat, Little Brown Myotis, Northern Myotis, Eastern Small-footed Myotis, and Tri-coloured Bat.

Three of these species are listed as endangered both provincially through the ESA and federally through SARA (Little Brown Myotis, Northern Myotis, and Tri-coloured Bat). Eastern Small-footed Myotis is listed as endangered provincially, but not federally.

OPG is making every effort to minimize the effects of construction activities on bats and their habitat. An ESA permit for site preparation activities incorporates mitigation measures and beneficial actions, many of which are the same as those listed above for Bank Swallows. Additionally, OPG's plans for beneficial actions for bats include woodland habitat creation and the installation of bat boxes.

The ESA permit application for construction is underway.

Fish

OPG is committed to monitoring for and mitigating adverse effects on fish during construction activities. The loss of nearshore aquatic habitat and biota is anticipated during such activities as in-water work for shoreline protection, and the construction of the intake and discharge structures. However, the nearshore habitat is distinctive as the high energy, unstable environments, with wind and wave action tend to limit species diversity.

Nevertheless, the DNNP construction activities will be conducted in accordance with the conditions of a Department of Fisheries and Oceans Canada (DFO) Fisheries Authorization and associated Fish Habitat Compensation Plan, particularly when undertaking activities that may negatively impact fish or their habitat.

OPG is actively engaging with the Williams Treaties First Nations in the development of the compensation plan, as well as the design of the intake and discharge structures.

Waste Management

The site-specific Hazardous Materials and Waste Management Plan is a deliverable required in advance of construction activities and highlights the management and mitigation measures for nonhazardous and hazardous materials related to the DNNP. This will ensure that the generation, storage, handling, and disposal of these materials is performed in an environmentally safe manner, meeting all applicable regulations.

A key component of the Hazardous Materials and Waste Management Plan will be a Hazardous Materials Inventory, which will include such information as chemical name, system/component, purpose, storage, disposal, inventory, form, and characteristics.

4.9.2 Assessment and Monitoring

OPG has a robust environmental protection program in place for the Darlington site that meets or exceeds all applicable regulatory requirements. The key monitoring programs that support environmental protection are the DNNP Environmental Monitoring and Environmental Assessment Follow-up (EMEAF) program, Environmental Monitoring Program and Effluent Monitoring Program, and Environmental Risk Assessments.

Together, these programs verify that releases to air, surface water, groundwater and soils from normal operation and waste management activities meet all regulatory, federal and provincial guidelines. Each of these programs has its own scope and objectives, but they are complimentary, in that the programs provide data that is useful for planning and implementing the long-term requirements of the EMS.

Where appropriate, environmental monitoring will be performed such that data can be shared to meet the collective requirements of all licensed activities on the Darlington Site. Monitoring in this way will consider the cumulative effects of all activities/operations within the Darlington site on the local environment. For other objectives, DNNP-specific monitoring will be conducted. The various monitoring programs are outlined in the following sections.

Environmental Assessment Follow-up Program

Environmental monitoring during DNNP construction is established through the EA follow-up program. The follow-up program will verify the predictions made in the EIS, confirm the effectiveness of mitigation measures, and provide assurance that the applicable guidelines and regulatory criteria are being met. The program's scope was further refined through the involvement of stakeholders and Indigenous Nations and Communities. Adaptive management will be applied throughout the construction phase to allow for continuous improvement of environmental management practices by applying gained knowledge to subsequent actions.

The EMEAF Plan documents the overall objectives of the EA follow-up program, the implementation framework, and the environmental monitoring components, and also discusses high-level scoping. The environmental components are consistent with those identified in the EIS: the atmospheric environment, surface water environment, aquatic environment, terrestrial environment, geological and hydrogeological environment, land use, traffic and transportation environment, and health of human and non-human biota.

As previously stated, the proposed activities under the construction licence do not include the possession and use of nuclear substances, and therefore will not result in any radiological releases. However, the Darlington Environmental Monitoring Program (EMP) will continue to monitor for radiation and radioactivity at the DN site.

Monitoring plans and methodology reports to support the follow-up program provide a detailed description of the objectives and rationale for the monitoring activities. Where relevant, the environmental media to be sampled, the parameters to be monitored, assessment criteria, sampling and analytical methods, sampling and analytical frequency, sampling locations, requirements for the calibration of equipment, and analytical detection limits are also included in the plans.

The DNNP EA follow-up monitoring activities will be conducted as supplementary studies to the Darlington site EMP. Groundwater monitoring will be compliant with CSA N288.7[R-25].

Environmental Monitoring Program

OPG maintains an Environmental Monitoring Program for the entire DN site that complies with CSA N288.4[R-26]. The EMP encompasses protection of both the public and the environment from nuclear substances, hazardous substances, and physical stressors resulting from operation of the DN site. The program monitors off-site air, water, aquatic samples, and terrestrial samples. Data gathered from this program is used to assess the annual radiological dose to members of the public living or working in the vicinity of the DN site.

DNNP EA follow-up monitoring activities will be conducted as supplementary studies to the Darlington site EMP, and therefore, will be subject to its requirements (CSA N288.4). Prior to operation of the DNNP, OPG will review and implement any necessary changes to the EMP to encompass environmental monitoring for DNNP operations. EA follow-up monitoring activities will either be closed off, if the objectives have been met, or integrated into the routine EMP.

Effluent Monitoring Program

OPG's Effluent Monitoring Program complies with CSA N288.5 [R-27] and establishes requirements for monitoring nuclear and hazardous substances in airborne and waterborne effluents. This program will be applied during the construction phase of the project.

The Effluent Monitoring Plan describes specific procedures for sampling and use of accredited laboratories as per CSA N288.5. In addition, also per CSA N288.5, OPG ensures that appropriate training and required certifications are in place for those specialists and contractors supporting implementation of this program. All aspects of effluent monitoring are subject to an appropriate Quality Assurance/Quality Control program. Audits of the core elements of the program are undertaken on a routine basis.

During construction phase, effluents and emissions will be limited to non-radiological discharges (stormwater runoff, dewatering, blasting, construction equipment, fuel-out commissioning, etc.). The management/monitoring of such releases will be addressed through the EMPP, EMEAF, and the Environmental Compliance Approvals (ECAs).

The DNNP will not produce any radiological releases during construction phase activities, and as such, DNNP-specific radiological release limits and action levels will not apply.

Environmental Risk Assessment

OPG conducts routine Environmental Risk Assessments (ERAs) in accordance with the requirements of CSA N288.6[R-28] and CNSC REGDOC-2.9.1[R-29]. The ERA informs the EMP and the Effluent Monitoring Program.

The most recent ERA for the DN site was issued in 2021, revised in 2022, and encompassed DNNP lands and associated environmental data. The ERA consisted of a Human Health Risk Assessment (HHRA) and an Ecological Risk Assessment (EcoRA) and concluded that the site is being operated in a manner that is protective of human and ecological receptors in the surrounding area.

OPG is conducting a Predictive Environmental Risk Assessment (PERA) for DNNP that will encompass the site preparation, construction, and operation phases of the Project. The PERA will be compliant with CSA N288.6 and REGDOC-2.9.1; will use the most recent ERA data; will include both an HHRA and an EcoRA; and will utilize the predicted releases to air and water during operations of the DNNP. Engagement with the Williams Treaties First Nations is being undertaken as part of the PERA development, particularly with respect to the refinement of receptors.

4.10 Emergency Management and Fire Protection

OPG has an effective emergency management program that meets or exceeds all applicable federal regulatory requirements and related objectives as well as all provincial emergency response plans. Emergency management ensures that response capabilities are in place at OPG to prevent and mitigate the effects of nuclear and hazardous substances releases, both on-site and off-site to protect workers, the public and the environment.

As there is no nuclear fuel on site during the construction and fuel-out commissioning phase, there is no possibility for a radiological emergency originating from the DNNP site, so potential emergencies and their required response will be the same as for other construction sites, with the exception of potential radiological emergencies originating at the operating DNGS. As stated in Section 4.8, while OPG will maintain overall responsibility for safety under the proposed licence, the lead contractor for construction will assume the role of constructor under the Occupational Health and Safety Act (OHSA) and oversee the emergency response on the DNNP site. The contract partner has prepared an emergency response plan which was reviewed by OPG. This emergency response plan includes worksite evacuation procedures, nearest regional emergency services and crisis management contact lists.

The emergency response to any radiological emergencies originating at the operating Darlington Nuclear Generating Station (DNGS) will be under the command and control of DNGS. This includes communicating and directing DNNP site management and workers in responding to radiological risks resulting from DNGS. As part of OPG's Emergency Preparedness Drills and Exercises procedure, emergency and site evacuation drills may be held across either or both the DNGS and DNNP site.

In preparation for a future operating licence application, OPG is providing the requested information to the Province of Ontario in support of the planned revision to the Provincial Nuclear Emergency Response Plan which will reflect appropriate emergency planning requirements for DNNP and future growth in the nuclear industry.

4.10.1 Fire Protection Program

Fire protection during construction is conventional in nature and will be governed by the constructor under the broader conventional health and safety plan as described in Section 4.8. Clarington Emergency Fire Services will be the primary responders as reflected in the current Memorandum of Understanding between OPG and the Municipality of Clarington.

OPG will use Fire Protection Assessments to ensure fire protection goals of CSA N293[R-30] are met through physical design, administrative controls and preventative practices for all operating modes including unit start-ups and outages. In support of a future operating licence, OPG will complete a Fire Response Needs Analysis to determine the fire response requirement and the extent of Clarington Emergency Fire Services support required once the reactor is operational.

4.11 Waste Management

Similar to the DNNP PRSL, the activities to be licensed under the DNNP LTC will not involve the generation of radioactive wastes. The handling of radioactive wastes is not a licensed activity under this application. However, information is provided for how these wastes will be managed and stored through the lifecycle of the BWRX-300 at the DNNP site.

OPG has a mature and effective waste management program that meets all applicable regulatory requirements and related objectives. These programs are fully developed, implemented and audited to control and minimize the volume of nuclear and hazardous wastes generated by licensed activities.

For the DNNP, OPG will have a similar program to ensure that spent fuel, low and intermediate level radioactive waste and non-radioactive hazardous substances and waste are handled, processed, transported and stored in accordance with the applicable federal, provincial and municipal regulations and authorizations. Waste generated will be minimized through application of the 3Rs – Reduce, Reuse, Recycle.

4.11.1 Soils, Wastes and Hazardous Substances

Hazardous substances that may be present and/or hazardous wastes generated as a result of construction activities will be limited to those employed during standard construction processes. These will include chemicals, fuel, lubricants and compressed gases used during operation and maintenance of construction equipment, as well as solvents and cleaners used to clean the equipment. Additional substances on-site may consist of paint, aerosol cans, oil, batteries and electrical components used in the construction of the facility.

DNNP construction activities may generate surplus soil that will require management or proper placement and/or disposal. Surplus soils will be handled in accordance with the requirements of the DNNP SSEMPP. During construction, non-nuclear hazardous substances and waste will be managed through site-specific environmental protection plans/procedures.

4.11.2 Radioactive Waste

The activities to be licensed under the DNNP LTC will not involve the handling of radioactive materials and will not generate any radioactive wastes.

The BWRX-300 will produce waste from its normal operations and maintenance activities, as well as from planned and unplanned outages. The waste will be classified as either radiological or conventional based on the radiological zone where it originated from and from radiological measurements, to make sure that waste is handled safely.

Interim Storage

With respect to the storage of radioactive waste generated under the operating licence, OPG has carefully considered the two options for the interim storage of low and intermediate level waste (L&ILW) that were assessed in and remain bounded by the EA: the construction of onsite licensed storage structures, and off-site transportation to a licensed facility. Subject to further necessary regulatory authorizations from the Commission, OPG intends to proceed with interim storage of L&ILW onsite at a licensed facility, followed by relocation to permanent offsite licensed L&ILW disposal facilities. OPG will continue to engage with Indigenous Nations and Communities and stakeholders with respect to the management of L&ILW and used fuel.

For the management of used fuel, OPG will utilize a similar process that is used at the existing Pickering and Darlington Nuclear Generating Stations which process is also used in the nuclear industry as the preferred method for safe and economical storage of used fuel. In addition to OPG there are other dry storage facilities in operation in Canada. There are facilities located at Atomic Energy of Canada Limited's (AECL's) Douglas Point Generating Station on the Bruce Nuclear Power Development (BNPD) site, Hydro Quebec's Gentilly Nuclear Power Plant, and New Brunswick Power's Point Lepreau NGS. The used fuel from all reactors in Ontario is currently stored in Spent Fuel Bays and dry storage facilities at the stations where the fuel was used.

When removed from the reactor, used fuel is transferred to a water-filled fuel pool (alternatively known as a Spent Fuel Bay) where it is contained to cool for a period of several years. Following the period of wet storage in the used fuel pool, the used fuel is transferred to dry storage containers and placed into appropriate facilities.

The dry fuel storage practices will reflect the fundamental safety aspects related to criticality, radiation exposure, heat control, containment and retrievability. Namely, the systems are designed and operated to assure subcriticality, control radiation exposure, assure heat removal, assure containment and allow retrievability.

Permanent Disposal

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 spent nuclear fuel – including that created using new or emerging technologies such as SMRs. NWMO is seeking to develop a Deep Geological Repository for the permanent disposal of spent fuel, including from new nuclear and Small Modular Reactors, through its Adaptive Phased Management (APM) approach. Canada's plan has always been adaptive so that flexibility is built into repository design to accommodate changes in technology. As of October 2023, the NWMO is also responsible for developing a consent-based siting process for a DGR for intermediate-level and non-fuel high-level radioactive waste.

The NWMO Deep Geological Repository (DGR) can accommodate the long-term storage of the BWRX-300 spent fuel and this small increase in volume. As a contingency, depending on communities' interests or if additional capacity is needed in the future, NWMO is also exploring the potential to include any future used fuel from SMRs and new nuclear in the same repository that will manage the intermediate-level waste and non-fuel high-level waste. While the GEH BWRX-300 fuel is new for Canada, it has been in use internationally for over 15 years, including in several countries with advanced DGR planning for spent fuel (e.g., Finland, Sweden, and Switzerland). The NWMO has stated that it aims to identify a single preferred location for the DGR in 2024, with the facility in service in the mid-2040s, following an extensive regulatory review process and construction of the facility. For the eventual transportation of spent fuel to a future DGR, the NWMO has prepared a preliminary transportation plan and a planning framework (both released in 2021) based upon the priorities, questions and concerns heard from Canadians and Indigenous peoples.

OPG is committed to developing lasting solutions for the permanent disposal of L&ILW radioactive materials from OPG-owned nuclear generating stations and supports Canada's Integrated Strategy for Radioactive Waste (ISRW). The ISRW was developed by the NWMO per the request from Natural Resources Canada and the recommendations for the strategy were endorsed by the Minister of Energy and Natural Resources in October 2023.

Per the ISRW, low level waste will be disposed in near surface disposal facilities, and it will be the responsibility of OPG as the waste generator and owner to develop such a facility for its waste. For intermediate-level and non-fuel high level waste, the ISRW determined that a deep geologic repository is appropriate for disposal, and the NWMO is currently implementing a consent-based siting process to select the facility location. Engagement and planning for both facilities are currently in the initial stages.

4.11.3 Decommissioning Practices

The Nuclear Sustainability division of OPG is responsible for planning, preparing, completing and funding decommissioning for the current and future fleet of OPG's nuclear generating stations such as the DNNP. The planning for the future decommissioning of the DNNP is conducted in accordance with OPG's Decommissioning Program which ensures the protection of health, safety, security and the environment is planned and optimized during decommissioning, as well as the waste generated from decommissioning activities are minimized and managed sustainably.

A Preliminary Decommissioning Plan (PDP) has been developed at each licensing phase of the project and will continue to be progressively updated over the life of the project. In general, the PDP defines the areas to be decommissioned and the sequence of the principal decommissioning work; the selected decommissioning strategy; main decontamination, dismantling and/or clean-up activities; end-state objectives; an overview of the principal hazards and protection strategies (including surveys and continuous environmental monitoring, etc.); a waste management strategy; a cost estimate; and financial guarantee arrangements.

For the Site Preparation licensing phase, the Site Preparation PDP was submitted to the CNSC in 2021. For the LTC phase, an As-Built PDP was submitted to the CNSC. It addresses the decommissioning activities that would need to be completed in the event the project is cancelled during or after completion of construction (prior to operations). This As-Built PDP for Construction phase will supersede the Site Preparation PDP when the construction licence is granted. In addition, an End-of-Life PDP was also submitted as part of the LTC application to demonstrate decommissioning of DNNP facility is technically feasible with existing technology. After dismantling and site restoration, the reactor site will be restored to brownfield status suitable for industrial re-use, and OPG will retain ownership of the lands.

Both the As-Built and End-of Life PDPs had been prepared to the requirements of the CNSC REGDOC-2.11.2 [R-31], REGDOC-3.3.1 [R-32], and CSA N294-19 [R-33].

The PDPs will be progressively updated, where needed, to reflect the appropriate level of detail required for the licensed activities.

4.12 Security

OPG has a mature and robust security program in place at the DN site. Details of OPG's Darlington security program are fully described in the DNGS Security Report submitted to the CNSC.

The OPG Security Program supports OPG's need to manage residual risk to the public created by the operation of its facilities, protect assets and respond to emergencies that may impact operations and the public. Key elements of this program include maintaining compliance with legislative requirements, while minimizing the adverse impact on staff and operations. The objective of the program is to establish a state of security readiness to ensure safe and secure operation of OPG stations and facilities.

Elements of OPG's security program for the DNNP are being revised in a phased approach, as required to address risk and regulatory requirements associated with the DNNP. The revisions reflect the stages of the project lifecycle from site preparation, through to construction, operation, and ultimately decommissioning.

The activities authorized under the Licence to Prepare Site for DNNP have limited nuclear security impact. The security program for the DNNP during the site preparation phase is focused primarily on ensuring that the site remains suitable for a new nuclear development from a security perspective, mitigating risk to existing DNGS facilities, and protecting prescribed information.

As part of the LTC application, potential risks were identified and analyzed through the preparation of a Site-Specific Threat and Risk Assessment which considers physical site characteristics that could impede the development and implementation of current and future adequate security measures. Additional Threat and Risk Assessments will be conducted at each phase of the project with security measures evaluated against these Threat and Risk Assessments to ensure credible threats are mitigated.

The program ensures security readiness and maximizes response capability to contain, mitigate and terminate security events. OPG continues to build strength in identifying areas for improvement by tackling adverse trends and processes to drive continuous improvement efforts. On an annual basis, OPG reviews its Memorandum of Understanding with Durham Region Police Service. This memorandum defines mutual responsibilities and provides a strong foundation for continued productive and integrated working relationships between Durham Region Police Service and OPG. As well, OPG Nuclear Security continues to maintain excellent working relationships with off-site emergency response organizations.

Improvements include several strategic initiatives aimed at implementing innovation and technology opportunities. These include mitigating security impairments with the use of security clearance system electronic application upgrade.

Furthermore, following a significant review of the overall program, OPG has initiated a Security Excellence plan focused on enhancing human performance and improving regulatory compliance.

OPG believes these improvements will better serve the industry and the program to maintain safe conditions in support of mitigation to security risk to all OPG assets.

OPG remains accountable to ensure adequate measures are in place for the administration and facilitation of persons entering, working at and exiting from the DNNP site. OPG has a robust security program in compliance with regulatory requirements that will continue to ensure the continued protection of people and assets through the construction phase and eventual operation of the DNNP.

4.12.1 Cyber Security

OPG's comprehensive cyber security program is applied to its nuclear power plant fleet, including the DNNP BWRX-300, and meets all regulatory requirements. The program, which is continually improved with Operational Experience, benchmarking, and industry best practices, is an integral part of OPG's commitment to maintain and enhance its cyber security measures.

OPG’s cyber security program and procedures are based on several key pillars:

- A preventative defence strategy coupled with a well-structured security framework.
- Comprehensive policies and procedures.
- An effective system for asset identification and classification.
- Clearly delineated roles and responsibilities.
- Rigorous security controls.

The BWRX-300 Cyber Security Program Plan is designed to meet regulatory requirements, relevant industry standards and best practices for the design, operation, and protection of the BWRX-300 I&C systems. The BWRX-300 Cyber Security Program Plan applies advanced security principles throughout the product development and deployment lifecycle of the BWRX- 300 I&C systems. The program is based on three key principles:

1) Regulatory compliance,

2) integration of cyber security controls into the BWRX-300 I&C systems development process, and;

3) integration of cyber security features into the BWRX-300 I&C systems.

The BWRX-300 Cyber Security Program Plan recognizes that protecting cyber essential assets is an ongoing program throughout the I&C system development and operations stages. It is designed to:

- Implement security controls to protect the necessary digital assets from cyber attacks
- Apply and maintain Defence-in-Depth protective strategies to ensure the capability to detect, respond to, and recover from cyber attacks
- Mitigate the adverse effects of cyber attacks
- Ensure functions of protected assets are not adversely impacted due to cyber attacks

Moreover, OPG utilizes specialized cyber security training, promoting individual skillsets across a range of nuclear-related business sectors. This training facilitates smooth configuration and lifecycle management through specific change control processes for cyber essential assets. These processes, fortified with security elements, comply with industry standards such as the CSA N290.7-14[R-34].

OPG embeds nuclear cyber security into all its programs, including the DNNP. The cyber security team is incorporated into the project, ensuring all the listed pillars and practices are effectively applied. This team ensures the inclusion of key steps within procedures and training and participates actively in company-wide cyber security meetings.

OPG has an established procedure to respond promptly to cyber security incidents. OPG has developed a reporting system within the scope of its cyber security program and procedure. Additionally, recovery plans are integral to the individual controls of cyber essential assets, leading to swift action when required. This guarantees that all OPG projects, including the new build project, are well-fortified and resilient to any potential cyber threats.

4.13 Safeguards and Non-Proliferation

OPG has an effective Safeguards and Nuclear Material Accountancy program for the successful implementation of the obligations arising from the Canada/IAEA safeguards agreement and non-proliferation Treaty, that meets CNSC regulatory requirements.

The program that is in place at existing operating nuclear facilities includes:

- Strict inventory tracking of nuclear materials by use of a nuclear material accountancy software;
- Training of staff involved with the maintenance, inspection, verification or movement of nuclear materials on the requirements of reporting and tracking information in software or by physical means;
- Site specific operating procedures that provide instructions on meeting the established Safeguards agreement;
- Rigorous access control to areas that contain nuclear materials; and
- Responsibilities of facility specific Safeguards Officers to perform day-to-day safeguard related duties.

The proposed activities under a Licence to Construct for DNNP do not include the receipt or handling of nuclear fuel. OPG will ensure that nuclear accountancy and control measures will be in place in support of a future application to receive and handle nuclear fuel at the DNNP. Additionally, OPG will meet the requirements such as declarations pursuant to the Additional Protocol on future plans and provide access and assistance to IAEA inspectors for complementary access.

The construction phase will include the construction of prescribed equipment and the installation of safeguards equipment that is subject to safeguards obligations.

Measures to control access to prescribed equipment, as well as prevent loss or illegal use, possession, or removal of prescribed equipment, already exist, or will be developed upon identification that any such equipment will be used during the licensed activities.

OPG has a number of Import and Export licences related to DNNP that will continue to be managed separately from the current PRSL and the proposed construction licence.

The records required by safeguards agreements will be kept and disclosed as appropriate to the CNSC and IAEA inspectors.

4.13.1 Design Information Questionnaire

OPG has submitted a Design Information Questionnaire (DIQ) for the facility to the CNSC as part of the supporting documents for the DNNP LTC Application. The DIQ provides the IAEA and CNSC with information pertaining to the facility's design, operation, locations of nuclear material inventory and nuclear material flow points. This ensures that the IAEA has the required information to establish safeguards measures and responsibilities.

OPG has committed to update the DIQ as needed to ensure that general information describing the facility, design and operation, nuclear material descriptions, processing and flow of nuclear materials, safeguards measures, and accounting and reporting of nuclear materials are accurate, up-to-date, and available to support a Design Information Verification inspection during future operations. Design Information Verifications are supported by Safeguards Officers and impacted work groups through planned or unplanned inspections.

4.13.2 Safeguards Equipment

Safeguards equipment for containment and surveillance is developed by the IAEA as a result of the DIQ and proposed safeguards approach. OPG will provide the IAEA with any requested assistance to facilitate access for the installation of safeguards equipment, including remote monitoring and surveillance systems.

OPG maintains a strong program and working culture based on IAEA support and respect for safeguards equipment and seals. Individuals that work on, around or near IAEA equipment will be trained to identify and not manipulate any IAEA equipment or seals. Future operating procedures will be developed outlining required responses and notifications in the event that services are lost, or damage occurs to IAEA equipment.

4.13.3 Access and Assistance to IAEA

OPG's safeguards implementing standard gives guidance on the reporting requirements and access by IAEA inspectors into the facilities. Under CNSC regulatory requirements, OPG will provide access to the IAEA following notification and identified scope of activities. OPG will provide prompt access for all reasonable requests on short notice for access to applicable DNNP facilities and equipment.

4.13.4 Nuclear Accountancy and Control

As previously noted, the proposed licensed activities from the DNNP LTC Application do not include the receipt or handling of nuclear fuel.

As per applicable CNSC requirements for a future operating licence, OPG will submit DNNP documents supporting Canada's Safeguards and Nuclear Material Accountancy obligations. Safeguards related information is maintained on a Nuclear Material Accountancy software, which provides near real-time inventory of:

- Fresh and irradiated fuels;
- Fuel that is in the reactor core;
- Fuel that is located anywhere else within the facility to support operations; and
- Other relevant non-fuel nuclear material required to support operations.

OPG will ensure that nuclear accountancy and control measures will be in place in support of a future application to receive and handle nuclear fuel at the DNNP.

OPG has a mature safeguards and non-proliferation program that will be implemented in a phased approach as the project proceeds through construction and eventual fuel-in commissioning and operation.

4.14 Packaging and Transport

The Packaging and Transport covers programs for the safe packaging and transport of nuclear substances to and from the facility.

The proposed licence activities under the LTC application will not involve any possession or use of nuclear substances or prescribed equipment.

While construction related tools containing radioactive nuclear substances may be used, these will be under the authority of separate CNSC nuclear substance and device licences. As such, no packaging and transportation of nuclear substances are expected under the proposed construction licence.

OPG has a mature and effective packaging and transport program that meets or exceeds all applicable regulatory requirements and related objectives. The objective of the program is to ensure the safe packaging and transportation of nuclear substances and radiation devices to and from OPG's nuclear facilities such that the risk to the public, workers and the environment is low.

The program addresses package engineering, qualification and certification, operations and maintenance (including periodic testing and inspection), records, staff training, preliminary event notification and transportation emergency response.

OPG has been safely transporting radioactive materials within nuclear sites, and between nuclear facilities, since the 1960s, when its predecessor company, Ontario Hydro, operated the Douglas Point nuclear station for Atomic Energy of Canada Ltd. In OPG's 50 years of Radioactive Materials Transportation, and over many millions of kilometers travelled, there has been no accident resulting in any injury to a driver or a member of the public or any release of radioactivity.

OPG's transportation packages are designed, analyzed and tested, certified as necessary, manufactured, operated and maintained according to OPG's procedures, and meet or exceed the regulatory requirements of the Canadian Nuclear Safety Commission and Transport Canada.

While there have been shipments of enriched fuel in Canada – for example, for refueling of research reactors and to repatriate spent enriched fuel from research reactors to the United States - OPG does not currently transport enriched fuel.

The shipments of fresh and spent enriched fuel for the BWRX-300 will be in accordance with the CNSC Packaging and Transport of Nuclear Substances Regulations, 2015 and the Nuclear Security Regulations, or amended or successor regulations. Detailed information pertaining to radioactive transportation operations specific to the DNNP is to be addressed in later licensing stages. The information provided will effectively facilitate commissioning before fuel load and allow preparation for the transition to fuel-in commissioning and operation upon a future Licence to Operate.

5.0 OTHER MATTERS OF REGULATORY INTEREST

5.1 Environmental Assessment

The DNNP underwent an Environmental Assessment (EA) between 2006 and 2009, under the 1992 Canadian Environmental Assessment Act. The EA assessed the lifecycle for up to four nuclear power reactor units supplying up to 4800 megawatts (MW) of electrical capacity. The results of the EA were documented in the DNNP Environmental Impact Statement (EIS).

The EA was conducted using a Plant Parameter Envelope (PPE) approach, wherein a range of design parameters and variables were considered based on the reactor technologies being contemplated at the time.

In 2012, a Joint Review Panel (JRP) of the Canadian Environmental Assessment Agency (CEAA) and CNSC concluded that the Project is not likely to cause significant adverse environmental effects, taking into account the implementation of mitigation measures [R-35].

In accepting the recommendations of the JRP and approving the DNNP under the 1992 Canadian Environmental Assessment Act, the Government of Canada stated that: "Any Regulatory Authority under the CEAA will need to determine whether the future proposal by the proponent is fundamentally different from the specific reactor technologies assessed by the JRP and if a new EA is required under the CEAA" [R-36].

Following reactor technology selection at the end of 2021, as part of its application for a licence to construct, OPG undertook a review of the PPE and EIS that demonstrated that results of the EIS remain valid for the deployment of four BWRX-300 small modular reactors.

The results of the PPE and EIS Review were the subject of a January 2024 CNSC Public Hearing for Determination of Applicability of Darlington New Nuclear Project Environmental Assessment to OPG's Chosen Reactor Technology. In April 2024, the Commission determined that the 2012 Environmental Assessment remains valid for the deployment of four GEH BWRX-300 units at the Darlington Site.

5.2 Public Information and Disclosure Program

OPG is committed to open and transparent communication. Our Nuclear Public Information Disclosure and Transparency Protocol ensures information is provided in a timely manner to the public, our host communities and stakeholders. Information is communicated in a number of ways to ensure a clear understanding of OPG's nuclear operations, activities and projects. This ensures the public can make informed, objective decisions through readily accessible information and open and ongoing dialogue.

OPG's Corporate Relations organization adheres to the standards and procedures for external communications governed by the OPG standard for Nuclear Public Information and Disclosure. This standard provides the expectations and requirements for OPG's stakeholder activities, public response requirements for issues or significant events and communications with the public. OPG's Nuclear Public Information Disclosure and Transparency Protocol is posted to our public website:

https://www.opg.com/documents/nuclear-public-information-disclosure-and-transparency-protocol/.

OPG's stakeholder relations and public information program has been recognized as a strength by national and international utility peers. OPG benchmarks current best practices amongst others within and outside the nuclear industry to ensure continuous performance improvement. OPG's relationship with the local community remains strong due to ongoing open engagement and sustainable partnerships with community stakeholders including government, media, business leaders, educational institutions, interest groups and community organizations.

<u>Communications and Engagement – Darlington New Nuclear Project</u>

OPG has been engaging with the local community in Durham Region for more than 50 years since the construction of our existing nuclear facilities. Additionally, since 2006 at the outset of the DNNP, OPG has undertaken a comprehensive outreach and communications program with stakeholders and the public on all phases of the project. This robust program has kept the public and stakeholders informed about the DNNP by integrating with and building on the existing public information program for the DNGS.

To ensure targeted and thorough engagement, the program is augmented to include activities and/or stakeholders potentially interested in the DNNP, but who are typically outside the scope of the DNGS program.

Members of the public and stakeholders are continually updated on the status of the DNNP, through various methods and forums including:

Information sharing and community outreach via:

- A fully staffed public information centre;
- A dedicated public website: www.opg.com/newnuclear;
- A toll-free information phone line;
- Environmental partnerships and programs;
- Station tours and site visits;
- Public inquiries and feedback;
- Public opinion polling;
- Community stakeholder letters;
- Social media platforms (Facebook, Twitter/X, Instagram, LinkedIn);
- Advertising (local publications, newsletters, television and radio);
- Contact us information (email, website, phone number) included in all communication materials;
- Briefings with key stakeholder groups, elected officials and municipal representatives;
- Presentations and site tours of the DNNP lands to community groups, key stakeholders, industry peers, partners and the public;
- Virtual reality tours of the BWRX-300 SMR technology to information centre visitors, tour groups, stakeholders and the public;
- Project updates and dedicated DNNP inserts in OPG's regularly issued Neighbours Newsletter, distributed to ~250,000 residents and businesses within ten kilometers of the Pickering and Darlington Nuclear Generating Station sites and posted to OPG's public website;
- DNNP booth, SMR virtual reality experience and information available at OPG's annual public open house (Community Power Expo), which in recent years has drawn over 3,000 people per year;

- Project information booths at community fairs, festivals and events offering information about the project status, next steps and how the public can be involved in the licensing process; and

- Regular updates to community committees (including the Darlington and Pickering Community Advisory Councils, and the Durham Nuclear Health Committee), Clarington Board of Trade and Office of Economic Development.

OPG has undertaken continued engagement activities to ensure stakeholders and members of the public are informed, provided required information and are offered opportunities to ask questions and provide feedback. through the following methods:

Key information on OPG's Licence to Construct application including OPG's desire to apply for a licence, the purpose of applying, the activities involved/required (Environmental Assessment study validation, etc.) and the estimated timeline (interventions, hearings, etc.) was shared <u>throughout the licensing phases of the project</u> in several ways including:

- A copy of the Licence to Construct application was posted prominently on OPG's public DNNP website (www.opg.com/newnuclear) for stakeholders and members of the public to review. OPG also posted the CNSC's Notice of Public Hearing and Participant Funding to the project website.

- More than 800 stakeholders and members of the public registered for four public information sessions on the project. The sessions provided a project update, introduced the Environmental Impact Statement review and Plant Parameter Envelope review, the Licence to Construct application and timeline, and outlined mechanisms for the public to be involved in the licensing process. The sessions also provided an opportunity for the public to ask questions and share their views.

- Stakeholder letters were sent to approximately 80 local community leaders and stakeholders several times throughout the year. These letters contained a project update including specifics on the Licence to Construct process and the opportunities to participate in CNSC public hearings.

- Dedicated presentations on the project status, including Licence to Construct were provided to the Darlington and Pickering Community Advisory Committees and the Durham Nuclear Health Committee. Project updates were provided at all meetings as part of the community update agenda item.

- Presentations and site tours of the DNNP lands to community groups, key stakeholders, industry peers, partners and the public.

- 3500 members of the community attended our annual Community Power Expo in 2023, where we had a dedicated DNNP space represented by all project partners with updates on the project and licensing phases.

- Engaged with more than 10,000 people at 30+ community-wide events, festivals and project kiosks, providing updates on the project and an opportunity to answer questions, including on the Licence to Construct process.

Throughout subsequent phases of the project, OPG will continue to engage with the public and stakeholders including information specific to the Licence to Construct through:

- Quarterly project update letters including summaries of our engagement and public feedback to interested parties.

- Project updates to community committees.

- Project kiosks in high traffic community centers/locations allowing the public to visit and ask questions in a convenient and accessible location.

- Stakeholder roundtable updates to community leaders, local elected officials and Municipal and Regional staff.

- In-depth project workshops with Municipal, Regional, Provincial stakeholders and organizations.

- Public Information Sessions to provide project updates and information and an opportunity to ask questions on Licence to Construct to interested members of the public.

- Presentations and site tours of the DNNP lands to community groups, key stakeholders, industry peers, partners and the public.

- OPG's Community Power Expo including a focused project area, information and staff on hand to discuss the project and Licence to Construct.

- Continued OPG attendance at community fairs, festivals and events across Durham Region with materials on the DNNP and project staff available to discuss the project, including the Licence to Construct process.

- Ongoing project website updates.

- Advertising in local publications, television and radio as applicable.

- A targeted social media presence.

- Project posters located in community spaces including a link to the project website.
- Project information and dedicated inserts in issues of Neighbours newsletter.
- Ongoing opportunities to engage with local community groups and provide a presentation on the DNNP through OPG's "Electrifying Community" program (Event > Electrifying Community Information Sessions – OPG).
- Ongoing opportunities to engage with local school-aged children and educators on the DNNP through OPG's "Electrifying Education" program (Event > Electrifying Education Presentations – OPG).

OPG's role is much more than the kilowatts it produces for the people of Ontario. We value our relationships with Indigenous Nations and Communities, our stakeholders in communities where our facilities are located, as well as the broader public. We strive to be engaged and valued community members, sharing information early and often, and offering and encouraging dialogue with our neighbours, local community and our stakeholders.

OPG has undertaken a comprehensive outreach and communications program including activities designed to reach a broad audience of stakeholders and the public to ensure they are informed on the DNNP. OPG will continue to maintain the comprehensive outreach and communications program and activities through all phases of the project.

5.3 Indigenous Engagement

OPG acknowledges the Aboriginal and Treaty Rights of Indigenous Nations and Communities as recognized in the Constitution Act, 1982. OPG's Indigenous Relations policy provides a framework for engaging with Indigenous peoples, advancing reconciliation and regular reporting on the company's activities and progress in achieving established goals, including OPG's Reconciliation Action Plan.

OPG's objective with respect to engagement with Indigenous Nations Rights holders and interested Indigenous Nations and Communities is to share information on DNNP, understand concerns and potential impacts to Aboriginal and Treaty Rights, promote dialogue and meaningful engagement, and create opportunities for participation in the development, implementation and review of mitigation measures informed by Indigenous Knowledge Systems. This engagement is built on an evolving relationship of mutual trust and respect.

In response to the proposed growth of the nuclear sector, OPG recognized that proactive steps needed to be taken in order to continue to meaningfully support our relationships with Indigenous Nations and Communities, and to achieve our reconciliation goals. In 2023, the Indigenous Relationships and Partnership team added capacity to the DNNP project team which now includes three full-time staff, supported by a director. OPG also created an internal readiness training program which is mandatory for all DNNP team members to participate in. This half-day training includes Treaty knowledge, education on the duty to consult, perspectives on working with Indigenous Nations and Communities, culture and traditions. As of December 2023, OPG met their interim goal of having 60% of DNNP team members take the training. In addition to OPG's new internal training strategy, we have also invested in the development of an energy education module, "Generation for Generations". This has been designed to help bring knowledge to Indigenous Communities, organizations and individuals about the history of energy in Ontario, how the grid works, who is responsible for which areas and much more. This training module can be customized to meet the education needs of each audience and will begin its pilot phase in Summer 2024.

OPG is also committed to providing capacity to support ongoing engagement with Indigenous Nations and Communities regarding the company's nuclear facilities and operations. OPG has entered into relationship framework agreements with Curve Lake First Nation, Hiawatha First Nation, and the Mississaugas of Scugog Island First Nation and is currently working to finalize an agreement with Alderville First Nation. The relationship framework agreements provide capacity to support regular meetings, information sharing and ongoing two-way dialogue with Indigenous Nations and Communities with respect to OPG's existing assets, operations, and initiatives.

DNNP also currently operates three project capacity agreements with Curve Lake First Nation, Hiawatha First Nation, and the Mississaugas of Scugog Island First Nation, all members of the Williams Treaties First Nations. A fourth agreement is in discussion with Alderville First Nation, also a WTFN member. The purpose of these agreements is to ensure that Indigenous Nations and Communities can engage meaningfully on the project. Capacity funding has also been provided to other Indigenous Communities based on submitted costs and expenses.

OPG recognizes that construction activities may have impacts to Aboriginal and Treaty Rights of the WTFNs. OPG endeavors to continue to work with Indigenous Nations and Communities to identify any impacts associated with the project, and to achieve mitigation measures informed by Indigenous Knowledge Systems.

OPG has engaged with the local Rights holders (WTFN) since 2018 on Small Modular Reactor Development as per CNSC REG DOC 3.2.2[R-37] and the Province of Ontario's direction on the delegation of the duty to consult in 2021 and amendment in 2024. WTFN member First Nations are:

- Beausoleil First Nation
- Rama First Nation
- Georgina Island First Nation
- Curve Lake First Nation
- Hiawatha First Nation
- Mississaugas of Scugog Island First Nation
- Alderville First Nation

Current engagement and consultation goals include, but are not limited to:

- Information sharing
- Engagement and employment opportunities
- Constructive dialog and involvement
- Trust building and collaboration
- Meaningful consultation
- Sustainable and empowered relationships

Engagement has also included invitations to virtual and in-person meetings, recurring meetings, newsletters, project permitting reviews and review of project activities which may impact Aboriginal or Treaty Rights. There are ongoing discussions on environmental impacts and monitoring, natural habitat restoration initiatives, archaeological monitoring, community visits and meetings with the leadership of Indigenous Nations and Communities. These discussions primarily take place during regularly scheduled meetings which occur twice monthly with the WTFNs (one focused on knowledge sharing, one on permitting). We also have quarterly meetings with the Metis Nation of Ontario, Region 8. Discussions have begun on future restoration planning and building a model for what this could include. OPG has committed to quarterly meetings with WTFN on this subject and have proposed dates for 2024.

As OPG reported at the January 2024 Hearing for Determination of Applicability of Darlington New Nuclear Project Environmental Assessment to OPG's Chosen Reactor Technology, OPG has agreed to support the four Mississauga Nations on developing an Indigenous Knowledge Systems Study which will help to inform DNNP on its environmental monitoring collaboration with the Nations. Through our discussions with the WTFNs it is understood that the Indigenous Knowledge Systems Study could become the basis for additional studies which could include:

- Cumulative Effects Study; and
- Rights Impact Assessment.

In addition, OPG is committed to supporting and working with the Rights holders to develop an Environmental Monitoring Augmentation Plan which would incorporate an Indigenous lens into our current environmental monitoring programs. Through this, we hope to identify opportunities to expand and strengthen processes and recognize ways that OPG can ensure our work doesn't only meet standards but exceeds them.

OPG understands that the safe-handling and storage of radioactive waste is of particular interest to First Nations throughout Ontario. For this reason, we regularly invite Rights holders and other interested Indigenous Nations and Communities holders to tour waste management facilities at OPG's Darlington and Pickering nuclear generating sites to see how spent fuel is safely managed and stored from existing operations. On August 24th, 2023, OPG provided a presentation about radioactive waste to WTFNs and began the process of knowledge-sharing. A follow-up DNNP radioactive (Low, Intermediate and High Level) waste discussion occurred on November 23, 2023, with continued engagement on the low, intermediate and high-level waste interim and long-term management plans on April 25, 2024. WTFNs have relayed the importance of safe storage of radioactive waste from their communities' perspectives; there is also a desire for them to learn more about waste storage best practices. OPG will continue to share information about its waste management practices and discuss opportunities regarding DNNP waste throughout the engagement process.

OPG is committed to exploring Indigenous commercial participation for new projects. To accomplish this with DNNP, OPG has been engaging with those Williams Treaties First Nations who expressed interest. Our conversations began in 2021 and were formalized in writing in 2022 allowing us to explore mutually beneficial commercial participation opportunities. Participating WTFN and OPG teams have been meeting on a bi-weekly basis to advance concepts, work through questions, and resolve issues to narrow in on a proposed financial structure that meets the objectives of all parties. OPG has provided capacity funding throughout this process, including for the establishment of a new First Nation partnership on April 1, 2024. The First Nation partnership is intended to represent the collective economic interests of the participating WTFN in the DNNP commercial discussions moving forward. Indigenous Communities with interests in the project have been engaged at various levels, these include the Métis Nation of Ontario Region 8, Kawartha Nishnawbe, Six Nations of the Grand River, Mohawks of the Bay of Quinte, Huron-Wendat Nation, and Saugeen Ojibway Nation.

OPG is committed to working with Indigenous Nations and Communities with Rights, asserted Rights and interests regarding project activities to develop positive, mutually beneficial relationships. OPG recognizes that each Indigenous Nation and community is distinct with its own unique history, worldviews and concerns. Engagement has included invitations to virtual and in-community meetings, the provision of project information for review, project newsletters and participation in reviewing of project materials.

Figure 22: OPG Indigenous Relations representatives meet with the Chief and Council of Alderville First Nation, Oct 19, 2023

A summary of key engagement topics for the period of May 2023 to April 2024 included cultural teachings, project permits, project design for shoreline protection, nuclear waste management, Small Modular Reactor site layout, potential impacts to Aboriginal and

Treaty Rights and site visits. Details on key engagements within the specified date range can be found below. Engagement prior to May 2023 can be found in CMD 24-H2.1[R-38].

- In May 2023, OPG met with the Mississaugas of Scugog Island and Alderville First Nations to discuss capacity agreements, DNNP, electricity generation in the province and steps toward better relationship building.

- During a regular monthly meeting with the Mississauga Nations of the WTFN, topics included a DNNP update, relationship building fundamentals and permits required as part of the SMR program.

- June 2023 saw Indigenous Relations representatives participate in the annual Métis Heritage Day in Oshawa with an information booth focused on DNNP and the Indigenous Opportunities Network (ION) program.

- Outreach was conducted with the Mohawks of the Bay of Quinte in June 2023 regarding the status of the DNNP and SMR as well as the CNSC Hearing for Determination of Applicability of Darlington New Nuclear Project Environmental Assessment to OPG's Chosen Reactor Technology.

- At a regular monthly meeting with the Mississauga Nations of the WTFN, a DNNP update was provided along with a discussion on in-site monitoring/testing, species at risk, beneficial actions areas as part of the Endanger Species Act permit, in additional to other pending permits.

- In July 2023, correspondence was undertaken with the Huron-Wendat Nation regarding the finalization of the marine archaeological report associated with SMR development.

- On July 8, 2023, Indigenous Relations and ION representatives operated an information booth during the Alderville pow wow.

- At a regular monthly meeting with the Mississauga Nations of the WTFN, a DNNP update was provided along with a discussion on environmental compliance approvals and species at risk.

- An update meeting with the Métis Nation of Ontario Region 8 was held in September 2023 with a focus on DNNP, nuclear waste operations and the DNNP site Environmental Assessment for the SMR and environmental monitoring.

- In September 2023, Indigenous Relations representatives were invited to participate in the quarterly Curve Lake First Nation harvester's gathering and discussed DNNP, employment and supply chain opportunities, as well as the licensing process for the hearing for Determination of Applicability of Darlington

New Nuclear Project Environmental Assessment to OPG's Chosen Reactor Technology in January 2024. The month also saw OPG staff receive teachings at Petroglyphs Park from a Curve Lake First Nation Elder to enhance their knowledge of local Indigenous culture and history.

- The regular monthly meeting with Mississauga Nations of the WTFN saw updates given on DNNP, stormwater management planning, site preparation for construction activities, soil spoil piles, and permits associated with the SMR.
- On October 19, 2023, Indigenous Relations representatives met with the new Chief and Council of Alderville First Nation to discuss DNNP, electrical generation, nuclear information as well as a tour of the First Nation's solar farm and Black Oak Savanna cultural site.
- Curve Lake First Nation hosted a career fair on November 2, 2023, that featured the variety of roles found within OPG's Advance Maintenance and Inspection function, a hands-on event which proved popular with First Nations student and community members.
- On November 23, 2023, representatives of Curve Lake and Hiawatha First Nations toured the Darlington Waste Management Facility followed by a presentation from the Nuclear Sustainability Services.
- The calendar year ended on December 7, 2023, with a tree ceremony conducted by an Elder from Curve Lake First Nation ahead of clearing work; the trees were thanked, and tobacco was offered.
- January 2024 saw engagement with Curve Lake and Hiawatha First Nations regarding engagement on cultural elements to be incorporated into the planned DNNP Administration Building.
- During the January 18, 2024 meeting, three permits were reviewed: Endangered Species Act (ESA), Permit to Take Water, and Overall DNNP & Stormwater Management Environmental Compliance Approval (ECA) Amendment.
- On January 31, 2024, a virtual meeting was held with the consultation representative for Alderville First Nation regarding a draft Capacity Agreement.
- February 14, 2024, saw the Chief of Rama First Nation and Nation representatives receive an overview of OPG Nuclear, waste operations and DNNP, followed by a tour of Darlington Station.

- The February 2024 regular meeting with the Mississauga Nations of WTFN covered the CCW system, shoreline protection, the thermal effects assessment (including non-thermal effects), and approaches to offsetting.
- The February 22, 2024, whiteboard meeting with the Mississauga Nations of WTFN consisted of a review of the proposed 2024 Roadmap with the Nations (scope of Indigenous Knowledge Study, Rights Impact Assessment, restoration meetings), and update on permits and the Environmental Risk Assessment (ERA) at DNGS.
- On March 13, 2024, an update meeting pertaining to the status of marine archaeology was held with the Mississauga Nations of WTFN representatives, which focused on chance find protocols and the status of the report submitted to MECP. WTFN representatives requested a summary document cover key actions taken and planned on this subject.
- March 13, 2024, saw the DNNP project team met with representatives of Metis Nation of Ontario Region 8. The purpose of the meeting was to review the submitted intervention on the EIS applicability and technology selection and answer queries not already answered. Topics included the status of SMR sites 1 through 4, the archaeological protocol for chance finds, status of bank swallows, the SMR climate change plan in addition to initial waste planning for the site.
- On March 18, 2024, representatives of OPG, Aecon and the architects contracted to work on the planned SMR Administration Building held an update meeting with Hiawatha First Nation. The purpose was to review Indigenous elements for the buildings design and grounds provided by the Nation to date and consider additional elements.
- The regular whiteboard meeting of March 21, 2024, with the Mississauga Nations of WTFN representatives focused on the Environmental Compliance Approval application and the MNRF work permit related to borehole drilling and geotechnical work. The status of the planned Indigenous Knowledge Study was also discussed.
- March 27, 2024, saw representatives of OPG Indigenous Relations and Human Resources participate in the Georgina Island Career Fair focused on the building trades. Potential candidates were encouraged to apply to the ION program for consideration, which may include work opportunities related to DNNP.
- The monthly March 28, 2024, meeting with the Mississauga Nations WTFN representatives focused on environmental updates, shoreline protection plans and the draft DNNP climate change assessment report, which was submitted to WTFN for review and comment.

- April 2, 2024, brought together Mississauga Nations WTFN representatives separate from OPG to discuss the Indigenous Knowledge Study, and collectively agreed that Mississaugas of Scugog Island First Nation staff will draft a framework embedding traditional governance structures to guide the execution of the Indigenous Knowledge Study. The draft framework will be circulated to each community for feedback and revisions before submission to the respective Chief and Councils of the Mississauga Nations.
- On April 8, Alderville First Nation Chief and Council signed a proposed Capacity Agreement regarding the DNNP. The agreement is in process to be executed by DNNP and will be operable between April 1, 2024, and March 31, 2026.

Additional engagement efforts have included employment opportunities through the ION program, including career fair events with a focus on the trades. In 2023, the ION program placed 32 Indigenous candidates into various roles within the energy sector. Since the program's start in 2018, ION has made 127 placements. The partnership between Kagita Mikam Aboriginal and Training, OPG and the Electrical Power Systems Construction Association to support ION was renewed with increased funding in the expectation of continued growth in the program stimulated by DNNP construction.

OPG also surpassed its Indigenous procurement goal of $84 million with a spend of $141 million. In the first quarter of the 2024 fiscal year, $17 million in Indigenous procurement was added for a total of $158 million for the period between January 2023 to April 2024. A nation-wide team of external Indigenous Business Developers is supporting this effort by finding and referring Indigenous businesses to OPG and our project partners.

Both activities are key elements of OPG's Reconciliation Action Plan.

Figure 23: Representatives of OPG Supply Chain, Human Resources, Advanced Inspection and Maintenance and Indigenous Relations at Curve Lake First Nation Career Fair November 2, 2023

5.4 Cost Recovery

Annual fees determined by the CNSC required under Part 2 of the Canadian Nuclear Safety Commission Cost Recovery Fees Regulations are included and budgeted for in OPG's business plans. During the current licensing period, upon receipt of invoices, OPG has provided regular payments to the CNSC. OPG will continue to make payments as required.

5.5 Financial Guarantees

The NSCA and its Regulations require that applicants make adequate provisions for the decommissioning of facilities licensed by CNSC. CNSC REGDOC-3.3.1, Financial Guarantees for Decommissioning of Nuclear Facilities and Termination of Licensed Activities provides guidance regarding the establishment and maintenance of measures to fund the decommissioning of nuclear facilities.

In June 2022, the CNSC Commission accepted OPG's financial guarantee for the PRSL. A financial guarantee in the form of a draft Letter of Credit instrument has been provided to CNSC staff to supplement the LTC Application. The Letter of Credit would satisfy the CNSC requirement for a five-year financial guarantee period from 2025 to 2029. This Letter of Credit would replace the current financial guarantee for the PRSL, following the issuance of the proposed licence to construct.

For the period post-2029, OPG will provide CNSC with an updated assessment of the financial guarantee in 2029 or before the CNSC Hearing for DNNP Power Reactor Operating Licence, whichever is earlier.

5.6 Nuclear Liability Insurance

Under a future Licence to Construct, there are no activities that will result in nuclear material being on site. As such, Nuclear Liability Insurance and limit is not applicable for the license application.

6.0 OVERALL CONCLUSION

OPG's history of safe operations and project management success, in particular large nuclear projects such as the Darlington Nuclear Refurbishment Project, demonstrates OPG's readiness to undertake the construction of a BWRX-300 unit at the Darlington New Nuclear Site. The BWRX-300 leverages operating experience from generations of previous BWRs, providing enhanced safety features that are demonstrated through the Licence to Construct Application.

OPG is committed to delivering the project in an environmentally sustainable manner. The Darlington New Nuclear Project will be a significant step for OPG towards net-zero carbon company by 2040 so that we can act as a catalyst for a net-zero carbon economy by 2050. OPG is committed to continuing to build partnership with Indigenous Nations and local communities as it works towards achieving these goals.

Under the existing site preparation licence, in its application for a licence to construct, and in response to the information requests by CNSC staff, OPG has demonstrated that it:

- is qualified to carry on the proposed licensed activities, and
- will make adequate provisions for the protection of the environment, the health and safety of persons and the maintenance of national security and measures required to implement international obligations to which Canada has agreed.

As such, OPG respectfully requests the Commission approve OPG's Darlington New Nuclear Project Power Reactor Construction Licence for one BWRX-300 unit. OPG also requests that the Commission accepts OPG's proposed Financial Guarantee for DNNP as part of the requested Power Reactor Construction Licence.

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[R-28] CSA288.6, "Environmental Risk Assessments at Class I Nuclear Facilities and Uranium Mines and Mills".

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[R-30] CSA N293-12 Update 1 (2017) AND CSA N293 Supplement 1 (2021), "Fire protection for nuclear power plants".

[R-31] CNSC Regulatory Document, "Waste Management: Decommissioning", REGDOC-2.11.2, January 2021.

[R-32] CNSC Regulatory Document, "Financial Guarantees: Financial Guarantees for Decommissioning of Nuclear Facilities and Termination of Licensed Activities", REGDOC-3.3.1, January 2021.

[R-33] CSA N-294-19 "Decommissioning of Facilities Containing Nuclear Substances".

[R-34] CSA N-290.7-14 "Cyber security for nuclear power plants and small reactor facilities".

[R-35] Government of Canada's Response to the Joint Review Panel Report for the Proposed Darlington New Nuclear Power Plant Project in Clarington Ontario https://iaac-aeic.gc.ca/archives/evaluations/29525/document-html-eng_did=55542.html.

[R-36] "Joint Review Panel Environmental Assessment Report: Darlington New Nuclear Power Plant Project" August 2011.

[R-37] CNSC Regulatory Document, "Public and Indigenous Engagement: Indigenous Engagement", REGDOC-3.2.2, Version 1.2, February 2022.

[R-38] OPG Letter, M. Knutson to D. Saumure, "Notice of Participation at CNSC Public Hearing 2024-H-02 and Written Submission in support of the DNNP Hearing on Applicability of the Darlington New Nuclear Project Environmental Assessment and Plant Parameter Envelope to the Selected Reactor Technology", CD# NK054-CORR-00531-10849, Sept. 18, 2023 (CMD 24-H2.1).

GLOSSARY

ALARA A principle of radiation protection that holds that exposures to radiation are kept as low as reasonably achievable, social and economic factors taken into account.

Best Practice An industry-accepted approach (for example, toward a design, process or procedure) that is acknowledged as consistently producing superior results.

Beyond-Design-Basis Accident (BDBA) An accident less frequent and potentially more severe than a design-basis accident.

Boiling Water Reactor (BWR) A common type of light-water reactor, where water is allowed to boil in the core, generating steam directly in the reactor vessel to generate electrical power.

Canadian Nuclear Safety Commission (CNSC) Canada’s nuclear regulator, established under the Nuclear Safety and Control Act to regulate the use of nuclear energy and materials to protect health, safety, security and the environment; to implement Canada’s international commitments on the peaceful use of nuclear energy; and to disseminate objective scientific, technical and regulatory information to the public.

Commissioning With respect to a reactor facility, a process intended to demonstrate that installed Structures, Systems and Components (SSCs) perform in accordance with their specifications before the facility is placed in service or before the SSCs are returned or placed in service.

Complementary Design Feature A design feature added to the design as a standalone structure, system or component or added capability to an existing SSC to cope with design extension conditions.

Construction The process of procuring, manufacturing and assembling the components, carrying out civil work, installing and maintaining components and systems, and performing associated tests.

Core Damage Accident leading to significant fuel degradation. For CANDU reactors, core degradation is defined as extensive physical damage of the multiple fuel channels due to overheating leading to loss of core structural integrity.

Core Damage Frequency An expression of the likelihood that an accident could cause core damage.

CSA Group A standard-setting body that works with the regulator, industry and stakeholders to produce consensus-based Canadian industry standards that may be used by the regulator or industry. Formerly called Canadian Standards Association.

Decommissioning Administrative and technical actions taken to allow the removal of some or all of the regulatory controls from a facility, location or site where nuclear substances are managed, used, possessed or stored.

Defence In Depth A hierarchical deployment of different levels of diverse equipment and procedures to prevent the escalation of anticipated operational occurrences and to maintain the effectiveness of physical barriers placed between a radiation source or radioactive material and workers, members of the public or the environment, in operational states and, for some barriers, in accident conditions.

Design Authority The entity that has overall responsibility for the design process, or the responsibility for approving design changes and for ensuring that the requisite knowledge is maintained.

Design Basis The range of conditions and events taken explicitly into account in the design of a nuclear facility, according to established criteria, such that the facility can withstand this range without exceeding authorized limits. Note: Design extension conditions are not part of the design basis.

Design-Basis Accident (DBA) Accident conditions for which a nuclear facility is designed according to established design criteria and for which damage to the fuel and the release of radioactive material are kept within authorized limits. DBA is a plant state.

Design Extension Conditions (DEC) A subset of beyond-design-basis accidents that are considered in the design process of the facility in accordance with best-estimate methodology to keep releases of radioactive material within acceptable limits. Design extension conditions could include severe accident conditions. DEC is a plant state.

Deterministic Safety Analysis An analysis of a nuclear facility's responses to an event, performed using predetermined rules and assumptions (such as those concerning the initial facility operational state, availability and performance of the facility systems and operator actions).

Equipment Pool A pool located at the opposite end of the Reactor Building Cavity from the RB Pool that holds the dryer and separator during the refueling outage.

Environmental Risk Assessment (ERA) A process that identifies, quantifies and characterizes the risk posed by contaminants (nuclear or hazardous substances) and physical stressors in the environment. An ERA is a practice or methodology primarily developed by regulatory agencies to provide scientific input to decision makers. In this way, ERAs commonly serve as a supportive tool providing technical information in a manageable form to a larger EA.

Heat Sink A system or component that provides a path for heat transfer from a source, such as heat generated in the fuel, to a large heat-absorbing medium, such as water.

Licensee An individual or organization that is licensed to carry on a Licensed Activity.

Loss-Of-Coolant Accident (LOCA) A type of reactor accident that results from a loss of coolant due to a break in the primary heat transport system.

Nuclear Facility (in the context of DNNP) a nuclear fission or fusion reactor or subcritical nuclear assembly.

Nuclear Power Plant A nuclear facility consisting of any fission- reactor installation that has been constructed to generate electricity on a commercial scale.

Offsite Power alternating current (AC) power supplied from the transmission system (grid), to the plant electrical power distribution systems.

Operating Experience (OPEX) Pertinent internal and external information, gained through practical experience, used to learn about and improve the safety and reliability of nuclear facilities.

Owner OPG is the Darlington Nuclear Site Owner where the future DNNP Facility will be located. OPG is current licence holder for the DNNP Site Preparation Licence and will be the licence holder for the proposed Construction License.

Pressure Boundary A boundary of a pressure-retaining structure, system or component of a nuclear or non-nuclear system. Note: This definition applies to components subject to registration under applicable boiler and pressure vessel legislation.

Probabilistic Safety Assessment (PSA) A comprehensive and integrated assessment of the safety of a facility. The safety assessment considers the probability, progression and consequences of equipment failures or transient conditions to derive numerical estimates that provide a consistent measure of the safety of the facility.

Sievert (Sv) The International System of Units (SI) unit of equivalent dose and effective dose, equal to 1 joule/kilogram.

ACRONYMS

AC	Alternating Current
ALARA	As Low As Reasonably Achievable
AOO	Anticipated Operational Occurrences
ASME	American Society of Mechanical Engineers
BDBA	Beyond Design Basis Accident
BEZ	Break Exclusion Zone
BIS	Boron Injection System
BWR	Boiling Water Reactor
CCS	Containment Cooling System
CDF	Core Damage Frequency
CEAA	Canadian Environmental Assessment Agency
CFD	Condensate Filters and Demineralizers System
CMD	Commission Member Document
CNSC	Canadian Nuclear Safety Commission
CRDH	Control Rod Drive Hydraulic
CWS	Circulating Water System
DBA	Design Basis Accident
DC	Direct Current
DCIS	Distributed Control and Information System
DEC	Design Extension Condition
DFO	Department of Fisheries and Oceans Canada
DGR	Deep Geological Repository
DIQ	Design Information Questionnaire
DL	Defence Line
DN	Darlington Nuclear
DNGS	Darlington Nuclear Generating Station

DNNP	Darlington New Nuclear Project
DPSC	Diaphragm Plate Steel Composite
DSA	Deterministic Safety Analysis
EA	Environmental Assessment
ECA	Environmental Compliance Approval
ECCC	Environment and Climate Change Canada
EcoRA	Ecological Risk Assessment
EDS	Electrical Distribution System
EIS	Environmental Impact Statement
EMEAF	Environmental Monitoring and Environmental Assessment Follow-Up
EMPP	Environmental Management and Protection Plan
EMS	Environmental Management System
ERA	Environmental Risk Assessment
ESA	Endangered Species Act
ESBWR	Economic Simplified Boiling Water Reactor
FFEE	Fixed Face Earthen Embankment
FFHE	Functional Failure Hazards Evaluation
FLEX/EME	Flexible Mitigation Strategies or Emergency Mitigating Equipment
FMCRD	Fine Motion Control Rod Drive
FMEA	Failure Modes and Effects Analysis
FPC	Fuel Pool Cooling and Cleanup System
FSF	Fundamental Safety Function
GEH	General Electric Hitachi
GT	Gamma Thermometer
HFE	Human Factors Engineering
HHRA	Human Health Risk Assessment
HSI	Human-System Interface

HX	Heat Exchanger
IAEA	International Atomic Energy Agency
ICS	Isolation Condenser System
INPO	Institute of Nuclear Power Operations
ION	Indigenous Opportunities Network
IPD	Integrated Project Delivery
ISO	International Organization for Standardization
ISRW	Integrated Strategy for Radioactive Waste
JRP	Joint Review Panel
L&ILW	Low and Intermediate Level Waste
LOCA	Loss of Coolant Accident
LPRM	Local Power Range Monitor
LRF	Large Release Frequency
LTC	Licence to Construct
masl	meters above sea level
MCA	Main Condenser and Auxiliaries
MCR	Main Control Room
MECP	Ministry of Environment, Conservation and Parks
MNRF	Ministry of Natural Resources and Forestry
MW	megawatts
MWe	megawatts electric
MWth	megawatts thermal
NBS	Nuclear Boiler System
NMS	Nuclear Management System
NRC	Nuclear Regulatory Commission
NSCA	Nuclear Safety and Control Act
NWMO	Nuclear Waste Management Organization

OHSA	Occupational Health and Safety Act
OLCs	Operating Limits and Conditions
OPG	Ontario Power Generation
PCCS	Passive Containment Cooling System
PCS	Primary Containment System
PDP	Preliminary Decommissioning Plan
PEP	Project Execution Plan
PERA	Predictive Environmental Risk Assessment
PIE	Postulated Initiating Event
PIT	Project Integration Team
PLT	Project Leadership Team
PMT	Program Management Team
PPE	Plant Parameter Envelope
PRSL	Power Reactor Site Preparation Licence
PSA	Probabilistic Safety Assessment
PSAR	Preliminary Safety Analysis Report
RB	Reactor Building
REGDOC	Regulatory Document
RIV	Reactor Isolation Valves
RPV	Reactor Pressure Vessel
RWB	Radwaste Building
SA	Severe Accident
SARA	Species at Risk Act
SAT	Systematic Approach to Training
SCA	Safety and Control Area
SCCV	Steel-Plate Composite Containment Vessel
SCR	Secondary Control Room

SMR	Small Modular Reactors
SRF	Small Release Frequency
SSCs	Structures, Systems and Components
SSEMP	Site-Specific Environmental Management Plan
Sv	Sievert
TQD	Training and Qualification Description
WRNM	Wide Range Neutron Monitor
WTFN	Williams Treaty First Nations