ONTARIO POWER GENERATION

Plan

OPG Proprietary	
Document Number: NK30-PLAN-00960-00001	Usage Classification: N/A
Sheet Number: N/A	Revision: R00

Title:
Pickering Nuclear Generating Station B Preliminary Decommissioning Plan

Pickering Nuclear Generating Station B Preliminary Decommissioning Plan

NK30-PLAN-00960-00001-R00
February 2025

Order Number: 00312357-00034
Other Reference Number: Project ID 10-87945

OPG Proprietary

Table of Contents

Page

List of Tables and Figures

Page

Revision Summary

Revision Number	Date	Comments
R00	February 21, 2025	Initial Issue

Acronyms

ALARA	–	As Low As Reasonably Achievable
APM	–	Adaptive Phased Management
CACs	–	Community Advisory Councils
CANDU	–	Canada Deuterium Uranium
CCNS	–	Centre for Canadian Nuclear Sustainability
CNL	–	Canadian Nuclear Laboratories
CNSC	–	Canadian Nuclear Safety Commission
COG	–	CANDU Owners Group
CSA	–	Canadian Standards Association
DDP	–	Detailed Decommissioning Plan
DGR	–	Deep Geologic Repository
DNHC	–	Durham Nuclear Health Committee
DP	–	Douglas Point
DRL	–	Derived Release Limit
DSC	–	Dry Storage Container
EA	–	Environmental Assessment
ECI	–	Emergency Coolant Injection
ESDR	–	End State Determination Report
FOAK	–	First Of A Kind
G-1	–	Gentilly-1
HF	–	Human Factors
HFEPP	–	Human Factors Engineering Program Plan
HPECIS	–	High Pressure Emergency Coolant Injection System
HSA	–	Historical Site Assessment
HWP	–	Heavy Water Plant
IAC	–	Indigenous Advisory Council
IAEA	–	International Atomic Energy Agency
IEP	–	Indigenous Engagement Plan
IFB	–	Irradiated Fuel Bay
ILW	–	Intermediate Level Waste
ISRW	–	Integrated Strategy for Radioactive Waste
L&ILW	–	Low and Intermediate Level Waste
LCH	–	Licence Condition Handbook
LLW	–	Low Level Waste
MAPLE	–	Multipurpose Applied Physics Lattice Experiment
MARSSIM	–	Multi-Agency Radiation Survey and Site Investigation Manual
MoU	–	Memorandum of Understanding
MSC	–	Modular Shielded Container
NBP	–	New Brunswick Power
NGS	–	Nuclear Generating Station
NPD	–	Nuclear Power Demonstration
NPP	–	Nuclear Power Plant
NRCan	–	Natural Resources Canada
NRU	–	National Research Universal
NRX	–	National Research Experimental
NSDF	–	Near Surface Disposal Facility

NSS-PWMF	–	Pickering Waste Management Facility
NSS-WWMF	–	Western Waste Management Facility
NWMO	–	Nuclear Waste Management Organization
OH&S	–	Occupational Health and Safety
ONFA	–	Ontario Nuclear Funds Agreement
OPEX	–	Operating Experience
OPG	–	Ontario Power Generation
PAPR	–	Powered Air Purifying Respirator
PCB	–	Polychlorinated Biphenyl
PDP	–	Preliminary Decommissioning Plan
PHT	–	Primary Heat Transport
PNGS	–	Pickering Nuclear Generating Station
PNGS-A	–	Pickering Nuclear Generating Station A
PNGS-B	–	Pickering Nuclear Generating Station B
PPE	–	Personal Protective Equipment
PTR	–	Pool Test Reactor
QA	–	Quality Assurance
RAP	–	Reconciliation Action Plan
RBSW	–	Reactor Building Service Water
REGDOC	–	Regulatory Document
RMS	–	Records Management System
RSSI	–	Radiation Survey and Site Investigation
RTS	–	Return to Service
SAP	–	Stabilization Activity Plan
SCA	–	Safety and Control Area
SCR	–	Station Condition Record
SOP	–	Sustainable Operations Plan
SSC	–	System, Structure or Component
SSS	–	Safe Storage State
SSTF	–	Spent Solvent Treatment Facility
SWS	–	Storage with Surveillance
VLLDS	–	Very Low Level Drain State
VSDS	–	Visual Survey Data System
WR-1	–	Whiteshell Reactor
ZEEP	–	Zero Energy Experimental Pile

Abstract

This Preliminary Decommissioning Plan (PDP) describes the activities that will be required to decommission Pickering Nuclear Generating Station (PNGS) B to meet the requirement of the Canadian Nuclear Safety Commission Regulatory Document (REGDOC)-2.11-2 and the Canadian Standards Association N294:19. The overall objective of decommissioning Pickering Nuclear Generating Station B (PNGS-B) is to restore the site for other Ontario Power Generation uses.

This PDP evaluates the different decommissioning strategies and provides the rationale for the proposed strategy (i.e., Deferred decommissioning) for the PNGS-B. This plan demonstrates that decommissioning is feasible with existing technology and provides the final end state post decommissioning that would lead to release from regulatory control.

1.0 INTRODUCTION

Pickering Nuclear Generating Station (PNGS) B is owned and operated by Ontario Power Generation (OPG). It is a four-unit Canada Deuterium Uranium (CANDU) Nuclear Generating Station (NGS), consisting of Units 5 through 8. Pickering Nuclear Generating Station B (PNGS-B) is located in the Municipality of Pickering, Ontario and is approximately 32 km east of Toronto.

PNGS-B is planned for refurbishment, pending regulatory approval, to enable extended operations and remains in the planning for decommissioning phase. A deferred decommissioning strategy is planned. However, flexibility is built into the process to cater to the final decision OPG may make with respect to the permanent shutdown dates.

This Preliminary Decommissioning Plan (PDP) is the proposed plan for decommissioning the PNGS-B and will be submitted to the Canadian Nuclear Safety Commission (CNSC) for acceptance in accordance with the conditions of its licence [1].

This PDP is prepared in accordance with the CNSC Regulatory Document (REGDOC)-2.11.2 [2] and Canadian Standards Association (CSA) Standard N294[1] [3]. It addresses the gaps identified in [4] for implementation of CNSC REGDOC-2.11.2. This PDP also addresses the comments from CNSC [5] [6] on the last Pickering Nuclear Site PDP issued in 2022 [7]. The purpose of this PDP is to define the areas to be decommissioned and the sequence of the principal decommissioning work for PNGS-B. This PDP also demonstrates that decommissioning is feasible with existing technology and provides a summary of the estimated costs for decommissioning PNGS-B.

Within five years of submission, the PDP (and the associated cost estimate) will be reviewed and updated as required, per REGDOC-2.11.2 [2].

Since PNGS-B is located on the same site as Pickering Nuclear Generating Station A (PNGS-A) and the Pickering Waste Management Facility (NSS-PWMF), an overarching PDP [8] has been prepared to describe the decommissioning interferences of these facilities. Further information on the decommissioning planning for PNGS-A and NSS-PWMF is documented in the PNGS-A Detailed Decommissioning Plan (DDP) [9] and NSS-PWMF PDP [10], respectively.

The scope and interfaces between the Pickering Nuclear Site Overarching PDP, PNGS-A DDP, PNGS-B PDP (this document) and NSS-PWMF PDP are shown in Figure 1-1.

[1] A preliminary review of the draft CSA N294:25 issued for Public Review was done. This PDP generally complies with the revised/new requirements in this standard.

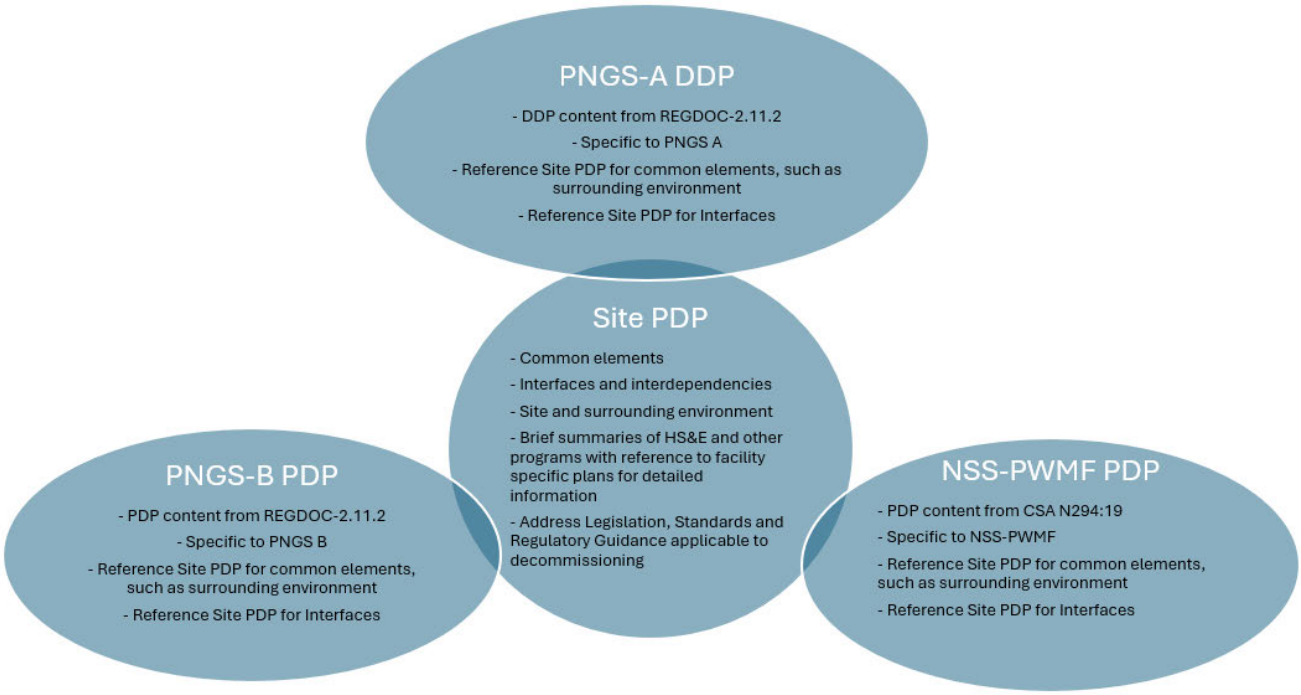


Figure 1-1: Interfaces between the Site PDP [8], PNGS-A DDP [9], PNGS-B PDP (this document) and NSS-PWMF PDP [10]

1.1 Land Acknowledgement

The lands and waters on which the PNGS is situated are the traditional territory of the Michi Saagiig and Chippewa Nations of the Williams Treaties First Nations. The Johnson-Butler Purchase (also known as the Gunshot Treaty 1877-88) covers the PNGS lands.

Alderville First Nation, Curve Lake First Nation, Hiawatha First Nation, Mississaugas of Scugog Island First Nation (known as the Michi Saagiig), Chippewas of Georgina Island First Nation, Beausoleil Island First Nation and Rama First Nation are all signatories to the Williams Treaties (1923) and to the Williams Treaties First Nations Settlement Agreement of 2018.

1.2 Phased Approach to Decommissioning Planning

Planning for the eventual decommissioning of PNGS-B is an ongoing process and the planning assumptions will evolve over time. This document describes the preliminary plan for PNGS-B as it exists at the time of writing, and it supersedes all previous versions of the PDP for the Pickering Nuclear site [7]. As OPG advances with the potential planned PNGS-B refurbishment, this decommissioning plan will be updated accordingly to reflect any design updates.

This PDP will also continue to be revised periodically, as required, throughout the life of PNGS-B to incorporate:

- Operational experience and lessons learned, especially from PNGS-A decommissioning planning and decommissioning activities;

- Technological advances, in particular decommissioning technology;
- Changes in site conditions, or incidents and events;
- Changes to proposed planning assumptions;
- Changes to proposed decommissioning objectives and/or strategy;
- Changes in ownership or management structure;
- Significant modifications to the facilities, location or site;
- Updated schedule, cost and funding information;
- Changes in regulatory requirements; and
- Availability of facilities, locations or sites for the management of radioactive waste and irradiated fuel.

OPG will inform the CNSC, in writing, at a minimum of two years before permanently shutting down PNGS-B or as soon as practical for unplanned shutdown. OPG will ensure that processes, systems, and personnel will be in place to maintain the facility in a safe state during the transition to decommissioning [11]. It is expected that the transition to decommissioning of the PNGS-B will be managed through the following regulatory submissions, utilizing a similar approach and lessons learned from PNGS-A decommissioning planning:

- A permanent shutdown plan – This plan will include the steps to transition PNGS-B, Units 5 to 8, from operation to a permanent shutdown state. This plan will be submitted to the CNSC for acceptance [2], [11]. This document is anticipated to be similar to the Pickering Sustainable Operations Plan (SOP). Further details on the SOP are provided in Section 4.1.3.
- A Stabilization Activity Plan (SAP) – The SAP will outline OPG's plan for managing the arrangements and activities that will be conducted in support of the transition of the PNGS-B Units 5 to 8 from its final shutdown state to its Safe Storage State (SSS) [11]. Further details on the SAP are provided in Section 4.1.3. The SAP will be submitted to the CNSC for acceptance [2].
- A DDP – The DDP will be prepared and submitted to the CNSC for acceptance, in accordance with the conditions of its licence, approximately two to five years prior to the Storage with Surveillance (SWS)[2] period. The DDP will cover the decommissioning activities for the entire period of the decommissioning. The DDP will be reviewed and revised in accordance with the requirements of CNSC REGDOC-2.11.2 [2]. Towards the end of SWS, the DDP will be revised to describe OPG's detailed plan for managing the arrangements and activities that will be conducted in support of Dismantling & Demolition. The methods and technologies available for use at the time of decommissioning will be reviewed and, where appropriate, they will be adopted and

[2] Storage with Surveillance is also referred to as Safe Storage/Safe Storage State (SSS) and can be used interchangeably.

described in the revised DDP. Further details on the DDP are provided in Sections 4.1.3 and 4.2.4.

- Decommissioning Safety Assessment – Safety assessment(s) will be prepared to support the activities listed in the DDP (see above). These safety assessments will be submitted to the CNSC as a stand-alone document (also referred to as the Decommissioning Safety Assessment report) or the safety assessment(s) will be included in the DDP. The safety assessment will cover the decommissioning activities that are planned to be executed in the next five years. Towards the end of SWS, the safety assessment will be revised to consider OPG's detailed plan for managing the arrangements and activities that will be conducted in support of Dismantling & Demolition. Further details on the safety assessment for decommissioning are provided in Sections 4.1.3 and 4.2.5.

- A SWS plan – The plan will be prepared and submitted, either as a stand-alone document or as part of the DDP, to the CNSC for acceptance. The SWS plan will address the requirements of CNSC REGDOC-2.11.2 [2] applicable at the time.

1.3 Applicable Legislation, Standards and Regulatory Guidance

A detailed discussion of the applicable legislation, standards, and regulatory guidance is provided in the Site PDP [8]. All decommissioning activities will be performed in accordance with the relevant legislation, regulations, codes, and standards.

1.4 Applicable Programs

OPG's Nuclear Management System [12] provides a framework that establishes the processes and programs required to ensure OPG achieves its safety objectives, continuously monitors its performance against these objectives, and fosters a healthy safety culture.

OPG is responsible for planning, executing and funding all the phases of PNGS-B decommissioning. OPG will ensure that the protection of health, safety and security of workers, the public and the environment is planned and optimized during PNGS-B decommissioning. Decommissioning work will be conducted in accordance with the management system requirements and in compliance with OPG's Decommissioning Program [13], which ensures that when retiring a licensed nuclear facility permanently from service and rendering it to a predetermined end-state condition, actions are taken in the interest of health, safety, environment, security, quality and economics. The Decommissioning Program is further implemented through two standards to address the requirements and processes for decommissioning planning [14] and conduct of decommissioning [11]. The Decommissioning Program describes the interface with the Nuclear Management System as well as other Interfacing Governance such as, but not limited to the Nuclear Waste Management program, Integrated Aging Management.

1.5 Regulatory Compliance with Applicable Standards

This document outlines the preliminary decommissioning planning work that has been completed and is in accordance with the requirements described in CNSC REGOC-2.11.2 [2] and CSA Standard N294:19 [3].

Appendix A and Appendix B refer to the specific requirements of CNSC REGOC-2.11.2 [2] and CSA N294:19 [3], respectively, and identify the respective sections of the PDP that cover these requirements.

1.6 Planning Assumptions

The assumed station permanent shutdown dates and decommissioning timelines (i.e., SWS, Dismantling & Demolition, and Site Restoration) are in accordance with the latest information available. Planning for decommissioning of the PNGS-B is based on the following fundamental assumptions:

1. For financial planning purposes, it has been assumed that the individual reactor units at the PNGS-B will be shut down per the sequence shown in Figure 5-1 [15].

2. For planning purposes, a 30-year SWS period is assumed, and Dismantling & Demolition will commence per the schedule shown in Figure 5-1 [15].

3. Dismantling of the units will be staggered as shown in Figure 5-1 [15].

4. All systems shared between PNGS-A and PNGS-B will have been separated before PNGS-A decommissioning.

5. OPG will retain ownership of the site throughout the course of the decommissioning and subsequent restoration for other industrial use (commonly known as ‘brown field’ status).

6. OPG, as the owner, will be responsible for all work conducted during the permanent shutdown of the units, the Preparation for Safe Storage or Stabilization period and the SWS period. OPG may retain one or more contractor/agent to conduct/oversee all or part of the planning or execution of decommissioning.

7. Heating will be available while PNGS-B is in SWS (for areas used during SWS), during preparation for Dismantling & Demolition, during Dismantling & Demolition, and up to the end of large component removal (calandria and steam generators).

8. Decontamination and dismantling activities will be coordinated at all four PNGS-B units to optimize the project schedule and maintain continuity in the overall process.

9. Low Level Waste (LLW) and Intermediate Level Waste (ILW) arising from decommissioning activities will be disposed of in long-term disposal facilities. Non-radioactive hazardous waste will be disposed of at approved disposal facilities.

10. ‘Clearance Levels’ based on guidance provided in CSA Standard N292.5 [16] will be developed prior to decommissioning (Dismantling & Demolition). These criteria will standardize the approach for segregation of the decommissioning wastes into those requiring long-term management and those that can be recycled, left on site or disposed of in conventional waste facilities.

11. For the purpose of the financial guarantee, no salvage credit is assigned to equipment and components removed during decommissioning; these are considered waste for

costing purposes. However, consistent with the principles of the waste management hierarchy, recycling of clean materials will be pursued.

12. Above-ground structures will be surveyed for contamination, decontaminated if required and demolished.

13. Underground metal and concrete piping will be excavated for survey and removed, if necessary. Uncontaminated materials beyond one meter will be left in place, while contaminated materials that exceed the site release criteria will be removed and disposed of appropriately.

14. Sub-surface structures will be surveyed for contamination, decontaminated if required and, consistent with international practices, dismantled to a nominal depth of one meter below grade, backfilled with concrete rubble and/or soil and graded over. If contamination is present beyond one meter depth, OPG will be responsible to remediate until the respective screening levels are met. Additionally, the one-meter depth allows for the placement of both gravel for drainage and topsoil for erosion control through the establishment of vegetation and provides significant attenuation of any residual gamma radionuclides that may remain within the site release limits. At-grade foundation slabs exceeding one meter in thickness will be abandoned in place and covered with a one-meter thick layer of backfill.

15. Final end-state surveys of the site will be performed to demonstrate that the site has met the release criteria so that it can be released from further regulatory control.

16. The site will be graded and made available for other OPG uses after completion of decommissioning as a 'brownfield'[3].

[3] As per nuclear industry practice, a brownfield is defined as a former industrial land that has the potential to be developed for new industrial uses.

2.0 DESCRIPTION OF PNGS-B

The location of PNGS-B and its detailed description are described in the Pickering Nuclear Site Overarching PDP [8] and its Safety Reports [17] and [18].

The location of PNGS-B on the Pickering Nuclear Site is shown in Figure 2-1. This figure also shows as highlighted in green the list of buildings that has been considered in the scope of this PDP. For further details, see Section 3.1.

The process and service systems at PNGS-B include, but are not limited to, the following including:

1. Condenser cooling water system;
2. Service water system;
3. Fire protection system;
4. Potable water system;
5. Demineralized water system;
6. Active and inactive water drainage systems;
7. Sanitary drainage system;
8. Ventilation, heating, and air conditioning systems;
9. Breathing air; and
10. Service and instrument air, etc.

Additional details of these systems are provided in [17] and [18].

This page has been left blank intentionally.

Figure 2-1: Map Showing Location of PNGS-B on the Pickering Nuclear Site [19]

This page has been left blank intentionally.

2.1 Description of the Surrounding Environment

A description of the environment in the immediate vicinity of PNGS-B, including the municipality, land uses, etc. are provided in the Pickering Nuclear Site Overarching PDP [8].

2.2 History and Current Status

Construction of PNGS-B started in 1974. The first unit (Pickering Unit 5) entered commercial service on May 10, 1983 followed by Pickering Unit 6 on February 1, 1984, Unit 7 on January 1, 1985 and Pickering Unit 8 on February 28, 1986. All four PNGS-B units have remained in service since the beginning of commercial operations except for maintenance outages [17].

The current plan is for Units 5 to 8 to be shutdown in 2026 and placed into temporary wet layup until the start of the planned refurbishment, pending regulatory approvals. Following the PNGS-B refurbishment, the preliminary expected Return to Service (RTS) dates are as follows:

- Unit 5: 2030;
- Unit 6: 2032;
- Unit 7: 2033; and
- Unit 8: 2034.

Note that these dates are tentative and subject to change.

3.0 PRELIMINARY DECOMMISSIONING PLAN

3.1 Scope of the Decommissioning Plan

This plan describes the decommissioning of the PNGS-B station. This includes but is not limited to the following:

- The Reactor Buildings, Units 5 to 8;
- The Irradiated Fuel Bay (IFB) B;
- The Pressure Relief Ducts and the Vacuum Ducts;
- The Vacuum Building;
- The Service Wing Extension Building;
- The Powerhouses including the Turbine Halls and the Turbine Auxiliary Bays;
- The Heavy Water Upgrading Building;
- The East Annex Buildings;
- The Administration Building;
- The Main Security Building; and
- All other small buildings, aboveground storage tanks, underground storage tanks and structures located inside the protected area.

A full list of buildings that has been considered when developing the cost estimates for decommissioning [15] (as detailed in Section 5.0) is provided in Table 3-1. Refer to Figure 2-1 for the location of buildings.

This plan will be revised as appropriate to incorporate any future changes in the scope of the decommissioning.

Table 3-1: List of Buildings Considered in Cost Estimations for PNGS-B

Location	Building Name
Units 5 to 8	
1	Service Area / Wing
2	Aux Irradiated Fuel Building
3B	Standby Generator Building
4B	Standby Generator Oil Pumphouse
5B	Screenhouse
6	Vacuum Building
8	Water Treatment Building
9	High Pressure Emergency Coolant Injection System (HPECIS) Pumphouse
10	HPECIS Auxiliary Services Building
11	Emergency Water & Power System Building
13	Administration Building
41	Transport & Work Equipment Garage
49	Oil/Chemical Storage Building
50	Service Wing Extension
55	Gas Bottle Storage Enclosure B
63	Setting Basin
64	Emergency Water & Power Oil Tanks
66B	Standby Generator Oil Tanks

Location	Building Name
67	Emergency Coolant Injection (ECI) Tower
68	Demineralized Water Tanks B
69	Transformer Building
74	Pressure Relief Duct
77	East Annex
78	Filtered Air Discharge
79	ECI Shield Tower
80-83	Emergency Control Center, Units 5 to 8
86	D_2O Upgrading Towers B
93-95	Reactor Auxiliary Bay B, Turbine Auxiliary Bay B, Turbine Hall B
97	IFB B
99	Service Wing Addition
100	Solid Waste Handling Facility
101	Tempering Water Pumphouse
126	Main Security Building
127	Auxiliary Security Building
37	Electrical/Pipe Shop
54	Standby Boiler Building
179	Reactor Building Service Water (RBSW) Environmental Building

3.2 Objective of the PNGS-B Decommissioning Program

The objective of the decommissioning program is to permanently retire PNGS-B from service in a manner that will ensure that the health, safety and security of workers, the public and the environment are protected. During the course of decommissioning, radioactive and other hazardous materials will be removed, and the site will be restored to meet the radiological release criteria approved by the CNSC. Upon completion of the decommissioning program, the site will be in a condition that will support an application to the CNSC for release from regulatory control. OPG will retain ownership of the site, and it will then be available for other OPG uses.

3.3 Decommissioning Phases

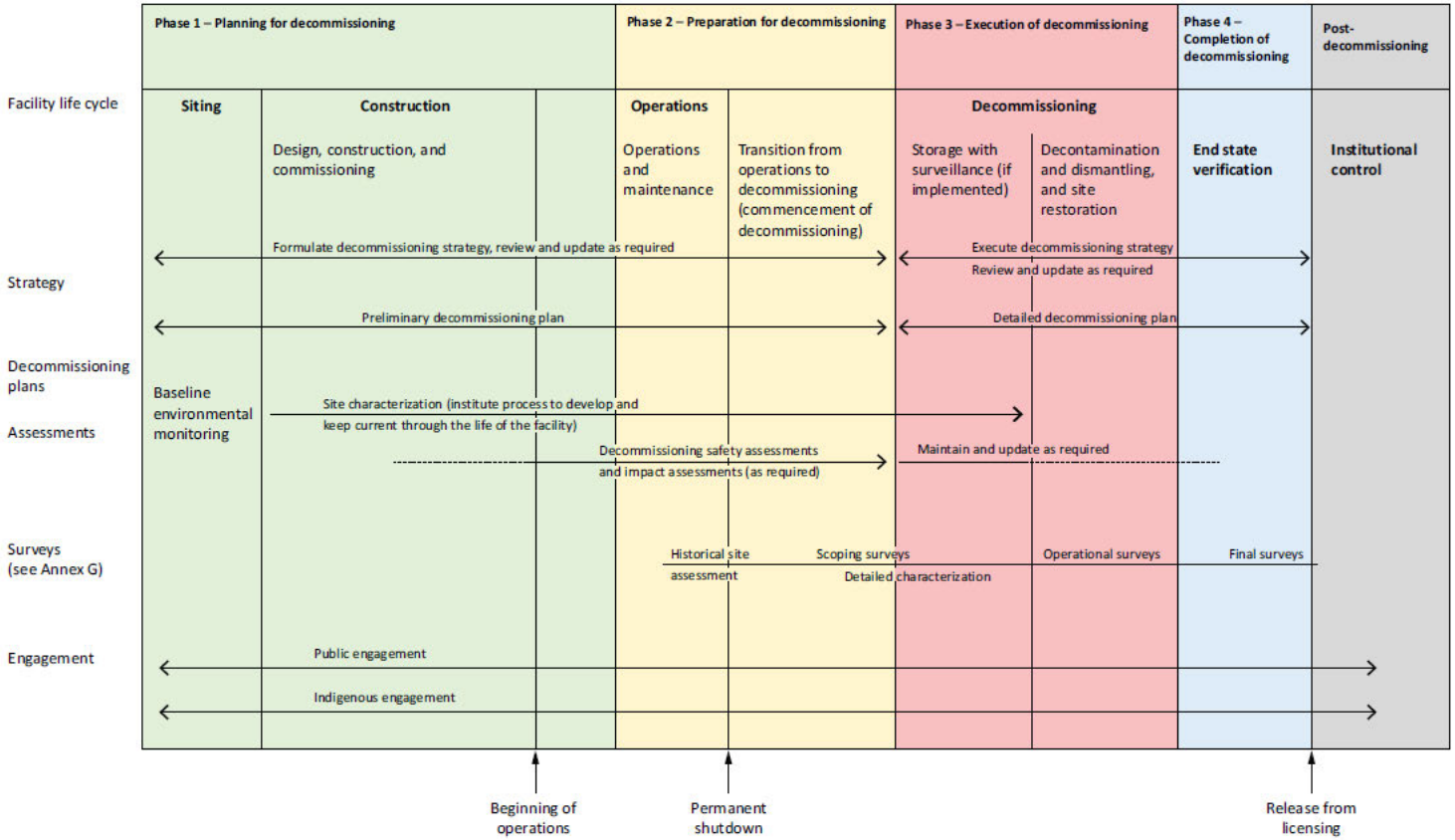
According to CNSC REGDOC-2.11.2 [2] and CSA N294:19 [3], decommissioning proceeds according to four distinct phases (see Figure 3-1):

(a) **Phase 1, Planning for Decommissioning**: This is carried out throughout the operating life of PNGS-B and results in the preparation of a decommissioning strategy (see Section 3.4) and a PDP (i.e., this document).

(b) **Phase 2, Preparation for Decommissioning**: This will begin when OPG decides to permanently shutdown PNGS-B after it has been potentially refurbished (see Section 2.2), and it has safely operated for 30-plus years. After the units in PNGS-B are permanently shut down, OPG will prepare for the transition to a stable state for SWS by defueling and dewatering the reactors and making all the necessary modifications to the Systems, Structures or Components (SSCs). This phase will end when the units enter into SWS. The PDP will be further developed into a DDP to include details of the activities that would be conducted in the next phase of decommissioning.

(c) **Phase 3, Execution of Decommissioning**: During this phase, a decommissioning licence will have been received from the CNSC and the DDP that was prepared in Phase 2 will be implemented. The PNGS-B will have been placed in SWS and will be monitored and maintained as deemed necessary while the radiation levels in the reactor systems decay. For planning purposes, it is assumed that the dismantling of the station will begin after a nominal 30 years of SWS. The activities under this phase also include the execution of the physical works (i.e., decontamination, Dismantling & Demolition of the facility) and site restoration. Note that site restoration is also referred to as ‘clean-up’ per CNSC REGDOC-2.11.2 [2] and can be used interchangeably throughout this PDP.

(d) **Phase 4, Completion of Decommissioning**: When Dismantling & Demolition and site restoration activities are completed, final surveys and an end state verification of the site will take place and release from regulatory control will be requested from the CNSC.



Time interval shown denotes the applicability of the plans and not the time when they are developed

Legend:

-------- identifies when the activity may be performed

—— identifies when an optional activity may be performed if required

Figure 3-1: Phases of Decommissioning [3]

This page has been left blank intentionally.

3.4 Decommissioning Strategy

3.4.1 Decommissioning Strategy Adopted by OPG

Three decommissioning options were considered, consistent with the CNSC REGDOC-2.11.2 [2] and CSA N294:19 [3]:

(a) **Prompt Decommissioning**, where the reactors and station would be decontaminated and, dismantled and cleaned-up, and the site restored promptly after shutdown.

(b) **Deferred Decommissioning**, where the reactors and stations would be safely stored for several decades after shutdown to allow radiation levels to decay prior to Dismantling & Demolition and Site Restoration.

(c) **In situ Decommissioning**, where the facility would be placed in a safe and secure condition, in which some or all of the radioactive contaminants will remain in-place, resulting in a waste disposal site.

OPG does not consider **In situ decommissioning** (c) as a sustainable decommissioning strategy so it was not considered in the assessment. **Prompt** (a) and **deferred** (b) strategies were considered and **deferred** decommissioning strategy was selected consistent with the decommissioning planning studies that OPG started in the 1980s. This strategy is considered to minimize both the occupational radiation dose to staff and the potential exposure of the public and the environment.

Preliminary schedule for the decommissioning of all facilities at the Pickering site, including PNGS-B, is provided in Pickering Overarching Site PDP [8]. It aligns timing of Pickering Unit 1 - Pickering Unit 4 and Pickering Unit 5 - Pickering Unit 8 Reactor Building demolition. As outlined in CNSC REGDOC-2.11.2 [2], the other key drivers in arriving at the strategy are as follows [2]:

- Political factors;
- Socio-economic impact;
- Lifetime cost;
- Financial resources;
- Waste facilities & infrastructure;
- Reactor type & facility history;
- Resources, technologies, & tools;
- Security;
- Health & Safety; and

- Environment.

Further considerations for selecting the deferred decommissioning strategy include:

(a) Lifetime cost – IFB B will take time to be emptied of fuel and contents. PNGS-B station systems support the operations of the bay. It would pose a challenge and add complexity to execute major dismantling work before all nuclear fuel is removed from PNGS-B and the station systems supporting fuel are end stated.

(b) Waste facilities & infrastructure – Generating radioactive wastes prior to the availability of radioactive waste disposal facilities introduces costs and risks. With the deferred dismantling sequence, it is expected that there is sufficient time to implement long-term disposal strategies for used fuel, LLW, and ILW to limit double handling of materials.

(c) Safeguards – Allows for removal of nuclear controlled substances, such as heavy water, resin, and nuclear fuel, from PNGS-B prior to any major dismantling.

(d) Health & safety – A deferral of greater than 10 years prior to major dismantling of nuclear systems allows for radioactive decay, though the decay characteristics vary significantly by radionuclide. While shorter-lived beta and gamma emitters decay relatively quickly, longer-lived radionuclides persist and become proportionally more significant over time. This changing radiological profile affects waste classification, handling requirements, and worker protection strategies. The deferral period can contribute to lower waste management costs associated with handling, packaging, shielding, transporting, and disposal, particularly for shorter-lived isotopes. While this generally improves worker safety through reduced radiation levels, comprehensive radiological characterization remains essential due to the complex decay patterns and presence of long-lived radionuclides. In summary, while the deferral period provides some radiological and economic benefits, these advantages must be evaluated within the context of the complex decay characteristics of different radionuclides present in the facility.

(e) Resources, technologies, & tools – Growth continues in decommissioning and nuclear waste management experience and technology across the industry, and a deferral of decommissioning of nuclear systems will allow time to leverage this experience to drive efficiency, gain knowledge and decrease cost.

(f) Socio-economic impact – Deferring dismantling provides valuable time to strategically engage stakeholders, plan future site uses, and align decommissioning end-states with evolving community needs, ultimately optimizing long-term socio-economic benefits for the region.

(g) Indigenous engagement – Allowing sufficient time for Indigenous engagement is essential to ensure impacts to Indigenous and Treaty rights are fully assessed. Deferred decommissioning allows time for this engagement, aligning on decisions and subsequently addressing any potential impacts. See Public, Stakeholders and Indigenous Engagement for more details.

(h) Knowledge & capability – Strategy is to start dismantling on less complex and more familiar activities, such as non-nuclear buildings and structures. This allows for building

of knowledge and capability in decommissioning before progressing to more complex activities, such as nuclear systems and the reactor.

Deferred decommissioning of PNGS-B will proceed according to a period of SWS followed by dismantling activities as shown in Figure 5-1, and planned to take into account resource availability, safety considerations, environmental hazards and conditions, and stakeholder inputs.

The dismantling and demolition sequence will be reassessed periodically considering operational plans, experience, updated cost estimates, changing technology, liabilities or risks identified during decommissioning planning, opportunities for risk reduction, and the potential repurposing of the site for future use. It is recognized that deferring decommissioning for extended periods of time can introduce a risk of losing institutional knowledge, and as such opportunities to leverage available personnel from other nuclear decommissioning will be considered in the schedule of dismantling work.

Given that PNGS-B will remain in operation for several decades, the choice of the best decommissioning strategy in alignment with the applicable regulatory framework will be reassessed periodically in light of experience, cost, changing technology and the possible requirement of the site for other purposes.

3.4.2 Deferred Decommissioning Strategy for PNGS-B

Applying the 'Deferred Decommissioning' strategy, PNGS-B will pass through the following decommissioning phases (as described in Section 3.3):

(a) Preparation for Safe Storage or Stabilization period (also referred to as Phase 2: Preparation for Decommissioning in Section 3.3(b));

(b) SWS (Part of Phase 3: Execution of Decommissioning, see Section 3.3(c));

(c) Dismantling & Demolition and Site Restoration (Part of Phase 3: Execution of Decommissioning, see Section 3.3(c)); and

(d) End State Verification (Part of Phase 4: Completion of Decommissioning, see Section 3.3(d)).

3.4.2.1 Phase 2 – Preparation for Decommissioning

During the Preparation for Safe Storage, OPG will plan and execute the safe transition of PNGS-B from its current (electricity generating) state, to a predetermined SSS. This will take place in the following order:

(a) Planning for stabilization and SWS – occurs before permanent shutdown. Details of the project planning activities are given in Section 4.1.2, and

(b) Stabilization – execution of activities detailed in the planning phase. Details of the project Stabilization activities are given in Section 4.1.4.

The planning for SWS will consist of activities to ensure that the physical and operational condition of the facility will meet all regulatory and operational requirements while minimizing the operational footprint of the facility to be maintained over the nominal 30-year SWS period. In preparation for scheduled permanent shutdown of PNGS-B, the design basis and safety analysis appropriate for the transition from operations to decommissioning will also be reviewed and modified to reflect plant conditions and the safety concerns consistent with permanent cessation of operations.

Stabilization activities will start following permanent shutdown of PNGS-B. The reactors will be defueled, and each unit will be dewatered, thereby reducing the radioactivity in the reactor by approximately 99 percent. All unnecessary SSCs will be placed into an inactive safe state, where they will be removed from the design basis, de-energized, drained of gas or fluids and isolated from operational systems. SSCs supporting continued operations will be reclassified and reconfigured, as required, to meet the operational needs of the SWS period. At the end of the Stabilization, the facility will remain intact with the structures in a safe condition.

3.4.2.2 Phase 3 – Execution of Decommissioning

3.4.2.2.1 Storage with Surveillance

SWS allows time for the decay of the short-lived fission and activation products that remain in plant components. The specifics of SWS will be outlined in the SWS plan (refer to Sections 1.1 and 4.1.3). During this period, used fuel transfer operations from the IFB will continue until all the used fuel has been transferred to NSS-PWMF or directly to the used fuel disposal facility. As such there will be two distinct phases of SWS:

- SSS (pools), when the used fuel is still in the IFB, and
- SSS (dry), when the IFB have been emptied of all used fuel.

3.4.2.2.2 Dismantling, Demolition and Site Restoration/Clean-up

Following SWS, Dismantling & Demolition are scheduled to occur over the duration identified in Figure 5-1 [15]. The first reactor will be dismantled, followed in sequence by the others. Radioactive and other hazardous materials will be removed from the site and transferred to approved disposal facilities. The site will then be cleaned-up and restored as described in Section 4.3.6 to a condition suitable for other OPG uses (see Section 4.4).

3.4.2.3 Phase 4: Completion of Decommissioning

During this phase, surveys will be conducted to verify the site meets the release criteria documented in the DDP. Surveys are further discussed in Sections 4.0 and 4.4. An end-state report will be submitted to the CNSC for acceptance so that the site can be released from regulatory control (see Section 4.6).

3.5 Decommissioning Strategy OPEX

Once PNGS-A enters decommissioning, OPG will have additional Operating Experience (OPEX) that can be used for planning PNGS-B decommissioning.

3.5.1 Domestic Decommissioning Strategies and Experience

OPG has successful decommissioning experience at both the Bruce Heavy Water Plant (HWP) and the Spent Solvent Treatment Facility (SSTF), which are both located on the Bruce Nuclear site.

OPG has an active decommissioning planning program and maintains formal knowledge exchange networks through the CANDU Owners Group (COG), the International Atomic Energy Agency (IAEA), and other international organizations. This includes both learning from other utilities' decommissioning experiences and committing to share its own decommissioning experience and lessons learned through established industry forums. Regular participation in technical committees, working groups, and peer reviews ensures systematic capture and exchange of operational experience, emerging technologies, and best practices.

Decommissioning strategies adopted in Canada for nuclear facilities are summarized below.

3.5.1.1 Bruce Heavy Water Plant

The Bruce HWP was in continuous operation from April 1973 until March 1998 for the purpose of producing reactor-grade heavy water [20]. After it was no longer in operation, the Bruce HWP decommissioning project was carried out in accordance with a DDP, remediation and an Environmental Assessment (EA) and follow-up program. Demolition began in October 2004 and was completed in 2006. The buildings were demolished using standard demolition techniques. The debris was removed from the site for recycling or disposal. Bioremediation of oil-contaminated soil in the effluent lagoons was required and began in 2006. About 25% of the soil was bioremediated to below the end-state criteria and was used as clean backfill in the immediate area. Any soil that did not meet the end state criteria was disposed of off-site at a licensed facility. The radiological end state was that no nuclear substances would remain within the Bruce HWP facility boundaries, and the remaining structures, equipment and grounds were free of significant radiological contamination. To demonstrate that this end state criterion was met, a final radiological survey was performed in 2012 using the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) methodology [21]. This survey found no radioactive contamination on the Bruce HWP site [22], [23] and a licence to abandon the facility was granted by the CNSC in 2014 [24].

3.5.1.2 Spent Solvent Treatment Facility

From May to December 2018, OPG completed decontamination of all radiologically contaminated piping in the SSTF. As decontamination progressed, each room or section was systematically surveyed and sampled for radiation in accordance with the MARSSIM methodology [21]. A Site Survey and Characterization report was prepared and approved by OPG in March 2019. This report concluded that radioactivity levels in the SSTF were below the site unconditional release criteria. The CNSC also concluded that OPG satisfactorily demonstrated that the SSTF was free of any contamination above the regulatory limits [25], [26] and [27]. This resulted in CNSC acceptance of OPG’s request to remove the SSTF from licensing control [28]. In November 2019, demolition of the above ground structure was completed. Most of the underground infrastructure was removed in February 2020, with the exception of some Bruce Power water lines that remained. Final site grading and remediation was completed in June 2020.

3.5.1.3 Gentilly-2 Nuclear Power Plant

Gentilly-2 Nuclear Power Plant (NPP), owned by Hydro-Québec, was shut down in 2012 and is currently in the SWS phase for approximately 40 years. Some of the main activities that have taken place from Gentilly-2 shutdown to reactor Stabilization and transition to SWS were [29]:

- Placing Gentilly-2 in guaranteed shutdown state;
- Removal of the fuel from the reactor;
- Transfer of resins and tank repairs;
- Emptying and transfer of heavy water;
- Preparations, modifications, removal of systems;
- Construction of infrastructure required for dry storage; and
- Transfer of fuel from the pool to dry storage (yearly summer campaign on site).

Hydro-Québec was granted (in June 2016) a 10-year power reactor decommissioning licence from the CNSC to continue activities related to the preparation for the decommissioning of Gentilly-2. Under this decommissioning licence, the activities include but are not limited to the following [29]:

- Construction of infrastructure required for dry storage; and
- Continuation of the transfer of fuel from the pool to dry storage (yearly summer campaign on site).

While emptying the fuel bays, Hydro-Québec utilized innovative technologies for canning and dry storage of damaged/defective fuel as well as waste segmentation tooling for ILW. This First Of A Kind (FOAK) approach is being evaluated for potential use within OPG.

3.5.1.4 Point Lepreau NGS

The Point Lepreau NGS, owned by New Brunswick Power (NBP) Corporation, has been operating since it was last refurbished in 2012. Currently, NBP has opted for the deferred decommissioning strategy.

3.5.1.5 Canadian Nuclear Laboratories Managed Facilities

Canadian Nuclear Laboratories (CNL) currently maintains several reactors in SWS including three prototype reactors (Nuclear Power Demonstration (NPD), Douglas Point (DP) and Gentilly-1 (G-1)) and several research reactors (Whiteshell Reactor (WR-1), National Research Experimental (NRX), Multipurpose Applied Physics Lattice Experiment (MAPLE)-1 and MAPLE-2). An eighth reactor, National Research Universal (NRU), is in a permanent shutdown state after ceasing operations in 2018. CNL originally proposed a deferred decommissioning strategy for all these reactors but changed to In-situ decommissioning for NPD and WR-1. This strategy

has been adopted for small reactors in several countries but is rarely used for a large power reactor. Both the Zero Energy Experimental Pile (ZEEP) reactor and the Pool Test Reactor (PTR) have been completely decommissioned. In addition to the reactors, CNL has been actively decommissioning legacy research and isotope production facilities and other support facilities across its sites.

The In-situ decommissioning strategy is usually limited to a small number of facilities in a given country, particularly to remote sites, in order to prevent the proliferation of waste disposal sites [30]. In 2019, the CNSC amended CNL's Waste Facility Decommissioning Licence into three separate licences for NPD, DP, and G-1. Under these new licences, CNL can proceed with the different decommissioning strategies and timelines for each site [31]. CNL is currently planning to proceed with final active decommissioning of nuclear facilities as well as continuing with its planned removal of remaining non-nuclear area facilities at the DP site [32], [33].

Within the last 10 years, CNL has accelerated its decommissioning timelines to reduce legacy liabilities and support the larger revitalization effort of its Chalk River campus. CNL applies a graded approach to its decommissioning activities that considers the unique radiological and non-radiological characteristics of facilities. In addition, CNL is considering multiple decommissioning strategies (prompt, deferred, and in-situ) for its portfolio of reactors and research facilities. Below is an update of the decommissioning plans for CNL's eight main reactors:

- At the NPD and WR-1, CNL continues to plan for in-situ disposal of the reactors and remaining systems;
- At DP and G-1, CNL is advancing the decommissioning of non-reactor components and hazard reduction while planning for the dismantlement of the calandria and reactor building internal systems; and
- At Chalk River (NRX, NRU, MAPLE-1, and MAPLE-2), decommissioning strategies are being explored to support the revitalization of the site. The NRX, MAPLE-1 and MAPLE-2 reactors have been in safe storage for several years while the NRU reactor was permanently shutdown in 2018. CNL is evaluating strategies to decommission these reactors in the near future to support construction of new Science and Technology research facilities. Characterization activities are currently in progress for these facilities, to help inform decommissioning strategies.

3.5.2 International Decommissioning Strategies and Experience

Decommissioning strategies adopted by the operators of other nuclear facilities around the world vary from Prompt Decommissioning (as referred to as immediate dismantling) to a variety of different Deferred Decommissioning approaches. The choice between Prompt and Deferred Decommissioning is influenced by many factors, as described in several publications prepared by the IAEA [34], [35] and [36].

Internationally, several small and some full-size power reactors have been successfully decommissioned and the sites made available for other uses. As of December 2023, 209 power reactors worldwide have been permanently shut down. Of these, 20 power reactors had been

fully decommissioned. Decommissioning strategies for these 20 power reactors were as follows [37]:

- 4 Deferred Decommissioning;
- 9 Prompt Decommissioning;
- 1 In-situ decommissioning; and
- 6 adopted a different decommissioning strategy.

OPG has conducted several benchmarking activities to gain experience and lessons learned from ongoing international Decommissioning projects. The international experience and lessons learned have been key inputs into the Decommissioning planning for PNGS-A to date. A summary of these activities is outlined in Table 3-2.

Table 3-2: Summary of Benchmarking Activities Conducted by OPG to Gain OPEX from Decommissioning Projects

Benchmark Date	Operator & Site(s)	Scope of Visit and Benchmark Areas
May 2022	Holtec • Indian Point Nuclear Power Facility (USA) • Oyster Creek Nuclear Power Facility (USA)	Site visit to stations undergoing execution of decommissioning. Benchmarking areas included technical aspects such as demolition strategy, waste management and site characterization; stakeholder consultation; regulatory approval process; and decommissioning project planning.
February 2023	Energy Solutions • Diablo Canyon Power Plant (USA) • San Onofre NGS (USA)	Site visit to stations undergoing execution of decommissioning. Benchmark areas included planning for transition from operations to decommissioning; community engagement; regulatory strategy; commercial strategy; technical aspects such as waste strategy, reactor segmentation and site characterization; and decommissioning project planning.
June 2023	Nuclear Decommissioning Authority • Sellafield Site (UK)	Site visit to station to observe decommissioning field work (e.g. fuel bay emptying) and waste storage. Benchmarking discussions around decommissioning strategy and program development; waste strategy; technical option development; and challenges.
January 2024	Pacific Gas and Electric Company • Humboldt Bay NPP (USA)	Conference call to review status of decommissioning project as well as discuss technical project challenges and lessons learned. Benchmarking areas included managed system changes; work package

Benchmark Date	Operator & Site(s)	Scope of Visit and Benchmark Areas
		development and work sequencing; security changes; licensing and permitting; resourcing; and waste strategy.
2024	Fortum • Loviisa NPP (Finland)	Site Visit to Fortum to share OPEX on waste handling processes. Shared knowledge and initiatives OPEX on waste minimization, and processing (including water processing), and nuclear waste interim storage and long-term disposal. Also discussed safety cases in relation to long term disposal.

OPG representatives have also gathered international benchmarking activities through participation at various conferences and industry groups. Some examples include:

- Power Plant Decommissioning Operational Excellence Conference;
- Waste Management Symposium;
- International Conference on Nuclear Decommissioning;
- IAEA Technical Working Group for Decommissioning; and
- COG Waste Management and Decommissioning Peer Group.

3.5.3 Records Management System OPEX and Lessons Learned

The implementation of a robust Records Management System (RMS) has proven to be a critical factor in the successful planning and execution of decommissioning activities. Drawing from OPEX and the guidance provided by the IAEA [38], several key lessons and best practices have emerged:

- Strategic Importance: An effective RMS is fundamental in providing comprehensive, up-to-date information to decommissioning teams and stakeholders. This enables informed decision-making throughout the planning and implementation phases, potentially averting significant financial consequences associated with inadequate documentation.
- Lifecycle Approach: The foundation of a successful RMS lies in the meticulous preservation of records spanning the entire facility lifecycle – from design and construction through operation and shutdown. This underscores the importance of early planning and the operator's responsibility in maintaining these critical records.
- Proactive Planning: Incorporating decommissioning considerations into the facility's design and operational phases has proven highly beneficial. This foresight ensures that essential information is readily available and easily transferable when needed, streamlining future decommissioning efforts.

- Early Establishment: The early implementation and continuous maintenance of an RMS have been crucial in preserving vital information throughout the active post-shutdown phase, SWS period, and final dismantling.

- Safety and Efficiency: A well-structured RMS has consistently demonstrated its value in facilitating safer and more efficient decommissioning processes.

- Regular Auditing: Regular, independent audits of the records archive, with a primary focus on decommissioning requirements, have been instrumental in maintaining the integrity and relevance of the RMS.

- Gap Identification: Implementing a robust auditing process has proven effective in identifying and addressing gaps within the RMS, ensuring the archives remain useful and comprehensive for decommissioning purposes.

- Long-term Usability: Given the potential for technological changes and diminishing facility knowledge over time, ensuring the long-term usability and understandability of transferred information has emerged as a critical consideration.

- Continuity of Knowledge: Maintaining control over both records and institutional knowledge throughout the entire decommissioning process has been identified as essential for success.

- System Resilience: Incorporating redundancy and diversity within the RMS has proven necessary for effective long-term records management.

- Media Selection: Careful selection of storage media, prioritizing durability, readability, and retrievability, has been crucial in ensuring the long-term preservation and accessibility of critical information.

These lessons learned highlight the pivotal role of a well-designed and maintained RMS in facilitating successful decommissioning outcomes. By incorporating these insights into its approach, OPG can enhance its preparedness and efficiency in future decommissioning projects.

3.6 Predicted Characteristics of the PNGS-B at Shutdown

As PNGS-B is shut down, it will be transitioned from operations to Stabilization (Preparation for Safe Storage), then SWS (Safe Storage), followed by Dismantling & Demolition and subsequent Site Restoration/clean-up activities. The actual station condition will be characterized, as required, prior to each activity. However, certain conditions such as the radiological, chemical and physical conditions of the station can already be predicted with sufficient accuracy for preliminary decommissioning planning purposes. A general description of the radiological, chemical and physical conditions of the stations at the time of permanent shutdown is outlined below and more details can be found in Section 8.0 and in [39].

The radiological condition of the station will depend on both the design and the operating history of the reactor units. Generally, the main sources of radiation at shutdown will be the used fuel resident in the reactors and stored in the IFB, the activated and contaminated sections of the

reactor internals and the components of the Primary Heat Transport (PHT) and moderator systems. Other sources of radiation can be found in the heavy water used in the PHT coolant and moderator, in fission products in the IFB, in the ion exchange resin and columns used in purification of the PHT and moderator system fluids and in the fuelling machines.

During operations, routine radiation dose rate and contamination surveys of the accessible, normally frequented areas of the facility are performed at regular intervals. Any loose contamination discovered outside of contamination control areas is removed or the area is re-designated as a contamination control area. In addition, non-routine radiation dose rate and contamination surveys (for exposure control) are carried out whenever abnormal or changed radiological conditions are known or suspected to exist [40].

In preparation for the decommissioning of PNGS-A, the Historical Site Assessment (HSA) has been updated. The context of this HSA will remain around planning for the decommissioning activities on the Pickering Nuclear site, and is, therefore, also applicable to PNGS-B. The HSA used historical information to provide initial area and facility classifications, which would be used in the development of a site characterization plan and for guiding remediation efforts. The HSA described the site physical configuration, identified the radioactive material, designated substances and hazardous constituents that constitute site contamination. In addition, the HSA assessed the potential migration of contaminants, identified contaminated media, identified impacted and non-impacted areas, and classified the impacted areas in accordance with a standard process. The HSA evaluated all structures and areas in the licensed portion of the site. However, since most of the contaminated structures and systems would be removed during the Dismantling & Demolition phase, the HSA focused more heavily on SSCs that would likely remain at the time of final status surveys and on open land areas.

The HSA has also been conducted as a precursor for further site characterization activities in a Radiation Survey and Site Investigation (RSSI) process and will be maintained up to the Dismantling & Demolition phase of decommissioning as per MARSSIM [21].

As mentioned in Section 4.1.4.4, post-operational/scoping surveys will be performed when the station is shut down. Characterization surveys will also be performed during the Preparation for Safe Storage or during the SWS period, prior to the start of the Dismantling & Demolition phase. The acquired site characterization field data will permit an appropriate assessment of the radiological and conventional hazards that can affect workers, the public and the environment.

The RSSI will use a graded approach for performing a site investigation and has begun by preparing an HSA and includes various surveys and sampling to assess site radiological conditions. The RSSI will conclude with a final survey (See Section 4.0), which is designed to show that residual radioactivity at the site meets regulatory approval, and which ultimately leads to final licence termination after decommissioning is completed.

The results of the radiation dose rate and contamination surveys, together with other information on the radiological hazards and conditions in the facility, are recorded in OPG's electronic database known as the Visual Survey Data System (VSDS). The information in this database will be available for use during the Preparation for Safe Storage, SWS and final preparation of the DDP. Other information on hazards that are discovered is also recorded in this database.

All records including those in OPG 'Station Condition Record' (SCR) electronic database, where adverse conditions are tracked, will be reviewed during the preparation for decommissioning.

OPG also has extensive programs to minimize spills to the environment and to effectively manage those that occur. Spills that may cause an adverse effect are categorized as Category A (Very Serious); Category B (Serious) and Category C (Less Serious), as per OPG Spill Management: OPG-STD-0152 [41] and are reported to the Spills Action Center, Ministry of the Environment, Conservation and Parks. A non-exhaustive list of radiological and non-radiological incidents during PNGS-B operations that could affect decommissioning efforts at PNGS-B is compiled in the updated HSA. The intent is for the events within this table to be reviewed during the Planning Phase of future characterization campaigns. The number of these spills has been decreasing due to improved environmental awareness and stricter spill control practices [42].

Most of the hazardous materials stored on the site (flammable, cryogenic gases, oxidizers, corrosives, etc.) will be consumed during routine station operations. Some of the remaining materials will be consumed during the shutdown period. Others, such as the fuel oil for the standby generators, can be removed for use at other sites when the systems have been permanently removed from service.

Until the final shutdown of PNGS-B, OPG will continue to maintain and operate the station SSCs in a manner that will minimize the deterioration of these assets. It is anticipated that these SSCs will be in good working condition at the time of permanent shutdown. Individual component condition assessments will be conducted prior to station permanent shutdown.

3.7 Uncertainty and Degree of Conservatism

There are several elements of risk and uncertainty associated with decommissioning PNGS-B. Some of the main ones include, but are not limited to the following:

- Planning assumptions;
- Physical, radiological and non-radiological state of the facility resulting from uncertainties in characterization, theoretical models used to support characterization, etc. [43];
- Regulatory framework;
- Technical strategy/approach for decommissioning;
- Waste disposition;
- Indigenous Rights Holding First Nations concerns; and
- Stakeholder concerns.

Risks associated with the planning assumptions supporting this PDP and the associated cost estimates have been identified, documented and are being tracked by OPG. The cost estimate is based on a well-established methodology and takes into account a risk contingency to

address impacts that are likely to occur beyond the project scope (i.e., unknown unknowns), as described in the PNGS-B Decommissioning Costing Report [15]. To further address uncertainties, relevant OPEX from other sites being decommissioned, industry best practices and the cost estimator's judgement were used for preliminary decommissioning planning. The PNGS-B Decommissioning Costing Report [15] provides a list of relevant OPEX sites that was reviewed as input to the preparation of the costing.

As mentioned in Section 3.6, characterization surveys will be completed and will be used as input in the development of the DDP. This thorough site characterization based on the MARSSIM approach will reduce the uncertainties associated with execution of decommissioning by addressing the following [44]:

- Understanding of the conditions of facility – radiometric, chemo-toxic, biological, physical and structural;
- Defining the amount, location and composition of contaminants (radiological and non-radiological) and the associated physical parameters; and
- Categorizing the SSCs and site areas (including ground water) in contaminated, potentially contaminated and non-contaminated areas as a basis for zoning or implementation of a graded approach for clearance.

The safety assessment, which will be prepared in conjunction with the DDP (see Section 4.2.4), will take into account identifiable uncertainties and address them as the decommissioning activities progress. The safety assessment should be conservative though not normally unduly so, unless this allows the safety assessment to be simplified and provides overall benefit to the decommissioning project. Typical sources of uncertainty as identified in the IAEA Safety Guide WS-G-5.2 [45] include:

- Source and magnitude of radiological hazards (e.g., inventory characteristics and source terms – location, dimensions, spatial distribution, constituents and quantities);
- Scenarios that could lead to these hazards such as the frequency of occurrence, exposure pathways, assumptions required in support of the calculations of frequencies and consequences, during both normal and accidental conditions;
- Predicted consequences – such as the dose rate and occupational doses; and
- The mathematical models used in the calculation of the effective doses or risks following normal and accident scenarios.

In addition, generic data may be primarily used in the preparation of the preliminary safety assessment. There is also an uncertainty issue arising from the state of the facility during and after the SWS period, in particular the extent to which aging may have compromised the building structures or engineered safety measures, which may affect the safety margins [46].

The safety assessment will be reviewed, revised or updated, as required, when additional information becomes available as compared to the earlier phases of the decommissioning

project. It is also expected that the uncertainty with regard to radioactive inventory and the condition of the facility may be reduced as decommissioning progresses.

Further details on the uncertainty associated with decommissioning safety assessment are provided in [45].

In terms of any uncertainty related to the regulatory framework, OPG maintains a good communication protocol with the CNSC and ensures that the PDP meets the regulatory requirements in its licence and Licence Condition Handbook (LCH), as described in Section 1.5, Appendix A and Appendix B.

This PDP demonstrates that decommissioning is feasible with existing technology. OPG will use applicable OPEX from refurbishment projects to further reduce the uncertainty associated with execution of the decommissioning tasks.

The PDP reflects OPG's assumptions for the long-term disposal strategy for its Low and Intermediate Level Waste (L&ILW) decommissioning waste, as described in Section 4.7.2.3. It is anticipated that these licenced disposal facilities for L&ILW will be available prior to the end of commercial operation of PNGS-B. As appropriate, future revisions to the PDP will update these assumptions.

To manage uncertainty related to stakeholder perception for PNGS decommissioning, OPG has extensive public and stakeholder engagement activities, as described in Section 12.0.

To further reduce the uncertainty associated with the decommissioning project, clear endpoints will be defined to accurately determine intermediate progress and develop reliable forecasts to complete remaining activities. This will be set up in the form of optimal selection and use of performance indicators in alignment with best practices recommended by the IAEA [47].

It is also expected that the level of uncertainty of knowledge relevant to decommissioning will decrease with maturity of the decommissioning planning [44], i.e., as this plan evolves from a PDP to a DDP.

4.0 DESCRIPTION OF PLANNED DECOMMISSIONING ACTIVITIES

This section describes the major activities that will be performed during the course of the planned decommissioning work at PNGS-B with respect to each of the decommissioning phases described in Section 3.4.2.

The Preparation for Safe Storage will begin before permanent shutdown and will utilize OPEX from PNGS-A. It is anticipated that three years will be required to complete execution of Stabilization for PNGS-B once it has been shut down. OPG will prepare and submit a DDP or a separate SWS plan to the CNSC approximately two to five years prior to the SWS period as part of OPG's application for a decommissioning licence.

All timing should be considered approximate and used for planning purposes.

The anticipated major project milestones for decommissioning the PNGS-B are provided in Figure 5-1 and the PNGS-B Decommissioning Costing Report [15]. More detailed schedules of decommissioning activities will be submitted to the CNSC as part of the DDP.

The SWS period will begin upon the completion of the preparatory work. The duration of the SWS period will be long enough to bring the total time from permanent shutdown to the beginning of the Dismantling & Demolition period to nominally 30 years.

It is anticipated that the detailed plans describing the work that will be performed in the Dismantling & Demolition, and Site Restoration/Clean-up period will be completed during the SWS period and submitted in a revised DDP for CNSC acceptance prior to the start of dismantling. OPG will consider operational experience gained from dismantling the first unit and apply to the other units.

A series of surveys for radiological and non-radiological conditions will be performed throughout the various phases in the lifecycle of PNGS-B to support decommissioning [2]. These surveys are further described in Section 4.4. The final end-state survey of PNGS-B will be initiated, according to a survey plan, when the last unit has been dismantled. Once site restoration/clean-up has been completed, a final end state report will be submitted to the CNSC for acceptance as part of the request for a release from regulatory control.

The interaction of PNGS-B and other facilities on the Pickering Nuclear site is described in the Pickering Nuclear Site Overarching PDP [8].

4.1 Preparation for Safe Storage

It is expected that OPG will utilize a similar approach to PNGS-A Preparation for Safe Storage for PNGS-B Preparation for Safe Storage, and lessons learned will be incorporated as appropriate.

4.1.1 Preparation for Safe Storage Project Scope

The Preparation for Safe Storage Project will plan and execute the safe transition of the PNGS-B from its current (electricity generating) state to its predetermined SSS. The SSS refers to the

physical, operational and administrative state in which PNGS-B will be maintained for the nominal 30-year SWS period until dismantling activities commence.

The Preparation for Safe Storage Project goals and objectives include, but are not limited to:

- Defuel and removal of heavy water from systems;
- Continue to safely and securely store nuclear substances, such as irradiated fuel and heavy water on site;
- Maintain the facility in a safe and stable condition while creating no new hazards;
- Reduce the footprint of the station in preparation for the next phase of decommissioning; and
- Protect workers, the public and the environment from residual radioactive sources and hazardous materials remaining on site and maintain exposures to As Low As Reasonably Achievable (ALARA).

4.1.2 SWS Planning Activities

Work to define the SSS will take place prior to permanent shutdown in order to confirm the physical and operational condition of the facility which will meet all regulatory and operational requirements, while minimizing the operational footprint of the facility to be maintained over the nominal 30-year SWS period.

Project planning activities will include:

- Developing strategies as well as timeline and resource estimates for major Stabilization activities, such as defueling, dewatering and system end-stating or reconfiguration taking into account OPEX from Pickering A Safe Storage, refurbishment projects, as well as international guidance referenced in the Pickering Nuclear Site Overarching PDP [8].
- Completing an environmental review to proactively assess the potential environmental impacts resulting from proposed SWS activities or physical/operational changes to the station. The results of the review will identify environmental monitoring studies and/or mitigation measures required to manage the predicted effects.
- Confirming the regulatory and system drivers that will determine the operational demands during the SWS period.
- Reviewing and revising programs that are in place during operations as well as applying OPEX from PNGS-A decommissioning to ensure that requirements for the remaining stages of decommissioning are met. Examples include, but are not limited to, environmental monitoring, radiation protection, emergency response, and fire protection. If required, new program documents will be developed. The plans and protocols, developed during the detailed planning stage, for monitoring the following will be submitted to the CNSC for acceptance and implemented during decommissioning:

- work hazards during decommissioning;
- personnel dosimetry;
- environmental emissions and effluents; and
- materials, sites and structures to be cleared from regulatory control.

- Completing engineering studies to determine the most efficient and effective means of reconfiguring station systems to meet SWS requirements, such as the alternative means for supplying and distributing adequate heating and ventilation, electrical supplies and service water to the station in the SSS.
- Conducting a system-by-system review of the plant through End State Determination Reports (ESDRs) to determine which modifications are required to the transition the plant to an SSS.
- Developing a safety assessment framework to manage the nuclear and reactor safety aspects of Stabilization activities.
- Developing a waste management strategy for all waste streams generated during decommissioning, including the plan for disposal of these wastes.
- Engaging stakeholders, including the public, as well as Rights Holding First Nations, in SWS planning activities.

In support of the Preparation for Safe Storage Project, a safety assessment will also be completed, including controls and approvals, to facilitate the permanent shutdown and Stabilization of the station. The safety assessment for decommissioning will follow REGDOC-2.11.2 [2] and CSA N294 [3] applicable at the time. The objectives for the safety assessment include:

a) Demonstrate that applicable regulatory requirements are met throughout Stabilization.

b) Demonstrate through systematic hazard analyses that the risks posed by hazards due to both Stabilization activities and for accident conditions are understood and managed.

c) Identify necessary mitigating measures, and limit controls and conditions to meet safety criteria throughout Stabilization.

d) Quantify the hazard reduction to be achieved through Stabilization activities.

4.1.3 Regulatory Submissions

As noted in Section 1.1, the SAP and SOP will be prepared and submitted to the CNSC prior to entering into the SWS period. In addition, a DDP and a SWS plan will be prepared and submitted to the CNSC with the application for a decommissioning licence as per REGDOC-2.11.2 [2] applicable at the time.

The SOP will describe the arrangements and activities that ensure safe and reliable operation of PNGS-B to the end of commercial operation. The SOP will cover the period starting five years prior to the final shutdown of the first PNGS-B operating unit and ending with the final shutdown of the last operating unit. The SOP provides confidence that as the PNGS-B approaches end of commercial operation:

- Nuclear safety is assured such that plant personnel, the public and the environment are protected;
- Systems, structures and components at the plant continue to be fit for service until its end of service life;
- Staff are qualified and competent to operate the plant, including sufficient staffing numbers;
- Impacts of plant operation to the public, workers, and the environment will continue to be of low risk and adequately mitigated, while continuing to provide the various societal and environmental benefits of plant operation;
- Transparency and appropriate public and Indigenous engagements and consultations will continue;
- End of Commercial Operation is structured to align with OPG's Nuclear Management System governance framework; and
- Planning is integrated to ensure consistency in the transition from commercial operation to the next phases.

The SAP will describe, at a high level, the plan for managing arrangements and activities that will be conducted in support of the shutdown and Stabilization of PNGS across all 14 Safety and Control Areas (SCAs) of the licence. The purpose of the SAP is to ensure the safe transition of the facility from its guaranteed shutdown state to its SSS [11]. The SAP is intended to be a living document, evolving with time and increasing in scope and definition with future submissions as planning progresses.

The DDP will outline OPG's plan for the continued safe operation and management of the facility over the SWS period covering all applicable SCAs of the licence and include information on the physical, operational and administrative state of the facility in the SWS period. This DDP will be prepared to meet the applicable requirements of CNSC REGDOC-2.11.2 [2] and CSA N294 [3] and it will be organized to address the various phases of the decommissioning project (Section 3.4.2). Since SWS will take longer than five years, the DDP will be reviewed and updated as required. The DDP will later be revised to provide additional details in preparation for, and execution of, Dismantling and Demolition and Site Restoration/Clean-up (see Section 4.2.4). It is expected that the DDP will be incorporated into a licence authorizing decommissioning of PNGS-B once it has been accepted by the CNSC.

A detailed safety assessment of the work to be performed during SWS will be prepared and submitted along with the DDP or included in the DDP. The decommissioning safety assessment

will address the requirements of CNSC REGDOC-2.11.2, Section 7.2 [2] applicable at the time and it will:

- Address potential radiological hazards to workers, the public, and the environment, from both routine decommissioning activities and credible accidents during decommissioning;
- Identify the mitigating methods to address the risks associated with these hazards and any residual risks to the public once decommissioning has been completed [3]; and
- Be updated as necessary in light of revised regulatory requirements, advances in decommissioning technology, changes in site characteristics, modifications to the design or operations, effects of aging, and operational experience and lessons learned [14].

The safety assessment will be conducted in accordance with a graded approach. The results of the safety assessment will be used to:

- support the development of the decommissioning plan and selection of the decommissioning strategy;
- specify the program for maintenance, surveillance and inspection;
- specify the procedures to be put in place for all decommissioning activities significant to safety for responding to accidents or any identified risks;
- specify the necessary competencies for the staff involved in the decommissioning of the facility, location or site; and
- make decisions using an integrated, risk-informed approach.

As mentioned in Section 1.1, a SWS plan will also be submitted to the CNSC for acceptance. The SWS plan will be developed according to CNSC REGDOC-2.11.2 [2] applicable at the time on the basis of the outcomes of the safety assessment and will be updated as necessary throughout the SWS phase. The SWS plan will include any activities envisioned or planned to reduce the risks at PNGS-B [2].

4.1.4 Stabilization

The transition, or Stabilization of the station, will commence immediately following the end of commercial operations and be completed once the physical, operational and administrative transition to the SSS is confirmed.

The Stabilization activities are expected to be undertaken as part of a Safe Storage Project that will be carried out under an existing Power Reactor Operating Licence and can be performed with currently available technology, while utilizing similar approach and OPEX gained from Stabilization of PNGS-A.

The Stabilization of the station will include physical changes to the plant, resulting from end-stating activities, as well as personnel and programmatic changes to how the plant is organized and managed.

Some of the key Stabilization activities are outlined in the subsections below. At the end of Stabilization, an interim end state report including the End State Declaration reports for Stabilization (see Section 4.1.4.3) will be produced and submitted to the CNSC to document the work that was executed. Any repurposing activities inside the protected area implemented after final shutdown will not negatively impact decommissioning activities.

4.1.4.1 Defueling

The first step to reducing hazards and placing each unit into its SSS will be reactor defueling. Defueling will be completed by plant personnel to achieve a guaranteed defueled state using conventional defueling practices (utilizing existing fuelling machines). All fuel removed from the units will be transferred to IFB-B for storage and monitoring. Thereafter, the fuel handling systems that are no longer required will be end stated.

4.1.4.2 Dewatering

Following the completion of defueling activities, each unit will be dewatered of heavy water. The moderator system will be drained, flushed and dried to reduce residual contamination. The heat transport system will be drained to Very Low Level Drain State (VLLDS) and then bulk vacuum dried. Heavy water removed from the reactor systems (see inventory in Table 1-1 of Pickering NGS B Safety Report – Part 1 [17]) will be stored in a suitable interim storage facility if required, prior to disposal.

4.1.4.3 End State of Stabilization Activities

As Stabilization activities progress, all contaminated and non-contaminated systems that are no longer required to support the operation of the station will be placed into an inactive safe state. That is, they will be de-energized, drained of gas or fluids and isolated from operational systems. Contaminated systems will be decontaminated as required for future maintenance and inspection.

Systems that will remain necessary to support continued operation in the SSS will be constructed, modified or left as is, as required to meet the SWS operational demands. A high-level overview of the anticipated system demands in the SWS phase is outlined in Section 4.2.

The operational requirements for each individual system (or groups of related systems) will be identified and will be documented in Safe Storage ESDRs. OPEX from PNGS-A will be utilized in preparing these ESDRs. In the case of active (or partially active) systems, ESDRs will describe the role of each system in meeting the SWS design basis. Alternatively, for inactive systems, ESDRs will provide justification as to why the system is no longer required to operate in the SSS. Collectively, ESDRs outline, in detail, the physical and operational footprint of the facility in the SSS. The ESDRs will also define the periodic monitoring requirements for these systems.

Final end state declaration(s) for Stabilization will be prepared to complete the documentation to describe the as-left Safe Storage configuration. The station end state will be declared when all the systems at PNGS-B achieve the conditions prescribed in the ESDRs for Stabilization.

4.1.4.4 Radiation Surveys and Decontamination

Detailed post-operational/scoping surveys will be conducted after PNGS-B is shut down and that will be used as input for preparation of the DDP. Radiation surveys will also continue to be performed throughout the Stabilization period to facilitate dose control and the requirements of the Radiation Protection Program [40]. Loose and/or fixed contamination will be removed, as required, from areas of the plant which would be accessed by personnel. Contaminated equipment located in accessible areas may be removed for decontamination or disposal, if appropriate.

Any radiation devices not required during SWS will be removed for use at another licensed facility or packaged and shipped for disposal at an approved facility.

After reactor final shutdown and as part of the Preparation for Safe Storage, the PHT system will not be chemically decontaminated.

The secondary side demineralized water will be sampled to confirm that the non-radiological contaminants in the water are within the Derived Release Limits (DRLs) and discharged (as appropriate) through the inactive drainage, using similar procedures adopted during outages.

4.1.4.5 Hazardous Material

In general, transient hazardous wastes will be removed as a result of Stabilization activities. Stabilization activities will include:

- Draining lubricants, coolants and other chemicals from inactive station systems, including above and below ground storage tanks and/or sumps; and
- Removing from the site hazardous chemicals or compressed chemical gases that are no longer required.

Pre-approved disposal pathways for hazardous material will be utilized for all Stabilization activities.

4.1.4.6 Site Characterization

OPG will perform a limited site characterization of the plant and the licensed site during the Preparation for Safe Storage to investigate the amount (if any) of contamination present on the PNGS-B site and to identify the decontamination necessary to reduce occupational exposure for facility maintenance during the SWS period. The site characterization will include, as needed:

1. soil;
2. groundwater;

3. surface water;
4. soil vapour;
5. air quality;
6. sediment;
7. biology; and
8. background radiological levels.

Characterization of the radioactive contamination remaining in the station will be performed based on the results of the radiation and contamination surveys (see Section 4.1.4.4) and the existing historic information (see Section 3.6). The results of these surveys will be recorded and eventually be used when preparing the work plans for the DDP (Section 4.2.4) that will be submitted for approval to the CNSC prior to Dismantling & Demolition.

4.2 Storage with Surveillance

The facility will be maintained in a safe and secure state over the SWS period to allow for the decay of residual activation and fission products that remain in the station's systems prior to commencing Dismantling & Demolition activities. For planning purposes, it is assumed that the SWS period will last for nominally 30 years from shutdown.

In order to reduce the operational footprint of the station for the SWS period, SSCs no longer required to support regulatory, or system requirements will be placed into an inactive safe state, that is, they will be removed from the design basis, de-energized, drained of gas or fluids and isolated from operational systems. SSCs that remain necessary to support continued operations (i.e., in active safe state) to meet operational demands will be modified or reconfigured, as required, during Stabilization. Based on the planning efforts to date and OPEX from PNGS-A Preparation for Safe Storage Project, systems required to satisfy operational and regulatory requirements in the SWS period include:

- IFB B (including sufficient cooling, purification, monitoring equipment, Emergency Mitigating Equipment[4] and the means to continue to transfer spent fuel to dry fuel storage containers);
- The NSS-PWMF, including the ability to continue to receive, package, process and store Dry Storage Containers (DSCs) containing spent fuel (Note: The NSS-PWMF is included here for completeness, however it is not included in the scope of the PNGS-B PDP – See Section 1.0);
- Select Heavy Water Storage Tanks located at various locations across the facility for interim storage of the tritiated heavy water if required;

[4] Emergency Mitigating Equipment or other equivalent equipment will be available to provide fuel cooling in the bays in case of Beyond Design Basis Events.

- IFB B operations support (e.g., spent resin storage and handling systems);
- Environmental monitoring equipment for intermittent (or continuous) monitoring of selected atmospheric and liquid emission streams;
- Active and inactive drainage systems, including the means to collect, store, treat and discharge liquid waste streams;
- Heating and ventilation systems to maintain minimum temperatures in all in-service (or partially in-service) areas of the facility, as required;
- Radiation monitoring equipment;
- Select fire protection equipment;
- Security systems;
- Auxiliary systems that will be required to support the above noted operational systems including, but not limited to, power (including back-up power) supplies, air supplies, service water, domestic water and demineralized water supplies;
- L&ILW management systems, including the means to collect, store, package, and ship L&ILW generated on site; and
- An (alternative) central monitoring and control station.

Essential facilities will have the necessary heating and lighting during the SWS period.

During SWS, OPG will ensure that [2]:

- Activities are conducted in accordance with the DDP (see Section 4.1.3) and associated programs (see further below);
- A decommissioning process and supporting programs are implemented to ensure safety;
- A methodology for issuing, modifying and terminating work procedures is established; and
- An up-to-date list of SSCs important to safety, as well as surveillance and maintenance plans for these SSCs is maintained.

Activities during SWS will include security, preventive and corrective maintenance on security systems, area lighting, general building maintenance, fire protection, heating and ventilation of buildings, routine radiological inspections of contaminated structures, maintenance of structural integrity, and a site environmental and radiation monitoring program.

Equipment maintenance, inspection activities, and routine service will be performed by resident maintenance personnel. This workforce will maintain the structures in a safe condition, provide

adequate lighting, heating, and ventilation, and perform periodic preventive maintenance on essential site equipment.

Administratively, programs that will continue to support station operations, organized by SCAs, will include:

- Management System;
- Human performance management, including training;
- Operating performance;
- Safety Analysis;
- Physical Design;
- Fitness for Service (including aging management and preventative maintenance programs);
- Radiation protection;
- Conventional health and safety programs;
- Environmental protection and environmental monitoring;
- Emergency management and fire protection;
- Waste management;
- Security;
- Safeguards and non-proliferation; and
- Packaging and transport.

Other matters of regulatory interest such as that stipulated in CNSC REGDOC-1.1.3 [49] will continue to be addressed during the SWS:

- Public and Indigenous engagement that meets the requirements of CNSC REGDOC-3.2.1 [50] and CNSC REGDOC-3.2.2 [51] respectively; and
- Financial guarantee that meets the requirements of CNSC REGDOC-3.3.1 [52].

In all cases, the programs and procedures will be adapted to meet regulatory requirements, while remaining commensurate with the complexity and risks of the SWS operations and any revisions to these programs and procedures will require acceptance by the CNSC, where applicable.

Activities involved in removing intermediate level operational waste generated prior to the stations entering SWS will also continue into the SWS period. Contaminated waste generated from periodic surveys, inspections and maintenance activities at PNGS-B during SWS will be managed at an appropriate licensed facility. OPG will also maintain the IFB and associated systems while the fuel remains in the bays, up until the fuel is transferred to NSS-PWMF or the used fuel disposal facility.

During the SWS phase, access to contaminated areas will be secured to provide controlled access for inspection and maintenance. OPG will perform continuous monitoring and surveillance of the facility to ensure that worker and public safety is maintained and to ensure that potential adverse releases of radioactive material to the environment are controlled and prevented.

The SWS plan (see Section 4.1.3) will be implemented during the SWS period to ensure that:

- The station remains safe;
- Any release of materials to the environment is controlled;
- Inadvertent entry of unauthorized persons in the facility is prevented; and
- Any biological hazards, which may result from any animals, plants, fungi or their detritus in the building or from the growth of moulds on exposed surfaces that may appear over time, are mitigated.

The radiological monitoring and survey plans approved by the CNSC (see Section 4.1.2) will also be implemented during the SWS.

An effluent monitoring program, consistent with CSA N288.5 [53] applicable at the time will be carried out during the SWS period to ensure any radiological and non-radiological emissions to the environment are controlled and monitored. Appropriate emergency procedures will be established and initiated for releases that could exceed prescribed limits. An environmental monitoring program, consistent with CSA N288.4 [54] applicable at the time, will be maintained and adjusted, as required, to reflect the activities and environmental effects during decommissioning. A small plant staff will be maintained during this period to support the maintenance, inspection, and monitoring/surveillance programs.

Routine radiological monitoring of contaminated structures and systems will also be performed. Procedures for responding to unanticipated changes in the radiological environment of the site and potential releases to the environment will be prepared and implemented, if required.

Security during SWS is limited to access control and is expected to be minimal. Security during the SWS period will be maintained primarily to prevent unauthorized entry due to the presence of spent fuel on the site. Once all the spent fuel has been removed from IFB-B, there will be a case for reducing the security presence on site. Security will be provided by the security fence, sensors, alarms, surveillance equipment, etc., which will be maintained in good condition for the duration of this period. Fire and radiation alarms are also to be monitored and maintained. A small group of plant staff will be retained during this period to support the maintenance, inspection and surveillance programs.

4.2.1 Used Fuel Transfer Operations

The used fuel transfer operations will continue during Preparation for Safe Storage and extend into the SWS period.

The IFB-B will remain in operation through the first part of the SWS period until all the used fuel has been removed from the bays. The defected fuel is planned to be removed last from the fuel bays.

In order to comply with CNSC and IAEA requirements, safeguard arrangements in the IFB-B will be maintained until all of the used fuel has been removed.

Used fuel will be transferred to NSS-PWMF or directly to the used fuel disposal facility, (i.e., Adaptive Phased Management (APM)) which is assumed to be available at the time. Once all waste has been removed from the IFB, the following will be carried out:

- Conduct surveys to confirm that no fuel particles remain in the IFB if fuel particles are found, the water will be treated to remove such particles;
- Collect samples of the IFB water and analyze it to confirm that it meets the radiological and chemical clearance levels that have been established;
- Drain the IFB and dispose of the water in accordance with the applicable regulatory requirements;
- Remove ion exchange resins for disposal;
- Survey and decontaminate the surfaces of the IFB;
- Mitigate any remaining hazards to workers through the erection of barriers and posting of warning signs;
- Perform a site characterization survey of the empty fuel bays and surrounding areas to confirm safe state;
- Secure the IFB for the remainder of the storage period; and
- With the approval of the CNSC, shut down and remove the safeguard monitoring equipment.

By the end of the SWS period, all used fuel is assumed to have been removed from the site to the used fuel disposal facility.

4.2.2 Planning for Dismantling & Demolition and Site Restoration

Towards the end of the SWS period, OPG will make detailed preparations for the dismantling of the remaining systems, structures, and the disposal of the waste. If a graded approach is utilized, the requirements in REGDOC-2.11.2 [3] shall apply. The DDP will be revised and submitted to the CNSC for acceptance (see also Section 4.2.4). The end-state objectives for

decommissioning will be developed to the guidance in CSA N294 Annex F [3]. A plan will be developed for the orderly progression from SWS to Dismantling & Demolition operations, including staff augmentation and any required plant system re-activation. Detailed work plans will be prepared to ensure that they remain appropriate in light of any improved knowledge of the condition of the site and the hazards that might be encountered during the course of the dismantling. The organization required to manage the intended dismantling activities will be assembled from available plant staff at PNGS-B, other OPG stations, and from outside resources such as Decommissioning Contractor(s), as required. The activities performed by the contractor(s) will include, but not be limited to, updating procedures for the characterization surveys, dismantling work, waste packaging, waste disposal, Site Restoration and final surveys. The Dismantling & Demolition operations will be designed to accomplish the required tasks while maintaining all doses ALARA. The procedures will also address the continued protection of the health, safety, security of workers, the public and the environment.

During this stage of the work, OPG staff and/or Decommissioning Contractor(s) will:

- Develop a detailed schedule of activities – sequential planning of activities to minimize conflicts with simultaneous tasks;
- Review the results of the site characterization (Section 4.1.4.6) and address any gaps or deficiencies in the information required to plan the decontamination, Dismantling & Demolition and disposal;
- Prepare the work packages for decontamination, Dismantling & Demolition, and disposal activities;
- Prepare the detailed work procedures for the decontamination of SSCs and procure decontamination equipment, which may include high-pressure sprays, chemical mixing tanks, decontamination solvent injection and treatment components, grit-blasting and abrasive jets devices, components for the scarification and spalling of concrete surfaces, chemical applicators, etc.;
- Prepare the detailed work procedures and sequences for the removal of systems and components;
- Evaluate the options for the disposal of the calandria and its internals;
- Evaluate the options for the removal, handling and disposal of other large radioactive components such as steam generators, etc.;
- A graded approach will be taken in reviewing and revising station drawings, consistent with the need to maintain configuration control of the facility;
- Design, procure and test the tooling and equipment (including remotely operated equipment) that will be used during the dismantling work;
- Procure Dismantling & Demolition equipment:

  - Heavy equipment, which may include lifting gear (cranes, hoists and rigging), material transfer equipment (forklifts and trucks), and demolition equipment (demolition hammers, cutting torches, saws);
  - Small tools, which may include hand and power tools such as drills, circular and band saws, slings, small cutters and power hack saws, etc.; and
  - Pipe cutting equipment, which may include plasma arc torches, track cutters, milling machines, band saws, etc.

- Procure or design and fabricate shielding and contamination control envelopes in support of removal and transportation activities;
- Develop the procedures for occupational dose control, contamination control, industrial safety, environmental protection, fire protection and emergency response;
- Develop/revise the emission monitoring program;
- Develop/revise the waste management program so that it covers the following processes, as applicable:
  - Characterization;
  - Classification;
  - Minimization;
  - Segregation;
  - Clearance;
  - Handling;
  - Volume reduction;
  - Treatment;
  - Packaging;
  - Storage;
  - Transportation; and
  - Final disposition.
- Develop a waste management plan (conventional and radioactive waste) that meets the requirements of CNSC REGDOC-2.11.2 [2] applicable at the time, which typically includes but is not limited to:

- Implement the waste hierarchy, based on the following approach [55]:
  - Safety and Risk Reduction (top priority);
  - Avoidance;
  - Minimisation;
  - Reduction;
  - Re-use;
  - Recycling;
  - Recovery;
  - Abate; and
  - Disposal (less desired).

- Developing a waste management strategy, including identifying the waste streams together with the estimated quantities and characteristics of the waste that will be generated during the next stage of decommissioning;
  - Develop a plan for both the short term and, where possible, the long term, for managing all decommissioning waste;
  - Develop the procedures for processing radioactive waste such as resins, filter media, metallic and non-metallic waste generated during the dismantling work;
  - Describe the systematic process for how the waste will be moved from the decontamination and dismantling areas to the areas for subsequent steps of waste management;
  - Ensure that processing and/or storage capabilities are adequate for the waste that will be generated from decommissioning;
  - Ensure the availability of packages for radioactive waste arising from decommissioning;
  - Determine the transport and disposal container requirements for radioactive materials and hazardous wastes including the requirements for shielding and stabilization of the waste. The monitoring and processing areas will be designed and operated to keep recyclable and reusable materials separate from waste materials;
  - Procure and test the transportation and disposal containers for radioactive materials and hazardous waste;

- Prepare the detailed procedures for the packaging, removal and disposal of radioactive materials, hazardous waste and construction debris;
- Ensure there are disposition paths and they have the capacity to accommodate the types and volumes of radioactive waste generated from decommissioning;
- Assess/investigate decontamination methods such as chemical cleaning, electro polishing, mechanical abrasion or melting. These methods may be used to decontaminate scrap metal if the reduction in the volume of the scrap is sufficient to justify further processing. Depending on the efficiencies achieved, metals will be considered as either radioactive waste for controlled disposal, lightly contaminated (or activated) for consideration for re-use within the controlled nuclear environment or decontaminated to levels below the clearance levels allowing release for recycling in the open market; and
- Assess the potential for producing non-radiological hazardous substances and consider the necessary precautions to be incorporated into the waste management plan (including the supporting programs and procedures for managing this type of waste).

- Prepare plans for final surveys;
- Prepare plans for site remediation; and
- Obtain any additional licences, permits or approvals that may be required and complete any other regulatory processes that may be applicable.

A safety assessment and an environmental review for the intended Dismantling & Demolition processes will also be performed as required by prevailing regulations prior to Dismantling & Demolition. Refer to Section 4.2.4 for additional details on the safety assessment.

Acceptable site radiological release criteria for decommissioning waste will be developed prior to Dismantling & Demolition. The guidance provided in CSA N292.5 [16] applicable at the time will be followed for the application of the clearance level criteria for the release of materials containing, or potentially containing, radioactive nuclear substances, and the activities necessary to demonstrate compliance with these criteria [16].

Based on the identified requirements and needs for Dismantling & Demolition, appropriate subcontractors will be identified and selected to support the various phases and project deliverables.

4.2.3 Building and Site Preparation

Building and site preparation work will include activities to prepare PNGS-B for subsequent Dismantling & Demolition work. The preparation work will be performed towards the end of the SWS period.

In preparation for dismantling, the following activities will be initiated:

- Prepare any required site support and storage facilities including a Central Waste Processing Area that will be used to process and package waste;
- Complete a comprehensive characterization survey of PNGS-B to determine extent of site contamination (see also Section 4.1.4.6);
- Use survey data to develop packaging and transportation requirements and procedures;
- Determine transport and disposal container requirements for activated materials and/or hazardous materials, including shielding and stabilization. Fabricate or procure such containers;
- Procure required transportation packages from suppliers;
- Reactivate, refurbish and/or procure essential plant services necessary for dismantling;
- Develop procedures for occupational exposure control, control and release of liquid and gaseous effluent, processing of radioactive wastes including resins, filter media, metallic and non-metallic components generated in dismantling, site security and emergency programs and industrial safety;
- Clean all plant areas of loose contamination and process all liquid and solid wastes; and
- Conduct radiation surveys of work areas, major components (including the calandria and internals), sampling of internal piping contamination levels and primary shield cores.

4.2.4 Detailed Decommissioning Plan

As mentioned in Sections 1.1 and 4.1.3, a DDP will be prepared and submitted for CNSC acceptance approximately two to five years prior to the SWS period. Towards the end of the SWS period, the DDP will be revised to describe OPG's detailed plan for managing the arrangements and activities that will be conducted in support of Dismantling & Demolition and Site Restoration. The DDP will be prepared to meet the requirements of CNSC REGDOC-2.11.2 (in particular Section 7.1) [2] and CSA N294:19 [3]) applicable at the time. It will include a corresponding schedule and an estimate of expected costs to complete the dismantling. It will also address any un-reviewed environmental impacts associated with the proposed decommissioning scenario.

The DDP will establish the criteria (clearance levels) that will be used to determine if the material is suitable for uncontrolled release from the site. The DDP will also establish the clearance levels and end-state criteria that will be used to determine if the site itself is suitable for release from further regulatory control.

The original DDP that would have been prepared prior to SWS (See Section 4.1.3) will be revised to include a detailed description of the decontamination, dismantling and demolition work that will be performed, broken down into a multi-volume document by Decommissioning Planning Envelopes which will be integrated with an overall plan to ensure the work is performed efficiently with safety being the top priority. The Decommissioning Planning Envelopes may include:

- Reactor Building and Calandria Vault;
- Vacuum Building and Pressure Relief Duct;
- Reactor Auxiliary Bay;
- Turbine Hall and Turbine Auxiliary Building;
- Service Wing Extension Building;
- Heavy Water Upgrading Building;
- Tempering Water Pumphouse;
- Emergency Water Pumphouse and Power Supply Building; and
- Standby Generator building, fuel storage tanks and other small buildings (machine shops, garages, etc.) located inside the fenced area.

Additional details of the site restoration work will also be included in the DDP. Since the next stage of decommissioning will take longer than five years, the DDP will be reviewed and updated as required.

A a decision may be taken to dismantle some of the conventional plants in the above list during the SWS period to reduce the risk at the facility and the 'footprint' of the site and in the interest of maintaining a safe shutdown state. If this is the case, any new hazards that could emerge as a result of these decommissioning actions will be assessed and addressed to maintain overall safety of the decommissioning actions undertaken [2].

4.2.5 Decommissioning Safety Assessment

As mentioned in Sections 1.1 and 4.1.3, a decommissioning safety assessment will be prepared and submitted for CNSC acceptance approximately two to five years prior to the SWS period, along with the DDP. Towards the end of the SWS period, a detailed safety assessment of the work to be performed during Dismantling & Demolition as well as Site Restoration will also be prepared and submitted along with the DDP or included in the DDP. This safety assessment will evaluate the processes for decontamination and dismantling the station, including waste handling, conditioning, on-site processing (if adequate), etc.

4.2.6 End State of SWS

By the end of the SWS period, all used fuel, including all defected fuel and all waste in the IFB, is planned to have been removed from the station. Radioactive decay will have substantially reduced the residual contamination levels throughout the station and reduced the dose rates surrounding the calandria and calandria internals. Station systems (except for those in use during the SWS period) will remain in a drained, de-energized and secure state. The station will remain intact with the structures and systems maintained in a safe condition. An interim end state report indicating the current status of the facility will be prepared at the end of the SWS period for submission to the CNSC.

4.3 Dismantling & Demolition and Site Restoration

Dismantling work would begin after the detailed planning has been completed and the necessary permits and approvals have been obtained. The work in this phase can be divided into a series of conceptual steps:

- Prepare the buildings and site;
- Decontaminate and dismantle systems;
- Decontaminate and dismantle structures;
- Dismantle non-nuclear systems;
- Demolish buildings;
- Manage and dispose the waste; and
- Restore the site.

Work in the different steps may occur in parallel. Decommissioning surveys for radioactive and other hazardous materials will be performed throughout the dismantling work, up to the final survey. See Section 4.4.

Consistent with the actions taken during SWS (see Section 4.2), OPG will ensure that during dismantling, demolition and site restoration [2]:

- Activities are conducted in accordance with the DDP (see Section 4.2.4) and associated procedures (see Section 4.2.2);
- A decommissioning process and supporting programs are implemented to ensure safety;
- A methodology for issuing, modifying and terminating work procedures is established; and
- An up-to-date list of SSCs important to safety, as well as surveillance and maintenance plans for these SSCs is maintained.

4.3.1 Dismantle Nuclear Systems

Dismantling activities are anticipated to involve the following:

(a) Construct temporary facilities, modify existing storage facilities, erect and place scaffolding in and around components to be dismantled to support the dismantling and decontamination activities. These may include a cutting station (for boilers and other large components), additional change rooms and contaminated laundry facilities for increased work force, establishment of laydown areas to facilitate equipment removal,

upgrading roads to facilitate hauling and transportation and modifications to the Reactor Building to facilitate access of large/heavy equipment.

(b) Remove the irradiated fuel stacking frames from the fuel wet storage bay. Frames will be disassembled, decontaminated with high-pressure water (to the extent possible) and packaged for off-site disposal.

(c) Design and fabricate shielding and contamination control envelopes to support removal and transportation activities. Identify and/or procure special tooling and remotely operated equipment. Modify containment to support segmentation activities and prepare rigging for segmentation and extraction of heavy components, such as the steam generators.

(d) Conduct decontamination of components and piping systems, as required, to control (minimize) worker exposure. Remove, package and dispose of all piping and components that are no longer essential to support dismantling operations. It is anticipated that radioactive corrosion products on inner surfaces of piping and components will not have decayed to levels that will permit unrestricted use or allow conventional removal. These systems and components will be surveyed as they are removed and disposed of in accordance with the radiological clearance levels that have been developed (see Section 4.2.2).

(e) Dispose radioactive Polychlorinated Biphenyls (PCBs) waste remaining at the Pickering site (see Section 4.7.3.1).

(f) Remove asbestos from PNGS-B (see Section 4.7.3.1).

(g) Remove the steam generators and feed and bleed system for shipment and controlled disposal. A potential method for removal (and the one used as the basis in this PDP for cost estimating) is the one-piece vertical extraction of the steam generators through the Reactor Building dome. Sections of the shield walls and floor grating in the compartment will have to be removed to allow for the vertical lift of the generators through the roof openings. Once removed, all nozzles will be welded shut and the interior volume will be filled with low-density cellular concrete for stabilization of the internal contamination. The steam generators will then be segmented at the site in order to meet the waste disposal site acceptance criteria prior to disposal since they are considered large objects which could exceed the waste disposal facility size/weight guidelines. The exterior surfaces will be decontaminated, as required, and openings will be seal-welded (inspection hatches and other penetrations). The segmented sections can then serve as their own disposal containers, provided that all penetrations are properly sealed and the internal contaminants are stabilized.

(h) Remove the feed and bleed system, moderator heat exchangers and bleed cooler intact from the reactor vault and prepare for transport and disposal to serve as their own container in a manner similar to the steam generators. All nozzles and other openings will be welded closed for containment of the internal contamination. Segmentation and packaging for these components will be completed similar to the work performed on the steam generators.

(i) At each calandria face, remove the fuelling machine bridge structure and insulated feeder cabinet which encloses the PHT headers and feeder tubes.

(j) Remove the PHT and moderator primary and auxiliary piping and pumps.

(k) Package the piping in transportation packages; the pumps are sealed with steel plates so as to serve as their own containers. Segment those components that are considered large object waste that exceed the waste disposal facility size guidelines. Ship piping and pumps for disposal.

(l) Install calandria segmentation system in reactor vault and test.

(m) Segment the calandria vault and internal components by remote in-place segmentation. Any LLW derived from these activities will be packaged in B-25 waste containers and ILW will be packaged in Modular Shielded Containers (MSCs). Major activities as part of this work will include the following:

- Install temporary shielding as necessary.
- Remove all horizontal and vertical control elements and their associated drive mechanisms.
- Remove all reactivity housing mechanisms (vertical and horizontal).
- Cut annulus bellows and cut the pressure tubes, remove end fittings and pressure tubes from calandria; cut into lengths to fit MSCs for disposal.
- Remove calandria tubes from calandria structure; cut into lengths to fit MSCs for disposal.
- Remove the end shield balls (PNGS-B) and fit into MSCs for disposal.
- Transport all waste in suitable containers to the transportation staging area.
- Segment the balance of the calandria structure.

(n) Remove the balance of the systems and equipment from the reactor vault. These components may be segmented prior to disposal.

(o) Remove systems and associated components as they become non-essential to the vessel removal operation, related decommissioning activities, or worker health and safety (e.g., waste collection and processing systems, electrical and ventilation systems, etc.).

(p) Remove any contaminated concrete from the biological shield. Remove those portions of the associated enclosures necessary for access and component extraction.

(q) Remove contaminated equipment and material from the Ancillary Services Building, East Service Area, Fueling Duct, Off-Gas System Room, Pressure Relief Duct, Fuel

Transfer Duct, and the Spent Resin Storage area. Remediate contaminated surfaces until radiation surveys indicate that the structure can be released for unrestricted access.

(r) Decontaminate tooling used for dismantling, disassemble and prepare for use at another unit at PNGS-B, as applicable. Solid and liquid radioactive waste generated from this activity will be either routed for treatment or removed to a centralized processing area for conditioning.

(s) Remove all remaining L&ILW along with any remaining hazardous materials. Material removed in the decontamination and dismantling of the nuclear units will be routed to an on-site central processing area. Material that meets clearance criteria will be released for unrestricted disposition, e.g., as scrap, recycle or general disposal. Contaminated material will be characterized and packaged for controlled disposal at the long-term disposal facilities for respective LLW and ILW (See Section 4.7.2.3).

(t) Remove remaining components, equipment and plant services in support of the area release survey(s).

(u) Conduct final radiation surveys to ensure that all radioactive materials in excess of permissible residual levels have been remediated.

All dismantling work performed on contaminated nuclear systems will be conducted in a manner that will minimize the spread of contamination and in accordance with OPG's Radiation Protection Program [40]. Appropriate contamination control techniques, including the use of portal monitoring systems at controlled egress points, temporary enclosures, local ventilation, Personal Protective Equipment (PPE) and contamination monitoring will be used when the work is performed.

4.3.2 Dismantle Contaminated Structures

Contamination will be removed from the surfaces of structures wherever possible in order to reduce waste volumes. Any contaminated paint, coatings, steel or other materials will be removed from the walls and floor. Removal can include surface scarification or physical dismantling depending upon the depth of contamination. If required, removal of surface structures will be pursued to sub-surface contaminants that have migrated to inaccessible locations over the operating life of the facility. Contaminated concrete will be removed by scarifying (needle de-scaling, scabbling or hammering), concrete shaving or by drilling and spalling. The contaminated debris will be collected and packaged for disposal as radioactive waste. Concrete waste will be packaged in steel containers, at an average waste density of approximately 1,400 kg/m^3.

Contamination may be removed from surfaces with chemical cleansers or by mechanically removing material from the surface (by planning, scarifying or drilling and spalling).

Large structures will be removed and segmented into smaller pieces at the site using commercially available equipment, e.g., diamond wire sawing, or other alternative technologies available at the time.

Metals will be decontaminated in place (if practical) or removed by dismantling or cutting. The scrap metal will be sent to the Central Waste Processing Area for further processing. Metallic waste will be packaged in steel containers, at an average waste density of approximately 1,000 kg/m^3.

Contaminated metal may be packaged for disposal as radioactive waste. However, chemical cleaning, electro polishing, mechanical abrasion or melting may be used to decontaminate scrap metal if the reduction in the volume of the scrap is sufficient to justify further processing. Depending on the efficiencies achieved, metals will be considered as one of the following three:

- Metals that are decontaminated to levels below the clearance levels will be released for recycling in the open market;
- Lightly contaminated (or activated) for consideration for re-use within the controlled nuclear environment; and
- Radioactive wastes for controlled disposal.

Structures designated as “likely clean” but located within potentially contaminated areas are treated as though they are contaminated.

All decommissioning work performed on contaminated structures will be conducted in a manner that will minimize the spread of the contamination. Appropriate contamination control techniques will be used when the work is performed. This may include the use of temporary enclosures, local ventilation, PPE and contamination monitoring.

This work will continue until surveys confirm that contamination levels have been reduced to below the clearance level established in the DDP, after which the structures will be treated as non-contaminated (see Section 4.3.4 below). It is assumed that demolition would be delayed until after all radioactive materials in excess of release levels have been removed.

4.3.3 Dismantle Non-Nuclear Systems

The non-nuclear systems will be dismantled using conventional demolition techniques, surveyed for radioactivity and other contamination and prepared for disposal. Components and equipment located outside the Radiological Controlled Area will be removed. Material deemed to be free from contamination (i.e., below the established clearance level) may be released for recycling or disposal. Dismantling activities are likely to include, but may not be limited to, the following:

- Remove secondary circuit steam cycle components (assumed to be within the clearance for free release);
- Cap-off the condenser cooling water inlet and outlet ducts and remove the condensers;
- Remove the turbines, generators and ancillary equipment;
- Remove the condenser cooling water pumps and associated piping;

- Remove the de-aerator; and
- Remove the feed water heaters, piping and other equipment.

The following are anticipated to be dismantled in conjunction with the last unit on site:

- Water Treatment Plant;
- The remaining Standby Generators and Emergency Power Generators;
- Above-ground storage tanks (after draining, purging, and decontaminating); and
- Remaining offices, workshops, laboratories and storerooms.

4.3.4 Demolition

Once contaminated systems, structures and non-nuclear systems have been dismantled and final surveys (see Section 4.0 and the overarching PDP [8]) have confirmed that the remaining structures are below radioactive and hazardous materials release limit, demolition activities may begin.

Efficient removal of the contaminated materials and verification that residual radionuclide concentrations are below regulatory limits will result in substantial damage to many of the structures. Blasting, coring, drilling, scarification (surface removal), and the other decontamination activities will substantially damage power block structures including the reactor, service and ancillary service buildings. Verifying that subsurface radionuclide concentrations meet site release requirements may require removal of grade slabs and lower floors, potentially weakening footings and structural supports. This removal activity will be necessary for those facilities and plant areas where historical records, when available, indicate the potential for radionuclides having been present in the soil, where system failures have been recorded, or where it is required to confirm that subsurface process and drain lines were not breached over the operating life of the station.

Any remaining structures (including buildings that were not contaminated and temporary structures) will be demolished by general demolition crews by drilling and controlled blasting or by other conventional demolition techniques. The waste blocks will be sized so that they can be handled and moved by the available technologies. All foundation and exterior walls will be removed to the nominal one-meter removal depth below grade whenever possible. At-grade foundation slabs exceeding one meter in thickness will be abandoned in place and covered with a one-meter-thick layer of backfill. Concrete rubble and other clean materials may be used to fill the voids left by the demolition, including the entire Turbine Building basement.

Underground metal and concrete piping will be excavated and removed for survey. Any piping that exceeds the site release criteria will be removed and disposed of appropriately. Clean metal piping will be considered scrap or will be recycled. Clean concrete piping will be used as backfill. Crushed concrete from demolition of the onsite facilities that is below the clearance level can also be used to backfill voids below grade. Clean piping, subterranean tunnels, chases, etc., will be abandoned in place unless deemed a hazard from collapse and subsidence. Circulating water intake and discharge tunnels will be exposed and the roof of the

tunnels collapsed, with the exception of the portion that runs under the station IFB. This portion will be abandoned in place and backfilled from each end of the tunnel segment. Shallow portions of the concrete circulating water closed-loop piping will be exposed, and the roof of the piping will be collapsed. Deeper portions of the piping will be capped and abandoned in place. OPG will investigate the requirements for capping the underground piping and utility lines while maintaining consistency with provincial and/or national regulations at the time of Dismantling & Demolition.

Asphalt will be removed from the immediate perimeter. Culvert and headwalls will be left to control drainage and minimize erosion. Road and parking areas with asphalt or concrete surfacing will be broken up and the rubble used for backfilling on site if needed.

Once demolition is complete, an interim end state report will be prepared for submission to the CNSC.

4.3.5 Waste Processing

All material removed during the decontamination and dismantling of the nuclear units will be routed to a Central Waste Processing Area. The radioactive waste generated during decommissioning will be characterized as per CSA N292 series of Standards and REGDOC-2.11.1 [56] applicable at the time, consistent with OPG's Nuclear Waste Management program [57]. This waste will then be released or shipped to an appropriate waste disposal, storage or recycling facility. The estimated maximum size of the packaged decommissioning waste, including any required shielding, is 2.65 m x 5.2 m x 14 m and the estimated weight criterion is 35 Mg (as required by transportation regulations [58]). Radioactive, hazardous and conventional wastes will be managed as described in Section 4.7.

4.3.6 Site Restoration

Depending on the nature of the future activities that will be carried out on the site, restoration work may include:

- Removing or remediating any remaining contaminated soil to meet the regulations for clearing the site as 'brownfield'[3] [industrial];
- Breaking up road and parking areas covered with asphalt or concrete surfacing and using the rubble for backfilling, if needed;
- Cleaning the site to remove any remaining inactive waste and debris;
- Covering the filled excavations with gravel (for drainage) and topsoil;
- Abandoning water drain holes at the bottom of all subgrade structures;
- Removing the rock breakwater structure extending out into Lake Ontario from the forebay in front of the intake screenhouses and relocating the excavated material along the existing shoreline in front of the station. The forebay will be filled in with the available breakwater material;

- Restoring the lake front property (including the water inlets and outlets and outfall deposits) to inhibit erosion and potential detrimental impacts on fish, fowl or other wildlife;

- Exposing shallow portions of the concrete circulating water closed-loop piping and collapsing the roof of the piping. Deeper portions of the piping will be capped and abandoned in place;

- Grading the area with gravel and topsoil to prevent ponding and inhibit the re-floating of subsurface material; and

- Establishing a covering of vegetation to prevent soil erosion.

The existing electrical switchyard will remain after decommissioning in support of the electrical transmission and distribution system.

Soil and structural surfaces that are within authorized limits may remain at site following Dismantling & Demolition activities.

4.4 Surveys

A series of surveys for radioactive and other hazardous materials will be performed throughout the various phases in the lifecycle of the facilities of PNGS-B to support decommissioning [2]. MARSSIM-like survey, surveys such as those based on Annex G of CSA N294:19 [3], and REGDOC-2.11.2 [2], and any other surveys based on guidelines available at the time decommissioning will be performed [3], [21], [59] during Dismantling & Demolition.

Several different types of surveys will be performed at different phases of the decommissioning:

- A scoping survey – to determine facility status (in preparation for the decommissioning phase);

- A characterization survey – to evaluate remediation options and perform risk assessments;

- Decommissioning surveys during the various decommissioning phases (including during SWS and Dismantling & Demolition) [2]:

    - To monitor radiological and non-radiological conditions;

    - To control the spread of contamination;

    - To confirm if the decommissioning is conducted effectively to reduce radiological and non-radiological risks;

    - To support the safe performance of surveillance and maintenance activities during periods when decommissioning is deferred; and

    - To determine levels of site remediation achieved;

- A final survey (also referred to as final end-state survey [2] and the abandonment survey) during Site Restoration – to provide evidence that a declared end state has been achieved; and

- A verification survey by an independent party may be performed to provide compliance monitoring and to ensure that agreed site remediation levels have been achieved, and which can then be used as the basis for removal from regulatory control.

According to international experience, scoping and characterization surveys (also referred to as post-operational surveys) should be performed as early as possible, prior to the start of decommissioning. Scoping surveys will be performed in order to identify contaminants, identify impacted and non-impacted areas and provide an estimate of the variability of the contamination (Annex G of [3]). Characterization surveys will be performed to provide a complete description of the nature, extent and variability of the contamination in each area of the site/facility (Annex G of [3]). Both of the above-mentioned surveys will assist with the planning of the decontamination work.

Decommissioning surveys will be performed throughout the dismantling and decontamination process in order to guide and monitor the decontamination work. They will also be used to help control the exposure of decontamination workers to radiation and hazardous materials. Decommissioning surveys are typically based on simple measurements such as contact radiation dose rates or direct contamination checks. More extensive surveys may be required in order to measure subsurface contamination. This may require the removal of grade slabs and lower floors, particularly where historical records indicate that process failures have occurred or where it is necessary to confirm that subsurface vessels or pipes have not leaked.

The final (end-state) survey will be performed to verify that the facility has been remediated to such an extent that all remaining buildings, components and the site itself have residual activity levels that are below the established end state criteria. A Final Survey Plan will be developed before any of the final survey work begins. The survey plan [2] will describe:

- The survey work that will be performed, including the final survey objectives and established acceptance criteria for data from other sources, such as previous survey work;

- The methods that will be used to collect and analyze the final survey results;

- The structure of the final report that will be produced;

- The sampling parameters and background levels; and

- The equipment, instruments, techniques and procedures.

The End State Criteria set out in the DDP (see Section 4.2.4) will be reviewed to confirm that they remain appropriate, and they will be revised if necessary.

Although the final survey is described as though it were a single activity performed at a well-defined stage of the decommissioning process, this will probably not be the case. The final surveys will likely be performed in stages and at different times in different units or different work

areas within a unit. In order to ensure that the surveys are thorough, they will be performed when the remaining structures and materials are still accessible. However, the surveys will be performed as expeditiously as possible after the completion of the decontamination work since the remaining structures may be unstable and could present a hazard to the decommissioning staff working in or around these structures. Any residual contaminants identified in the survey will have been remediated. Administrative and/or physical controls will be in place to isolate the surveyed areas and prevent recontamination. Demolition work (see Section 4.3.4) may proceed once the final surveys have confirmed that the residual contamination levels in a work area or unit are below the established clearance levels and the results of these surveys have been accepted by the CNSC and other regulatory agencies.

The final stage of the survey will be performed after all demolition work is complete to ensure that no residual contamination remains on the site. Periods of deferral (called 'Survey Delays') may be incorporated into the decommissioning schedule (see Figure 5-1) to ensure that all decommissioning work has been completed before this final stage of the survey work begins.

A report on the Final Release Survey will be prepared upon completion of all survey work. The report will present a description of the methods used to collect and analyze the data. The results of the analyses that were performed and the results of the analysis of the data will include the following [3]:

- The criteria used to define the end-state;
- The methods and procedures used to ensure that the criteria were met; and
- The measurement data, including appropriate statistical analysis and systematic approaches.

Data from other surveys performed at earlier stages of the decommissioning process, such as the characterization survey and the decommissioning surveys, may be incorporated in the final survey if they meet the acceptance criteria that were set out in the Final Survey Plan. The results of the analyses will be compared to the End State Criteria and the conclusions drawn from that comparison will be included in the report.

Regulatory agencies may wish to perform additional surveys or a verification survey by an independent survey organization may be requested by the regulator to assess any residual activity on site and this will form the basis for the release of the site from further regulatory control. This possibility will be provided in the DDP.

All of the surveys will be performed according to approved procedures that will be based on the recognized standards and guidelines applicable at the time [3], [21], [59]. The procedures will describe:

- The sampling strategies and methods that will be employed during the survey;
- The instruments and laboratory methods that will be used;
- The statistical techniques that will be used to analyze and interpret the data;

- The documentation that will be prepared and retained; and
- The Quality Assurance (QA) and quality control program that will be in place.

4.5 Final End State

By the end of Dismantling & Demolition and Site Restoration, the site will be free of industrial and radiological hazards. All of the station SSCs will have been dismantled and all non-essential buildings and site facilities will have been demolished to a depth of one meter below grade. The switchyard is anticipated to remain for continued use.

All radioactive contamination above the established clearance levels for a 'brownfield' [industrial] site and all other hazardous materials will have been removed from the site. It is expected that the clearance level used for the clean up of the site will not require institutional controls after the release from regulatory control.

Subsurface structures will have been drained and de-energized. These subsurface structures will also have been surveyed for contamination, decontaminated, if required, and dismantled to a nominal depth of one meter below grade (consistent with international practices), backfilled with clean concrete rubble and/or soil and graded over. The remaining site will have been backfilled to prevent future subsidence and restored to a state suitable for other OPG uses. By the end of this stage, the end-state objectives defined in the DDP will be verified to have been achieved and the site will meet the criteria to release from regulatory control.

Since brownfield/industrial reuse is being contemplated as the proposed end-state land use, the cleanup criteria will be based on, but not limited to, the following radiological, chemical, and physical objectives. These will be reviewed and, if required, updated regularly with each revision of the DDP.

- In terms of radiological activity, the intent is to remove contaminated structures and/or decontaminate them to clearance levels within the OPG Radiation Protection Program [40] in place at the time. Recommendations by the International Commission on Radiological Protection in place at the time will be taken into consideration when developing a clean-up criterion.
- With respect to chemical contaminants, the soil, ground water and sediment standards for use under Part XV.1 of the Environmental Protection Act [60], or the relevant requirements at the time will be used.
- Regarding the end-state physical state of the site, all aboveground structures and underground structures including foundations to a depth of one metre below grade will be removed, backfilled, and graded with gravel and topsoil, and landscaped. At-grade foundation slabs exceeding one metre in thickness will be abandoned in place and covered over with a one-metre-thick layer of backfill.

4.6 Release from Regulatory Control

Upon completion of decommissioning, PNGS-B will be in a condition that will support its removal from regulatory control. The final end state report on the decommissioning program

will be prepared. The final report will describe the decommissioning work that has been performed and the outcome of that work, the results of the final surveys that were performed and the interpretation of those results (i.e., whether the results meet the end-state objectives defined in the DDPs for each facility and the Pickering Nuclear Site Overarching decommissioning plan). Any other information required by the applicable regulations will also be included in the report. The final report will be submitted to the CNSC for acceptance as part of the request for a release from regulatory control. It is not expected that any period of institutional controls will be required.

4.7 Waste Management

4.7.1 Management of Operational Waste

Waste at the PNGS is managed in accordance with OPG's Nuclear Management System. The managed system contains programs and procedures, one of which is the Nuclear Waste Management Program (W-PROG-WM-0001) [57]. Appendix A of the OPG's Nuclear Waste Management Program outlines all subordinate/interfacing documents.

The station procedures are:

- N-PROC-RA-0017, Segregation and Handling of Radioactive Waste [61]; and
- P-PROC-WM-0006, Segregation and Handling of Low and Intermediate Level Radioactive Solid Waste [62].

Also being utilized are two electronic record-keeping systems which include the Nuclear Waste Management System Plan for the management of L&ILW and NUFLASH for the management of used fuel. It is expected that similar record-keeping systems will be used for ensuring the traceability of waste generated during PNGS-B decommissioning and for maintaining up-to-date records of the waste that will be segregated, packaged and shipped to other locations. These records will include the estimated quantities, characteristics and disposal paths for each waste streams.

OPG has allocated an allowance to address the operational waste currently on site. This cost is included in the accompanying decommissioning cost estimate.

4.7.2 Radioactive Waste Management

4.7.2.1 Radioactive Waste Inventory

The radioactive material inventory of a reactor at the time of final shutdown will depend on both the design and the operating history of the unit. The inventory will decrease over time due to the removal of activity by any decontamination work and the natural decay of the radioactive material. Estimates of the activity that will remain at PNGS-B at the end of the SWS period are shown in Table 4-1. These estimates are based on the assumption that the units have been in service for 40 years after which the radioactivity will be allowed to decay for 30 years [63]. However, it is important to note that the current estimates of radioactivity may need to be updated post targeted site characterization activities at the PNGS-B.

Table 4-1: Summary of Radionuclide Inventory at PNGS-B

(After 40-years in-service and 30-years storage)

Radionuclide	Residual Activity		Half-life	Percentage
	Type	PNGS-B (Bq)	(years)	(% total)
C-14	β	4.9×10^{13}	5,730	0.29
Fe-55	γ	1.2×10^{14}	2.73	0.70
Ni-59	γ	1.0×10^{14}	76,000	0.58
Co-60	β-γ	1.6×10^{15}	5.27	9.32
Ni-63	β	1.5×10^{16}	100	87.35
Zr-93	β-γ	1.4×10^{13}	1,530,000	0.08
Nb-94	β-γ	2.9×10^{14}	20,300	1.69
TOTAL		1.7×10^{16}		

It is expected that the radionuclide inventories will be recalculated as further information becomes available throughout the course of the decommissioning phases. Improved estimates will be available before the DDP for the SWS period is submitted but it is not expected that the full (invasive) characterization will be completed until later in the SWS period and a further recalculation will be completed prior to the submission of the DDP for the succeeding phases of decommissioning.

Estimates of the volume of L&ILW that will be generated during the decommissioning of PNGS-B are provided in the PNGS-B Decommissioning Costing Report [15].

The characteristics of L&ILW are included in eMWaste, which is an electronic database for managing waste, and the characteristics of fuel are included in 06819-REP-01200-10029 [64]. The characteristics of waste derived in the first few years of SWS will be detailed in the Waste Management Plan as part of the DDP/SWS plan. The characteristics of waste will, in part, be dependent on the systems that will remain in service during the SWS period.

At the current time OPG expects that the waste volumes will be small, and the characteristics of the waste derived in the first few years of SWS will closely mirror those during operations. No dismantling operations (e.g., asbestos remediation, taking down buildings, etc.) are expected to be undertaken at this time during this period; however, this will be assessed in more detail in the development of the DDP/SWS Plan.

The radioactive wastes generated during decommissioning will consist mainly of those wastes generated during dismantling. Wastes generated during Preparation for Safe Storage are likely to include:

- Filters and ion exchange resins;
- Wastes from decontamination activities; and
- Routine radioactive waste from the Preparation for Safe Storage period.

The radioactive waste generated during Dismantling & Demolition and Site Restoration will consist of process components and structural materials contaminated with residual activity. The principal sources generated during dismantling are:

- Component parts of the reactor assembly;
- Calandria and shield tank;
- PHT System pumps and other smaller pumps;
- Steam Generators;
- Piping and valves;
- Heat exchangers;
- Fuelling machines; and
- Other components of active systems.

Demolition will generate large amounts of concrete wastes.

A single unit inventory of plant system equipment and components of PNGS-B was taken as a base inventory for all units. Modifications performed to one or two units are likely to be performed on the other units.

Material quantities for plant structures (i.e., concrete, steel, etc.) may vary from unit to unit due to the differences in the arrangement and location of exterior walls.

4.7.2.2 Management of High-Level Waste

During the operating life of the station, used fuel from the reactors is initially stored in the IFBs for cooling. Used fuel that has been stored in the IFBs for the required minimum cooling period is then loaded into DSCs and transported to the NSS-PWMF.

When the station is shut down, all the used fuel (resident in the four reactor units) will be transferred to the IFBs for an initial cooling period. All the support programs for fuel (including monitoring, security, safeguards and criticality safety) will be maintained while the used fuel is at PNGS-B. It is anticipated that all the used fuel remaining in the IFB will be transferred to dry storage (NSS-PWMF or directly to the used fuel disposal facility). The transfer will continue for 10 to 15 years after station shutdown. Once all of the used fuel has been removed, the IFB will be decontaminated and secured for the remainder of the SWS period. It is not anticipated that any activity will remain in the IFB after the decontamination is complete. Although the decommissioning of the IFB is addressed by this PDP, the used fuel transfer activities from the IFB and operations of the NSS-PWMF are not part of PNGS-B decommissioning scope.

The Government of Canada passed the Nuclear Fuel Waste Act in 2002. The legislation required nuclear energy corporations to establish the Nuclear Waste Management Organization

(NWMO) to study the options available and to recommend a long-term management approach for used fuel.

The NWMO has issued a study report "Choosing a Way Forward - The Future of Canada's Used Nuclear Fuel", in 2005 [65]. This report was intended to assist the Federal Government in defining the approach for the long-term management of Canada's nuclear fuel waste. On June 14, 2007, the Government of Canada selected APM as the best plan for Canada for safeguarding the public and the environment over the very long time in which used nuclear fuel must be managed [66]. APM involves the containment and isolation of used nuclear fuel in a Deep Geological Repository in a suitable rock formation. All used fuel on the Pickering Nuclear Site is assumed to be removed from the site to the used fuel disposal facility (i.e., APM) prior to facility decommissioning.

4.7.2.3 Management of Low- and Intermediate-Level Waste

Radioactive wastes will be treated (e.g., by volume reduction where foreseeable) and packaged on site by the Decommissioning Contractor(s) in order to reduce worker exposure and, to meet the regulatory requirements for waste transport and disposal. Liquid waste will be generated from decontamination activities, cutting operations in the PHT system, selective decontamination of laundry, personnel showers, etc.

All processing and packaging of decommissioning waste will also be performed on site by the Decommissioning Contractor(s) and not by OPG. The following waste treatments are assumed for planning purposes:

- Decontamination using aggressive cleaning solutions, and/or using decontamination equipment described in Section 4.2.2;
- Dewatering of waste slurries either by removing the activity from the liquid (using filters and resins) or by evaporating the liquid from the waste;
- Waste processing units, which are usually self-contained and portable, are delivered on skids, from which hook-ups are made to the plant's waste collection tanks;
- Waste immobilization by solidifying concentrated liquid wastes; and
- Volume reducing low-density materials by compaction and packaging.

The waste treatment processes will be reassessed in more detail during the preparation of the DDP.

The decommissioning of PNGS-B will produce a relatively large number of components such as pumps, vessels, motors, concrete, structural steel, construction debris, etc., which will need to be packaged for disposal as LLW. Large components will be segmented and packaged as such (e.g., steam generators as described in Section 4.3.1). Other large components (e.g., calandria) will be processed and packaged in suitable containers. Other smaller components and equipment will be cut to fit and be placed in standard waste containers. Contaminated concrete (e.g., surface contaminated concrete from the IFB) will be broken up, loaded into

disposal containers and shipped to a licensed long-term LLW facility. The remaining concrete that meets the clearance criteria will be crushed and graded, and used on-site as backfill.

Wastes will be packaged for transport and disposal according to the requirements of the applicable federal and provincial regulations. It is assumed that the waste produced in the decommissioning of the nuclear units will be moved by truck or multi-wheeled transporter to the waste disposal facility. The necessary packages will be identified, designed, tested and procured prior to the decommissioning project. The required licences, approvals and certifications will also be obtained before the packages are put into service.

There are no plans to store or dispose dismantlement waste from PNGS-B at the Western Waste Management Facility (NSS-WWMF) on the Bruce Power site. Any loose contamination removed by Operations prior to stations entering into SWS may continue to be sent to the NSS-WWMF and waste from PNGS-B during SWS may be processed at the NSS-WWMF until it is shut down.

Contaminated material characterized as ILW is assumed to be placed for controlled disposal in a Deep Geologic Repository (DGR) in Ontario. In 2023, Natural Resources Canada (NRCan) issued their modernized Policy for Radioactive Waste Management and Decommissioning and the recommendations in the associated Integrated Strategy for Radioactive Waste (ISRW) were accepted by the federal Minister of Energy and Natural Resources. Based on this, ILW and non-fuel high-level waste will be disposed of in a DGR implemented by the NWMO, whose site will be chosen through a consent-based siting process. The planning process for this new work is now underway. It is assumed that this facility is available prior to the end of PNGS-B commercial operation.

Contaminated material characterized as LLW is assumed to be placed for controlled disposal in an OPG Near Surface Disposal Facility (NSDF) in Ontario. This is based on a Near Surface Vault, in which waste packages are placed in independent concrete containment vaults just below the ground surface. The facility is anticipated to be available prior to the end of PNGS-B commercial operation.

As appropriate, future revisions to this PDP will update the LLW and ILW disposal facilities' assumptions.

4.7.3 Hazardous Waste Management

4.7.3.1 Hazardous Waste Inventory During Operation

Designated Substances are defined in the Regulations made pursuant to the Ontario Occupational Health and Safety (OH&S) Act. An assessment of the Designated Substances used at the PNGS-A and PNGS-B has been completed as required in 2024 [39]. The results of the assessments indicate that seven designated substances have been found in the stations.

(a) Asbestos – OPG has a program in place to control all hazardous materials including asbestos-containing materials [67]. The asbestos management is implemented through Health and Safety Management of Asbestos-Containing Material OPG-PROC-0124 [68] and Asbestos Work Procedure OPG-GUID-08963-0003 [69]. In addition, with the assistance from industry experts, OPG maintains an asbestos database which is

updated on an on-going basis. Asbestos is likely present in SSCs such as gaskets, thermal insulation, magnesia block and parging cement. There is also an ongoing effort to inspect and repair the asbestos insulation used in the station. Damaged insulation is removed if it cannot be repaired.

(b) Lead – Lead blocks, plate and blankets are used for radiation shielding around both stations. Lead can also be found in product categorised as follows: Lead Sheets, Lead wool, Hilti cartridges, Lead shot, Solders alloy, Lead wire, Lead batteries, Abrasive shot (copper slag with minor lead contamination) and lab standards. A large inventory of unused lead block and plate previously stored on the site has been removed. The melting and pouring of lead for shielding is no longer carried out at PNGS-B. Some contamination may remain on surfaces from previous lead melting operations.

Lead paints are no longer used at either station. However, a survey of Unit 5 indicates that lead-based paints were used. A more complete survey will be required before beginning decontamination work.

A Designated Substance Assessment for lead was conducted at PNGS in compliance with Ontario Regulation, O. Reg. 490/09, Designated Substances. This was performed to determine the presence of lead-containing products at PNGS, whether workers were likely be exposed to lead during their job functions, and whether or not their health was likely to be affected by this exposure [70].

(c) Mercury – Mercury was not used as a construction material. However, it is used in thermometers, manometers, hygrometers, mercury-wetted relays, magnetol and mercoid switches, vacuum pump temperature switches, transformer deluge systems, sealed batteries and various types of lamps (fluorescent, mercury vapour, metal halide, etc.). Free mercury is not stored or used at PNGS-B.

Other designated substances such as benzene and isocyanates are occasionally used during projects, but they are not routinely stored at PNGS-B. Although silica is used in some of the structural products such as cement, concrete, and grouting products, it is not typically used during operations. Silica containing materials are not used as decontamination (sandblasting) agents within the protected area of the stations; however, they may be used in workshops outside of the protected area. Lastly, very low concentration of arsenic is present in SSCs such as batteries. Additional information on these Designated Substances is documented in [39].

Most of the hazardous materials stored at PNGS-B (flammable, oxidizers, corrosives, etc.) will be consumed during routine plant operations. It is anticipated that the inventories will be reduced as the units are successively shut down so that only small quantities will remain after the last unit is shut down. Some of the remaining materials (e.g., welding gases) will be consumed during the Preparation for Safe Storage period. Others, such as the fuel oil for the standby generators, can be removed for use at other sites. Hazardous wastes (i.e., asbestos, PCBs, etc.) which cannot be reasonably removed during station/facility operations will be included as part of Dismantling & Demolition activities.

PCBs waste management will be handled as follows:

- Non-radioactive PCBs: On March 22, 2021, 271 lighting ballasts were removed from PNGS Site. Currently there is no PCB material at the storage sites [71]. Any remaining non-radioactive PCBs waste generated will be disposed of in accordance with Federal PCB Regulations.

- Radioactive PCBs: Waste containing radioactive PCBs[5] will be stored at PNGS-B in accordance with PCB storage requirement until a disposal pathway approved by the Environment and Climate Change Canada becomes available.

A number of other materials used during routine station operations are potentially harmful to workers or the environment. The inventories of these materials will be reduced as the plant approaches shutdown so only small quantities should remain at the start of decommissioning. These hazardous materials include:

(a) Compressed gases including oxygen, helium, carbon dioxide, hydrogen and sulphur hexafluoride. Compressed gas cylinders are stored on-site;

(b) Flammable liquids including fuel oils and organic solvents used as decontamination agents:

  - Fuel oil is stored in outdoor tanks with secondary containment;
  - Lubricating oil and seal oil are stored in three tanks on the north side of the Turbine Hall;
  - Insulating oil, used for cooling transformers, is brought in by trucks;
  - Diesel, used in diesel fire pumps, is stored in tanks on-site;
  - Hydraulic oil, used in the fuelling machines, is stored in tanks on-site;
  - Four large above-ground oil storage tanks are located between the station and the lake shore (two south of Unit 5 and two south of Unit 8);
  - One waste oil storage tank for PNGS-B is located inside the Powerhouses;
  - Industrial-sized containers (e.g., 200 L drums) of oils and organic solvents are stored in the Oil and Chemical Storage Building located north of the Main Transformer for Unit 7; and
  - Small volumes of other flammable liquids are stored in special storage cabinets located in laboratories and workshops around the stations.

(c) Corrosives:

  - Morpholine and hydrazine are used to prevent corrosion of piping and equipment; morpholine is added to the Steam Generator and condensate

[5] Radioactive PCBs waste contains low levels of radioactivity but above the Nuclear Substances and Radiation Devices clearance levels [85].

feedwater to control the pH while hydrazine is added to the ECI system, Steam Generator feedwater, condensate feedwater, recirculating cooling water system and shield cooling water to remove dissolved oxygen and to control the pH;

- Lithium hydroxide is used to control the pH and is added to the Heat Transport system, end shield cooling system and recirculating cooling water system;
- Sodium hypochlorite is used in the zebra mussel control program; it is currently stored in tanks in the chlorination house; and
- Sodium metabisulphite is used for dechlorination; it is added to inactive drainage and RBSW.

(d) Toxic substances:

- Boric acid and gadolinium nitrate, used for reactivity control in the moderator system, are stored mixed with D_2O in the liquid poison tanks;
- Ion exchange resin: Neutral mixed bed resin, used for pH control and removal of impurities in the Moderator system, IFB, auxiliary fuel bay, liquid zone control stator cooling water, is stored in purification ion exchange columns;
- Ion exchange resin: Lithiated mixed bed resin, used for pH control and removal of impurities in the heat transport system, end shield cooling system and recirculating cooling water system, is stored in purification ion exchange columns;
- Ion exchange resin: Deoxygenating resin, used for oxygen removal in the stator cooling water system, is stored in ion exchange columns;
- Ion exchange resin cation, used for removal of cations in the moderator, is stored in purification ion exchange columns;
- Ethylene glycol, used as chillers in various systems, is stored in small tanks in the Powerhouse; and
- Reolube Turbofluid (fire resistant fluid), used as hydraulic fluid for turbine governor valves in turbine governor, is stored in tanks in the Powerhouse.

(e) Ozone depleting substances are used in chillers and air conditioners (there are no halon fire suppression systems at PNGS-B) but these were replaced by less detrimental refrigerants. R11 and R12 are no longer used at PNGS; R22 is still used in some small air conditioners. The purchase and sale of hydrochlorofluorocarbons have been phased out (with the exception of Freon 123 (R-123)). R-123 will be phased out in January 2030; and

(f) Pesticides and herbicides are applied by licensed contractors when required to control weeds, insects, rodents and other pests but they are not routinely stored on the site.

Small quantities of other chemicals are used in the laboratories and workshops located around the facility. The Pickering NGS Hazardous Substances report shows the types, quantities and locations of hazardous materials at PNGS [39].

4.7.3.2 Hazardous Waste Inventory During Decommissioning

Hazardous wastes removed during the Preparation for Safe Storage period will include oils, lubricants and refrigerants. Many of these wastes can be recycled. Other hazardous wastes likely to be generated during the SWS period are the decontamination agents used during the decontamination of the IFB and associated equipment. The volume of hazardous waste generated during this phase of the project is expected to be minimal.

Hazardous wastes generated during the Dismantling & Demolition and Site Restoration period of the decommissioning will likely be limited to hazardous materials originally used as building materials. Volumes of these wastes are likely to be small since very few hazardous materials were used in the construction of the plant. Dry active waste such as combustibles (paper, cloth, wood, filter cartridges) could also be generated in the removal of plant systems.

Hazardous materials that might be used during the decommissioning, such as welding gases, petroleum products (e.g., gasoline and diesel fuel) and organic solvents, are anticipated to be similar to materials used during station operations and maintenance.

4.7.3.3 Management of Hazardous Waste

OPG is already registered with the Resource Productivity and Recovery Authority as a generator of hazardous wastes. The waste generator registrations will be reviewed prior to beginning the decommissioning project to ensure that all of the wastes that will be generated are registered.

Appropriate disposal facilities for hazardous wastes will be identified prior to the beginning of the decommissioning project. Hazardous wastes will be packaged for transport and disposal according to the requirements of the applicable provincial regulations. All hazardous wastes, including non-radioactive hazardous wastes, will be transferred to an appropriate, licensed waste management facility for storage or disposal at approved disposal facilities. Waste manifests will be prepared and submitted as required by provincial regulations. Mixed waste (i.e., radioactive waste mixed with clean waste that is also hazardous) will be transferred to an appropriate long-term disposal facility.

4.7.4 Other Wastes

The bulk of the non-hazardous waste materials generated during decommissioning will be produced during the Dismantling & Demolition and Site Restoration period, although some is likely to be produced during the Preparation for Safe Storage period. Non-hazardous wastes that meet the established clearance levels will be re-used or recycled wherever possible or disposed of at approved disposal facilities.

If the volume or value of the contaminated scrap metal generated during decommissioning is sufficient to justify further processing, chemical cleaning, electro polishing, mechanical abrasion or melting may be used to decontaminate scrap metal. Any metals that are decontaminated to

levels below the clearance levels established in the DDP will be released for recycling or disposal.

Clean concrete rubble may be used on site for fill. Other non-contaminated materials will be released for disposal according to the applicable regulations.

5.0 DECOMMISSIONING COST ESTIMATE, SCHEDULE, AND FINANCIAL GUARANTEE

This section discusses the costs associated with decommissioning PNGS-B and the provision of a CNSC financial guarantee for the accumulated liability.

5.1 Decommissioning Cost Estimate

The decommissioning cost estimate update and the cost associated with decommissioning PNGS-B can be found in [15]. The decommissioning cost is accurate as of the time of PDP approval. As OPG is currently in the process of preparing an updated Ontario Nuclear Funds Agreement (ONFA) Reference Plan, to be effective in 2027 and subject to the approval by the Province of Ontario, this decommissioning cost may change pending further reviews. As part of each reference plan, OPG conducts comprehensive reviews of baseline cost estimates and underlying assumptions with respect to its obligations for nuclear waste management and nuclear facilities decommissioning. Under the ONFA between OPG and the Province of Ontario, OPG maintains certain segregated funds for the purposes of paying for, among others, the decommissioning of PNGS-B.

The costs associated with the management of used fuel from PNGS-B including interim storage, transportation and disposal are not included in this estimate. Plans and cost estimates for these activities are described in separate documents.

OPG will continue to provide an annual report to the CNSC staff detailing amounts accumulated in the applicable segregated funds for decommissioning and management of used fuel and other wastes, which are used to satisfy OPG's Financial Guarantee Arrangements. The report will also identify any material changes in decommissioning plans or cost estimates, which may affect the financial guarantee requirement.

Only facilities and land within the licensed/protected area are covered, with respect to decommissioning, by the segregated funds under the ONFA.

5.2 Decommissioning Schedule

The anticipated major project milestones for decommissioning PNGS-B are shown in Figure 5-1. More detailed schedules of decommissioning activities will be submitted to the CNSC as part of the DDP.

The SWS stage will begin upon the completion of the preparation work. The duration of the SWS period will be long enough to bring the total time from shutdown to the beginning of the Dismantling & Demolition period, nominally 30 years for each unit.

It is anticipated that the detailed plans describing the work that will be performed in the Dismantling & Demolition, and Site Restoration period will be submitted in a revised DDP prior to the start of dismantling for CNSC acceptance. The preparation for Dismantling & Demolition, and Site Restoration is expected to begin in 2098 for Unit 5 and the execution of Dismantling & Demolition work itself is expected to begin in 2099. Work on the other units is expected to begin at intervals of approximately one year. OPG will consider operational experience gained from dismantling of PNGS-A units and the first unit of PNGS-B and apply to the other PNGS-B units.

As shown in Figure 5-1, the final survey of PNGS-B will be initiated in 2105 when Unit 8 (the last unit at PNGS-B) has been dismantled.

Site restoration of PNGS-B will take place from 2105-2107, and decommissioning is expected to be complete in 2107.

This page has been left blank intentionally.

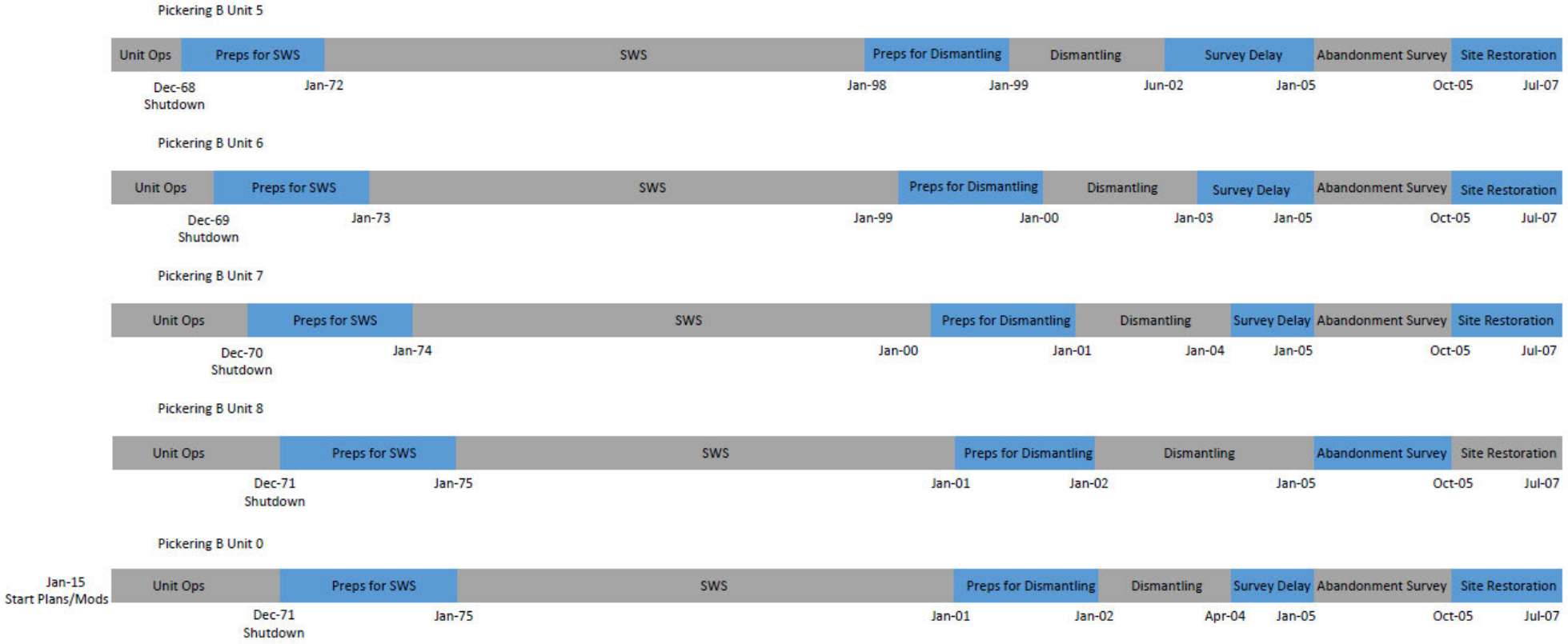


Figure 5-1: PNGS-B Decommissioning Schedule

This page has been left blank intentionally.

5.3 Financial Guarantee

In December 2022, the CNSC accepted OPG's proposed CNSC financial guarantee requirements for the 2023 – 2027 period to be satisfied by the federally mandated Ontario Nuclear Fuel Waste Act Trust and by providing the CNSC with access to the two segregated funds under the ONFA, without the requirement for a Provincial guarantee from the Province of Ontario [72].

As discussed in Section 5.1, OPG will continue to provide an annual status update to the CNSC with respect to amounts accumulated in the above noted segregated vehicles and identify any material changes in decommissioning plans or cost estimates which may affect the financial guarantee requirement. An assessment of the impact on the financial guarantee requirement of the revised planned decommissioning activities as detailed in this PDP is being performed and provided as part of OPG's 2025 Annual Report for the 2023-2027 CNSC Financial Guarantee submission.

OPG's next consolidated financial guarantee submission to the CNSC will cover the 2028-2032 period and is expected to be submitted in 2027, following the finalization and approval of the updated ONFA Reference Plan to be effective in 2027.

6.0 HUMAN AND ORGANIZATIONAL FACTORS

The term 'Human Factors (HF)' refers to those factors that influence human performance as it relates to the safety of a nuclear facility or activity over all phases, including design, construction, commissioning, operation, maintenance and decommissioning. The term 'HF engineering' refers to the application of knowledge about human capabilities and limitations to facility, system and equipment design. HF engineering ensures that the design of the equipment, human tasks and work environment are compatible with the sensory, perceptual, cognitive and physical attributes of the personnel who operate, maintain and support the facilities, systems and equipment. The goal in any phase of station life, including decommissioning, is to achieve productive, error-free and safe system performance.

Unique Human and Organizational Factors issues can occur during decommissioning that do not exist during the design, construction or operational phases of an NPP. The Human and Organizational Factors issues that may arise during the decommissioning of PNGS-B can be split into the following three categories [73]:

(a) Work Environment, which may include:

- Activities that may be hazardous to personnel and the environment;
- Material that may be in less than optimal condition at the facility; and
- Incomplete documentation and records from operation that can create uncertainty among decommissioning staff.

(b) Work Planning, which may include:

- Activities unique to decommissioning that can impose burdens on development and maintenance of staff skills and technical knowledge;
- The long timeframe of decommissioning that can pose difficulties to organizational continuity, culture, staffing and knowledge;
- Complications in decommissioning planning due to the potential for the need to replace obsolescent systems and work practices; and
- Unique issues with human performance resulting from new tasks.

(c) Work Execution, which may include:

- Adaptations to the decommissioning work plans due to unexpected findings ('discovery work');
- Impacts of a declining staffing resource as the decommissioning program proceeds; and
- Complications with control over monitoring remote and automated operations as well as overseeing less knowledgeable contract staff.

OPG will establish, prior to decommissioning, a Human Factors Engineering Program Plan (HFEPP) for the decommissioning of PNGS-B according to the recommendations of CNSC REGDOC-2.5.1, General Design Considerations: Human Factors [74] and REGDOC-2.2.1 'Human Factors' [75] applicable at the time. The details of the Plan will be included in the DDP (see Sections 4.1.3 and 4.2.4). The following items will be included in the HFEPP:

- Human-machine interface system;
- Human-machine allocation of function;
- Human reliability;
- Job design;
- OPEX review;
- Physical working environment;
- Activities with potentially hazardous human interactions;
- Procedures development;
- Shift-work systems;
- Staffing; and
- Validation & verification.

Decommissioning work will also comply with requirements of HF program in design and any other guidelines available at the time of decommissioning. HF in design applies to nuclear safety, protection of the environment, health and safety of persons, security, productivity, and economics [76].

6.1 Transition to Decommissioning

The period of transition from operations to decommissioning poses different Human and Organizational Factors challenges to OPG than during the operational phase because of the complex process and the long-time frame required to complete decommissioning. There are many HF issues that are unique to decommissioning that are not encountered during the commissioning or operational phases. To manage human and organizational factors as PNGS-B is shutdown and transitioned to decommissioning, it is expected that OPG will utilize a similar approach to PNGS-A, and lessons learned will be incorporated as appropriate.

Human and Organizational Factors issues that arise during the transition to decommissioning may include [77] [78]:

- Planning for transition requires timely allocation of dedicated human and financial resources;

- Significant cultural and organizational changes will occur during the transition which need appropriate consideration and management;
- Implementation of transition will require comparable management focus and workforce attention to detail as during normal operation;
- Loss of personnel expertise during the transition from operations to decommissioning;
- Immediate reduction in the number of employees working at the station;
- Reliance on contractors during decommissioning instead of knowledgeable and experienced station staff;
- Decommissioning activities, such as Preparation for Safe Storage, may occur while other units on site continue to operate;
- The maintenance of safety culture of the station during the transition from operations into decommissioning;
- The change of mission from operations to decommissioning;
- The change in management and organizational structure;
- The morale of station personnel, both as the station nears scheduled shutdown and after shutdown; and
- The impact of delaying the Dismantling & Demolition of the decommissioned station and the duration of the SWS period, e.g., reduction in staff numbers.

The Human and Organizational Factors issues listed above may have a major impact on the course of the PNGS-B decommissioning project. OPG will ensure that Human and Organizational Factors issues are considered throughout the planning and execution of the project. Special attention will be given to staffing and training in order to minimize potential problems resulting from the loss of experienced personnel over time. Furthermore, a plan to manage staff reductions during the period following final shutdown will be implemented.

As mentioned in Section 3.7, the risks associated with the PNGS-B decommissioning activities will be managed as per OPG's risk management process to ensure these risks are identified, analyzed, documented and appropriate measures are put in place to mitigate these risks.

6.2 Administration

OPG will retain responsibility for the PNGS-B station throughout the course of the Preparation for Safe Storage period for the project. OPG staff will perform the work in this phase although contractors may be retained to provide specialized services under the supervision of OPG staff.

OPG will also retain responsibility for the station throughout the course of the SWS period of the project and OPG staff will perform the work required during this phase of the project, such as equipment maintenance, inspection activities, and routine service.

It is anticipated that during Dismantling & Demolition, the organization required to oversee the decommissioning program will be assembled from available OPG station staff and outside resources as needed. Decommissioning Contractor(s) will be retained to perform the Dismantling & Demolition and Site Restoration work. OPG will provide the necessary oversight during this time period. The Decommissioning Contractor(s) will be a company or consortium selected on the basis of factors such as decommissioning experience, safety record, overall approach and cost. OPG will remain the owner and licensee of PNGS-B throughout the course of the decommissioning, but the Decommissioning Contractor(s) will be given charge and control of the site during the Dismantling & Demolition and Site Restoration. Other contractors may also be given charge and control of designated portions of the site during the earlier phases of the decommissioning. During these periods, the contractor will become the 'Constructor' for the decommissioning work as defined by the Construction Safety Regulations made pursuant to the OH&S Act. The Decommissioning Contractor(s) and sub-contractors will be required to comply with OPG procedures related to Nuclear Energy Workers and other federal and provincial regulations such as the Construction Projects Regulation [79].

6.3 Staffing

The staffing numbers for each phase of decommissioning can be found in [15] and have been estimated based on activities in each phase, schedule, work difficulty factors, industry experience, etc.

The numbers should be considered preliminary (i.e., for cost estimating purposes only). Given the timeframes involved, business plan staffing numbers for these activities will not be established for a number of years.

6.4 Training

OPG will ensure that all workers are qualified to perform the work assigned to them. They will be provided with training on the hazards associated with their work and the procedures that may be used to protect against those hazards. All workers will be provided with the training through OPG's training program [80]. This will include training in:

- Radiation protection;
- Construction safety;
- Workplace Hazardous Materials Information System;
- Emergency procedures; and
- Any other topics that may be deemed appropriate at the time.

Long term fleet staffing plans, which will include clearly defined training requirements, will be developed to cover a 10-year rolling window and these plans will be refreshed yearly. The staffing plans, and associated training requirements, will ensure training can be delivered within the specified timeframe to ensure capability is maintained, and that sufficient resources are available for safe and reliable operation.

Details of the training program for SWS will be provided in the DDP.

Detailed descriptions of the required training for Dismantling and Demolition will be included in the DDP which is expected to be available prior to the entering this phase.

7.0 POTENTIAL ENVIRONMENTAL AND SOCIO-ECONOMIC EFFECTS

The Pickering Nuclear Site Overarching PDP [8] highlights some of the effects on the natural environment that might occur over the course of the decommissioning work. The following sections describe the human and socio-economic effects resulting from PNGS-B decommissioning.

A predictive effects assessment for the Pickering Nuclear Stabilization and SWS Phases was conducted to assess the potential interactions with the environment resulting from transition from its current operational condition to its SSS and from SWS activities. Based on the conclusion of the predictive effects assessment, no predicted potential adverse effects are expected neither to humans nor to ecological receptors from the activities proposed to take place during the Stabilization and SWS phases [81].

An addendum to the predictive effects assessment [82] was prepared in 2022 to document and demonstrate that human health and the environment will continue to be protected based on updated environmental conditions and operational assumptions for the Stabilization and SWS Phases. No potential adverse effects were predicted from the updated assumptions evaluated in the Addendum [82]. In addition, no additional risk management recommendations were identified.

An environmental review encompassing the full scope of activities for decommissioning PNGS-B will be performed and captured in the DDP.

7.1 Preparation for Decommissioning/Permanent Shutdown/Preparation for Safe Storage

The most significant source of community effect is anticipated to be changes in the size of the workforce when the station is shut down. The estimated number of staff at PNGS-B station is expected to reduce. The numbers of staff assumed during the different phases of decommissioning is provided in the associated cost estimate report [15]. In total, about three years are assumed to be needed to complete the transition activities from operations to SWS for PNGS-B. After the station is shut down, most of the established workforce will no longer be required. The reduction of staff may be staggered, as the units are shut down.

Some displaced workers and their families may not move away from the community and may or may not find employment locally. Other workers and their families may move away from the community. The loss of jobs, income and population can affect the local communities in a variety of ways, including effects on the housing market, services, consumer spending and social aspects.

Local traffic patterns would change, as the numbers of staff are reduced at the stations. Any nuisance effects associated with worker traffic would change.

L&ILW generated by the decommissioning in the Preparation for Safe Storage period will be transported by truck to respective long-term disposal facilities as described in 4.7.2.3.

The closure of PNGS-B will change the pattern of local expenditures and tax payments. Local and regional purchases of goods and services associated with the operation of the stations would cease. There may be some spending associated with the permanent shutdown activities.

It is possible that indirect economic effects would occur. Under current assessment legislation, property tax monies will continue to be paid on buildings and structures until the structures are removed. For planning purposes, it is assumed that the amount will vary as the work progresses through each phase of decommissioning.

7.2 Storage With Surveillance

The SWS period will last for nominally 30 years for the station. Over that period, a small workforce will be required, which may represent opportunities for local employment and consumer spending. Towards the end of the SWS period and during preparation for Dismantling & Demolition, the staff complement is expected to increase at PNGS-B to accommodate the planning activities and mobilizing for Dismantling & Demolition and Site Restoration.

7.3 Dismantling & Demolition and Site Restoration

When Dismantling & Demolition begins, the workforce is expected to increase at PNGS-B. The duration for Dismantling & Demolition and Site Restoration activities at each PNGS-B unit will extend as shown in Figure 5-1 [15]. Consequently, some of these workers may move into the community. There may be local spending associated with the Dismantling & Demolition activities. It is possible that local contractors and suppliers will benefit. These changes will affect the local and regional community.

Other activities associated with Dismantling & Demolition will also be a source of effects. Most of the waste generated by the Dismantling & Demolition will not be radioactive. Of this waste, the concrete-based materials are anticipated to be used for filling at the site. The availability, proximity and cost of the disposal and any impacts related to haulage may potentially affect community services and infrastructure. Similar to L&ILW produced during Preparation for Safe Storage (Section 7.1), L&ILW generated during this period of decommissioning will be transported by road to respective long-term disposal facilities as described in 4.7.2.3. The volume of these wastes would be substantial (~ 30,000 m^3), so it is expected that the number of truck trips would be considerable.

At the conclusion of the Dismantling & Demolition period for both stations, the site will be restored for other OPG use(s). During Site Restoration, the workforce will decrease significantly at the Pickering Nuclear Site. The site will remain under the control of OPG and the input of a broad cross-section of stakeholders will be sought for the future use of the site, as described in Section 1.1. Under current assessment legislation, property tax monies will continue to be paid on buildings and structures until the structures are removed. It is assumed that the tax amount paid will vary as the work progresses through each phase of decommissioning. The amount of taxes paid after the Dismantling & Demolition of all buildings will depend on the new land uses.

8.0 POTENTIAL HAZARDS AND HEALTH & SAFETY

8.1 Hazard Assessment

A thorough assessment of the radiological, chemical and construction safety hazards that might be encountered in the course of the decommissioning project will be performed during the preparation for decommissioning. A preliminary assessment of some of the hazards likely to be encountered during the course of the decommissioning of the PNGS-B is summarized in Table 8-1. This preliminary hazard assessment is not exhaustive. Other potential hazards may be identified during the course of decommissioning planning and these will be addressed as appropriate. This assessment will be further refined, and it will be presented in the Safety Assessment which will accompany the DDP for the station (see Sections 4.1.3 and 4.2.5).

Table 8-1: Preliminary Hazard Assessment for the Decommissioning of PNGS

Hazard	Most Likely Source(s) of Hazard	Description/Comments	Group Potentially Impacted
Radiation Hazard	**Preparation for Safe Storage** • Handling used fuel, tritiated heavy water, filters and resins. • Performing decontamination work (including the chemical decontamination). • Working in gamma radiation fields produced by fission and activation products in station systems and components. • Waterborne radiation hazard during PHT vacuum drying (or drain/dry) and moderator flush.		Workers
	Storage With Surveillance • Storage of used fuel in the facility. Radiation fields will exist in other parts of the facility throughout SWS.	Used fuel will continue to be stored in the facility for an initial cooling period after permanent shutdown and the work required to transfer this fuel to dry storage will continue. At the beginning of this phase, the radiation fields will primarily be due to short-lived activation products such as tritium and cobalt-60 and these fields will decay significantly over the course of the SWS period.	Workers
	Dismantling & Demolition and Site Restoration Internal and external radiological hazards include: • Radiation fields produced by the fission and activation products that remain in station systems and components. • Hot spots from radioactive particles. • Radiation fields produced by the radionuclides in the waste. Loose surface contamination (including alpha emitting radioisotopes) on tools, equipment and systems that are opened during the work. • Airborne contamination generated during the decontamination work or the packaging of the waste.	All of the radiological hazards will be removed by the end of the decontamination and disposal work during Dismantling & Demolition and Site Restoration period.	Workers, Public, Environment

Hazard	Most Likely Source(s) of Hazard	Description/Comments	Group Potentially Impacted
Chemical Hazard	**Preparation for Safe Storage** • Draining and cleaning of water treatment facility tanks, etc. • Handling the cleaning agents used during decontamination work. • Transporting bulk/waste chemicals. • Waterborne contamination due to decontamination activities.		Workers, public Environment
	Storage With Surveillance • No unusual chemical hazards are expected during this phase.	Chemical storage during SWS and decommissioning will include appropriate storage requirements including separation of chemicals where required to avoid potential chemical hazards/explosions in case of spills or common mode event (earthquake).	Workers
	Dismantling & Demolition and Site Restoration • Handling the cleaning agents used during decontamination work. • Transporting bulk/waste chemicals. • Concrete dust generated during the dismantling work. • Waterborne contamination due to decontamination activities.		Workers, public, Environment
Industrial and Construction Hazards	**Preparation for Safe Storage** • Similar hazards to those encountered in an operating station during a shutdown (such as during a scheduled outage). • Airborne hazards necessitating the use of breathing air or Powered Air Purifying Respirator (PAPR).		Workers
	Storage With Surveillance • Similar hazards to those encountered in an operating station during a shutdown. • Airborne hazards necessitating the use of breathing air or PAPR.		Workers

Hazard	Most Likely Source(s) of Hazard	Description/Comments	Group Potentially Impacted
	Dismantling & Demolition and Site Restoration • Airborne hazards necessitating the use of breathing air or PAPR. • The operation of heavy construction equipment in close proximity to workers. • Fires caused by cutting torches and grinders. • The collapse of equipment or structures during dismantling. • The use of blasting and other techniques to demolish concrete structures. • Falls, lifting heavy objects, falling objects, use of hand tools and the other hazards routinely encountered during construction work. • Working at heights inside the station. • Hazards from decontamination activities (mechanical/chemical). • Hazards from concealed or hidden services.		Workers
Biological Hazards	Biological organisms and materials that might be found on the site during the decommissioning could also produce hazards that include: • Stings and bites from insects, rodents, birds or other animals that might live or nest inside accessible buildings. • Toxins and antigens produced by moulds and other fungi that might grow on surfaces (particularly those made of biological materials). • Infections or adverse reactions resulting from exposure to organisms living in decaying biological material (such as carcasses and droppings) or their by-products.		Workers
Motor Vehicle Accidents	• Highway travel/shipments. • Vehicle/pedestrian collisions. • Vehicle/wildlife collisions.		Workers, public
Inclement Weather	• Temperature extremes (hot/cold). • Lightning. • High winds.	Workers at the above grade structures face the greatest risk of lightning strike.	Workers

Hazard	Most Likely Source(s) of Hazard	Description/Comments	Group Potentially Impacted
Work around Open Water	• Work around the forebay.		Workers
Work at Heights	• Work on the meteorological tower, stacks, and other tall structures.		Workers
Fire/Explosion	• Hot work (e.g., cutting torches, etc.). • Storage of flammable liquids.		Workers, public, environment
Flying/Falling	• Objects falling from heights.	Pipes, walkways and other equipment will fall to the ground after it is cut.	Workers
	• Objects falling off buildings/structures as they are demolished.	Objects could fly off buildings and structures as they are being demolished.	Workers
Sharp/Heavy Objects	• Heavy objects.	Objects will be cut to the size required by recyclers, etc. Most objects will be too heavy to lift by hand.	Workers
	• Sharp objects.	Metal objects that are cut or torn may have sharp corners/edges.	Workers
Confined Spaces	• Work in confined spaces.	Little work will be performed in confined spaces.	Workers
Power/Hand Tools	• Working with power tools and hand tools.		Workers
Heavy Equipment	• Working around heavy equipment.		Workers
Excavations	• Work in or near below grade structures.	There are open, below-grade concrete structures on the site.	Workers, environment
	• Work in or near excavation in soil.		Workers
Demolitions	• Working near buildings and structures under demolition.		Workers, environment
Noise	• All conventional industrial processes.	PPE will be used.	Workers, public, environment
Work around Live Services	• Work near live aboveground services.	Due to the tight footprints of the stations, the logistics for safe work areas, laydown areas and access for heavy lifts, etc. need to be planned,	Workers
	• Work near live underground services.	Live electrical and water lines are buried below the site.	Workers

8.1.1 Occupational Dose Estimate

An Occupational Dose Estimate for the decommissioning of PNGS-B will be prepared prior to Dismantling & Demolition and included as part of the DDP (see Section 4.2.5). The Occupational Dose Estimate will be prepared by:

- Reviewing the work breakdown to identify those decommissioning tasks that will result in an occupational exposure to workers;
- Determining the location of the work that will be performed and the number of person-hours required to complete each task;
- Using survey results or numerical models to estimate the radiation dose rates that will be encountered in each location during the performance of each task; and
- Calculating the anticipated occupational dose that will result from the performance of each task.

8.1.2 Hazards to Workers

Primary hazards to workers throughout the decommissioning will be from conventional (non-radiological) hazards, particularly through the Dismantling & Demolition and Site Restoration period. Radiological hazards will be significantly reduced by removal of contamination and/or sealing of contamination in the Preparation for Safe Storage and through the SWS period with the removal of used fuel from the IFB. Further details on the hazards that are likely to exist during decommissioning are provided in Table 8-1.

8.1.3 Hazards to the Public

It is currently assumed that throughout the decommissioning project, radiological hazards to the public are most likely to result from accidents during the off-site transport of radioactive wastes. The bulk of the off-site transport is expected to occur during the Dismantling & Demolition period. Since this activity is scheduled to occur nominally 30 years after the final station shutdown, OPG will perform an in-depth analysis closer to the end of the SWS period. This will allow OPG to take advantage of the technological advances and industry experience, further minimizing any radiological risks to the public.

8.2 Radiological Safety

All decommissioning activities will be carried out in accordance with the ALARA principle and the Radiation Protection Program of OPG [40]. The procedures set out in the Radiation Protection Program with respect to dose control, contamination control and so forth will continue to be followed until they are suspended or modified in consultation with the CNSC. Some of the actions that will be taken to help ensure the radiological safety of workers prior to and during decommissioning are described in Sections 8.2.1 through 8.2.3. Where required, Radiation Work Plans and detailed procedures will be prepared before work begins.

Qualified staffs will be used throughout decommissioning to perform the work assigned to them using approved procedures to mitigate/eliminate hazards and any potential releases.

8.2.1 Preparation for Safe Storage

OPG station staff will perform the defueling, dewatering activities with contractors performing decontamination activities during Preparation for Safe Storage. The decontamination work that will be performed at this time should further reduce the radiation dose rates in the station. When

these activities are complete, the portions of the station that still contain radioactivity will be sealed off and all systems and services essential to caretaking will be kept in service.

Routine radiation surveys to help ensure public, environmental and personnel safety will be performed throughout this phase of the decommissioning. Environmental monitoring will continue in order to confirm that radioactive emissions to the environment are kept ALARA. Surveys of work area contamination and radiation levels will also be routinely conducted and documented. The results of surveys performed at the end of this period will be used to more accurately predict the radiation levels that are likely to exist during later stages of the work.

8.2.2 Storage With Surveillance

Spent fuel transfers from the IFB to the NSS-PWMF will continue during the SWS period for 10 to 15 years after station final shutdown. OPG staff will perform this work.

Radiation fields will exist in parts of the facility throughout the SWS period. At the beginning of the period, the fields will primarily be due to short-lived activation products such as tritium and cobalt-60 and these fields will decay over the course of the SWS period. During this period, surveillance, inspection and maintenance of the buildings and site will be carried out in order to ensure that the nuclear building structures and system envelopes retain their integrity. Hence, routine radiation surveys to help ensure public, environmental and personnel safety will be performed throughout this phase of the decommissioning. Consequently, employee exposure to the remaining fields and the resulting dose will be limited.

Environmental monitoring of the site and surrounding area will be maintained in order to confirm that radioactive releases are being controlled. Periodic gamma dose rate surveys will be carried out and documented to more accurately predict the radiation fields that will exist during Dismantling & Demolition and Site Restoration.

8.2.3 Dismantling & Demolition and Site Restoration

In order to minimize radiation doses during the Dismantling & Demolition process:

- Radiation surveys will be performed and dose estimates will be prepared before work begins;
- Work plans that make allowance for the difficulty of the work to be performed will be prepared (the cost and duration estimates will make allowance for the difficulty of the work by adjusting for respiratory protection, protective clothing, breaks during shift work and radiation protection/ALARA);
- Workers will be qualified in radiation protection and trained to perform the work. The level of training will be commensurate with the work being performed;
- The most active part of the station, the reactor calandria and associated systems will be dismantled using remotely-controlled cutters and manipulators. The operators will remain in a shielded control room and the resulting wastes will be packaged by remotely controlled manipulators;

- Where possible, components will be removed in one piece without dismantling;
- Because of the potential for airborne activity, temporary containment envelopes will be erected and many dismantling operations will be carried out by workers using approved PPE and respiratory protection;
- Contamination control procedures will be strictly observed; and
- Regular contamination and dose rate surveys will be performed and documented.

Procedures will be implemented to ensure that all persons, packages or flasks leaving the site satisfy the radioactive material transport or clearance levels. Environmental monitoring of the site and the surrounding area will be maintained throughout dismantling and waste transport operations. On completion of these operations, the final surveys will be performed to confirm that all prescribed substances have been removed to the extent specified in the DDP (see Section 4.2.5).

8.3 Chemical and Demolition Safety

OPG will ensure that all decommissioning work is conducted in accordance with the requirements of the applicable federal and provincial OH&S regulations. OPG currently has a comprehensive OH&S program that meets the requirements of the OH&S Act of Ontario [83]. This program recognizes:

- The right of employees to know of the hazards associated with their work;
- The right of employees to participate in decisions related to health and safety; and
- The right of employees to refuse to perform work that is considered to be unsafe.

As described in Sections 6.2 and 4.2.2, Decommissioning Contractor(s) will perform the decommissioning work during the Dismantling & Demolition and Site Restoration period. The contractor(s) will be given charge and control of the work area (or designated parts of the work area) as the 'Constructor'. The Decommissioning Contractor(s) will be responsible for:

- Registering the Construction Project with the Ontario Ministry of Labour as required by the Construction Safety Regulations made pursuant to the OH&S Act; and
- Providing the personnel, equipment, procedures and training required for the protection of workers, the public and environment.

OPG will provide oversight of the Decommissioning Contractor(s) to ensure that the work is performed in accordance with the requirements of the decommissioning licence, OPG policies, and the contract.

8.4 Emergency Response Planning

During the preparation of the DDP (see Section 4.2.5), OPG will prepare an assessment of the potential hazards to workers, the public and the environment. During Stabilization, while there

is still fuel in the reactors, it is anticipated that the real or potential emergency situations that might occur will be similar to those that might occur in an operating station during a shutdown. It is also anticipated that the emergency response plans and resources required to deal with these situations would be similar to those required in an operating station during a shutdown and, on this basis, it will be necessary to maintain the operational emergency response capability until the reactors are defueled and dewatered. For example, provision of Emergency Mitigating Equipment or equivalent will still be retained for back up fuel cooling in the bays to respond to emergencies (such as Total Loss of On-Site Power). Subsequently, the response may be reduced to address spent fuel stored in the IFB. For example, distribution of KI pills to residents in the vicinity of the Pickering site will no longer be required.

As the project progresses, the potential emergency situations will come to resemble more closely those that might occur during the course of a major construction project.

Throughout the decommissioning period, OPG will ensure that:

- The required emergency response plans and procedures are in place;
- The plans are reviewed and exercised regularly;
- An adequate number of personnel are available to respond to any emergency situation that may occur;
- The emergency response personnel receive the training required to respond appropriately to any emergency situation that may occur; and
- The necessary equipment and supplies are available for use by emergency response personnel.

OPG will coordinate its response to a real or potential emergency situation with the appropriate federal, provincial, regional and municipal agencies.

9.0 SECURITY AND SAFEGUARDS

9.1 Security

During decommissioning, OPG will continue to comply with the CNSC regulations on the physical security of nuclear facilities. OPG will be responsible for the security of the site throughout the course of the decommissioning project.

OPG will ensure the security of the site and the Decommissioning Contractor(s) and sub-contractors will be required to comply with licensing conditions and OPG procedures regarding the physical security. During most of the decommissioning of PNGS-B, the NSS-PWMF will still be operational. Even though they are two different facilities that are currently under separate licences, the same security staff will be responsible for both facilities.

9.2 Safeguards

In accordance with an agreement between the Government of Canada and the IAEA, nuclear safeguards are implemented at OPG's NGSs. These international safeguards apply to used fuel management.

The existing safeguards arrangements for used fuel will continue until modified or terminated by agreement with the CNSC.

10.0 QUALITY ASSURANCE

OPG has QA programs for its operations, which is detailed in the Nuclear Management System [12] and that meet the requirements of national (i.e., CSA N286) and international standards. A QA program for the decommissioning work will be prepared and revised at the time of the DDP and will meet the requirements of the QA program of OPG.

The Decommissioning Contractor(s) and all sub-contractors will be required to have a QA Plan that meets the standards established by OPG's QA Plan. OPG may perform audits to ensure that they perform their work in accordance with the requirements of their QA Plan.

11.0 RECORDS AND RECORDS RETENTION

11.1 Records

The operating records (see Section 5.2.3 of CSA N294:19 [3]) and decommissioning records (see Section 5.2.5 of CSA N294:19 [3]) required for long-term retention will be prepared, stored, and preserved electronically in accordance with OPG's Nuclear Management System [12] requirements.

Records will include, but not be limited, to the following:

- Operating Records, such as Operating Logs, Waste Records, Operations Manuals, Procedures, Conditions and Maintenance Records.
- Configuration Records, such as Maps, Drawings, Photographs, Engineering Records, Design Records, Technical/Materials Specifications, Change Control Information.
- Environmental/Radiological/Incident/Regulatory Records, such as Annual Reports, Unplanned Event Reports, Radiation Zone Surveys, Survey Logs, Hazardous Materials Inventory/Controls, Licensing Reports, Compliance Reports, Safety Analysis Reports.
- Decommissioning Records, such as Detailed Work Plans, Characterization Reports, Assessment Reports, Project Plans, Detailed Work Plans, SWS Plans, QA Records, Licences, Permits, Schedules, Remediation Verification Results, and Interim and Final End State Reports.

Additional lessons learned from IAEA guidance on records documented will be consulted for additional guidance – see Section 11.2.

11.2 Records Retention

Records filing and retention are governed by OPG's Information Management program, which identifies records relevant to decommissioning as permanent records.

At the completion of decommissioning, all appropriate records will be retained for the purpose of:

- Confirmation of completion of decommissioning activities;
- Recording the disposition of wastes, materials, and premises; and
- Responding to possible liability claims.

Decommissioning records will be kept in the storage medium in standard use at the time of decommissioning. All records will be assembled and maintained in accordance with the document and record management process and governance. Because of the long timeframe anticipated for the decommissioning, records will be periodically checked to ensure their preservation and protection from loss, deterioration, and destruction.

12.0 PUBLIC, STAKEHOLDERS AND INDIGENOUS ENGAGEMENT

OPG believes in timely, open and transparent communication to maintain positive and supportive relationships and confidence of key stakeholders, and Indigenous Nations and communities, in accordance with CNSC REGDOC-3.2.1, Public Information and Disclosure [50] and REGDOC-3.2.2, Indigenous Engagement [51]. As such, OPG regularly and proactively provides information to the public and Indigenous Nations and communities, on current operations and potential projects.

12.1 Public and Stakeholder Engagement Program

OPG values the relationships it has with local communities, the public, and all its stakeholders, and fosters open and ongoing communications through a comprehensive public outreach program (Public Information and Disclosure Protocol).

The public and stakeholder engagement program complies with the applicable requirements of [50], and OPG reports on this program annually to the CNSC. The program includes a variety of communication methods and engagement opportunities that meet the needs of the audience and the objectives of the business.

In relation to the DDP and related activities, including the environmental risk assessment, the program ensures communications are informative, timely and accurate which allows the public to make informed, objective decisions through readily accessible information, open dialogue, and opportunities to ask questions.

Communication methods utilized to distribute information, and to solicit feedback and input, can include updates to opg.com, annual public open house, information sessions and workshops, community councils and committee meetings, stations tours and presentations.

Specific to the DDP, information has been shared through a variety of means, including through direct dialogue with Community Advisory Councils (CACs), Durham Nuclear Health Committee (DNHC), Neighbours newsletters, tours and presentations, and public information sessions and stakeholder workshops.

12.2 Engagement with Indigenous Nations and Communities

12.2.1 Overview

OPG is committed to taking concrete and measurable actions to advance reconciliation with Indigenous peoples and to regularly report on the company's activities and progress in achieving established goals. In the fall of 2021, OPG launched its Reconciliation Action Plan (RAP). The RAP is a public document that serves as a roadmap to reconciliation and the inaugural 2021 edition included a number of specific actions and commitments with clear deliverables and timelines spanning between 2022 and 2031.

The Indigenous Relations Policy, OPG-POL-0027 [84], describes OPG's commitment to work with Indigenous Nations and communities and peoples. This policy governs OPG's engagement with Indigenous peoples with respect to end of commercial operations, planned PNGS-B refurbishment, safe storage and eventual decommissioning of PNGS.

12.2.2 Approach to Indigenous Engagement at PNGS

To guide engagement, OPG developed an Indigenous Engagement Plan (IEP) that identifies engagement scope and activities for ongoing and proposed initiatives at PNGS. OPG pursued the development of a site-wide IEP based on interests shared from Indigenous Nations and communities for a holistic and coordinated approach to support effective engagement at PNGS.

A draft of the IEP was shared with the Williams Treaties First Nations, Huron-Wendat Nation, Mohawks of the Bay of Quinte, Métis Nation of Ontario – Region 8 and Six Nations of the Grand River in January 2024. Based on comments and recommendations from Indigenous Nations and communities, OPG provided responses to all comments received, updated the IEP, and issued a final working version of the IEP in May 2024. Additionally, a Memorandum of Understanding (MoU) and Capacity Agreements with each of the Michi Saagiig have been developed and are being reviewed by the Nations.

The IEP is intended to be a living document that can be updated over time to respond to engagement priorities and needs. As a demonstration of this intent, OPG added the Saugeen Ojibway Nation as an Indigenous Nation expressing interest in PNGS and shared the IEP with the Saugeen Ojibway Nation for review and comment in September 2024.

12.3 Engagement Summary on Decommissioning

OPG continuously hears that nuclear waste and waste management operations is an important issue to Indigenous Nations and communities, including waste streams and volumes. To support this, decommissioning-specific presentations have been shared with the Michi Saagiig Nations (Alderville First Nation, Curve Lake First Nation, Hiawatha First Nation and Mississaugas of Scugog Island First Nation). OPG's Indigenous Relations team continues to engage with the Chippewa Nations (Beausoleil First Nation, Georgina Island First Nation and Rama First Nation) to begin relationship building. A plan is in development to determine the best path to information sharing with these Nations.

OPG continues to host site visits and meetings and to visit communities to share information, answer questions, and raise awareness of the work being undertaken to manage both the nuclear and conventional waste at the company's various facilities. To respond to the interests of the Michi Saagiig Nations, OPG and the Michi Saagiig Nations established a Waste Table in August 2024 to have a coordinated, holistic and comprehensive engagement approach to waste across PNGS and the Darlington Nuclear Generating Station.

12.4 OPG's Centre for Canadian Nuclear Sustainability (2020-2023)

In October 2020, OPG launched the Centre for Canadian Nuclear Sustainability (CCNS) in Pickering, Ontario. The centre was dedicated to the safe and responsible decommissioning of nuclear facilities and focused on developing best practices and innovative approaches to manage decommissioning processes while prioritizing environmental protection and community engagement, particularly for the Pickering Decommissioning project. An essential aspect of the CCNS was its Indigenous Advisory Council (IAC), which played a crucial role in ensuring that Indigenous perspectives and knowledge are integrated into decommissioning activities. This collaborative effort aimed to address community concerns, foster transparency, and enhance

the long-term sustainability of nuclear energy in Canada by promoting strategies that minimize waste and ensure safe site transitions post-decommissioning.

Throughout 2020-2023, the CCNS team delivered initiatives to its members through innovation funding, Indigenous Knowledge sharing webinars, industry networking opportunities and community programing while simultaneously exploring additional strategic opportunities. In 2023, after much discussion with CCNS members, community stakeholders and the IAC, the conclusion that the successes of the CCNS could continue without need for a physical space and associated membership model. Additionally, it was important to engage with the Williams Treaties First Nations (Rightsholders) in the territory and with this, the decision was made to wind down the membership and operations of the CCNS.

13.0 REFERENCES

[1] CNSC , "Nuclear Power Reactor Operating Licence, Pickering Nuclear Generating Station," PROL 48.01/2028.

[2] CNSC, *Waste Management, Decommissioning, REGDOC-2.11.2,* January 2021.

[3] CSA, "Decommissioning of facilities containing nuclear substances," N294:19, November 2019.

[4] OPG, *Gap Analysis for Implementation of CNSC REGDOC-2.11.2 Decommissioning, N-REP-00960-10016,* January 3, 2023.

[5] OPG Letter, T. Dekker to CNSC, “OPG Follow-up Response to CNSC Staff’s Outstanding Comments on OPG’s Submission: Preliminary Decommissioning Plans", CD # N-CORR-00531-23670, June 22, 2023.

[6] Letter from CNSC to OPG, OPG Response to CNSC staff’s Review of OPG’s Submission: Preliminary Decommissioning Plans, N-CORR-00531-23829, October 4, 2023.

[7] OPG, Pickering Nuclear Site Preliminary Decommissioning Plan, P-PLAN-00960-00001-R003, January 2022.

[8] OPG, "Pickering Nuclear Site Overarching Preliminary Decommissioning Plan," P-PLAN-00960-00008-R00, January 2025.

[9] OPG, "PNGS A Detailed Decommissioning Plan - Program overview," NA44-PLAN-00960-00004.

[10] OPG, "Nuclear Sustainability Services – Pickering Waste Preliminary Decommissioning," 92896-PLAN-00001 R004, December 2021.

[11] OPG, "Conduct of Decommissioning," W-STD-WM-0005.

[12] OPG, "Nuclear Management System," N-CHAR-AS-0002.

[13] OPG, "Decommissioning Program," W-PROG-WM-0003.

[14] OPG, "Planning for Decommissioning," W-STD-WM-0006.

[15] OPG, "Pickering B Nuclear Generating Station Decommissioning Cost Study," Document O05-1780-019.

[16] CSA, "Guideline for the exemption or clearance from regulatory control of materials that contain, or potentially contain, nuclear substance," CSA N292.5.

[17] OPG, "Pickering NGS B Safety Report – Part 1," NK30-SR-01320-00001 R006, October 7, 2022.

[18] OPG, "Pickering NGS B Safety Report – Part 2," NK30-SR-01320-00002 R006, October 7, 2022.

[19] OPG, "Building Development Site Plan," NK30-D0A-10200-0001, Rev. 39.

[20] CNSC, Comprehensive Study Report, Bruce Heavy Water Plant Decommissioning Project, March 2003.

[21] Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), NUREG-1575/EPA 402-R-97-016, U.S.NRC, Revision 1, August 2000.

[22] OPG, "Final End State Report, Bruce Heavy Water Plant Decommissioning," 0124-REP-00960-00012 R000, June 2013.

[23] OPG, "Bruce Heavy Water Plant Environmental Assessment Follow-Up and Monitoring Closure Report," 0124-REP-00960-00013 R000, June 2013.

[24] CNSC, "License to Abandon a Heavy Water Plant Ontario Power Generation Bruce Heavy Water Plant’," E-DOCs-#4237004, March 2014.

[25] OPG, "Licence Amendment Request for RWOS-1 Waste Nuclear Substance Licence WNSL-W1-320.04/ind," 0125-CORR-00531-18999, March 2019.

[26] CNSC, "Review of Final Status Survey Report WWMF Spent Solvent Treatment Facility Decontamination and Demolition Phase II," 0125-CORR-00531-19013, May 2019.

[27] OPG, "OPG Response to CNSC Comments from the Review of Final Status Survey Report WWMF Spent Solvent Treatment Facility Decontamination and Demolition Phase II," 06116-CORR-00531-00082, August 2019.

[28] CNSC, "Decision on the licence amendment for Ontario Power Generation-RWOS-1 Waste Nuclear Substance Licence WNSL-W1-320.04/ind," 0125-CORR-00531-19024, October 2019.

[29] CNSC, "Protocol on the End of Commercial Operation of the Gentilly-2 Nuclear Reactor," Rev. 4, April 2013.

[30] Michele Laraia, Entombment: A Viable Decommissioning Strategy for Research Reactors?, International Nuclear Safety Journal, Vol. 3, Issue 3, 2014, pp. 1-10, November 2014.

[31] CNSC, Record of Decision, Applicant: Canadian Nuclear Laboratories Ltd., Application to Separate the Waste Facility Decommissioning Licence for Douglas Point, Gentilly-1 and Nuclear Power Demonstration, February 2019.

[32] CNL, "Douglas Point Waste Facility Detailed Decommissioning Plan Volume 1: Program Overview," 22-00960-DDP-001, Revision 1, December 2019.

[33] CNSC, "Written Submission from Canadian Nuclear Laboratories Ltd. Douglas Point Waste Facility: Application to amend the waste facility decommissioning licence for the Douglas Point Waste Facility," CMD 20-H4.1, November 2020.

[34] IAEA, "Selection of Decommissioning Strategies: Issues and Factors," TECDOC-1478, November 2005.

[35] IAEA, "Decommissioning of Nuclear Power Plants, Research Reactors and Other Nuclear Fuel Cycle Facilities," Specific Safety Guide, No. SSG-47, October 2018.

[36] IAEA, "Decommissioning Strategies for Facilities Using Radioactive Material," Safety Reports Series 50, March 2007.

[37] IAEA, Nuclear Power Reactors in the world, IAEA-RDS-2/44, Reference Data Series No. 2, 2024 Edition, July 2024.

[38] IAEA, "Record keeping for the Decommissioning of Nuclear Facilities: Guidelines and Experience," Technical report Series No. 411, 2002.

[39] OPG, "Pickering NGS Hazardous Substances," P-REP-08965-0905442 Rev 002, March 12, 2024.

[40] OPG, "Radiation Protection Program," N-PROG-RA-0013.

[41] OPG, Spill Management, OPG-STD-0152.

[42] OPG, "OPG Written Submission in support of the renewal of Pickering's POWER REACTOR OPERATING LICENCE," CMD 18-H6.1, P-CORR-00531-05310, April 2018.

[43] IAEA, Managing the Unexpected in Decommissioning, No. NW-T-2.8, 2016.

[44] OECD/NEA, "Preparing for Decommissioning During Operation and After Final Shutdown," 2018.

[45] IAEA, "Safety Assessment for Decommissioning of Facilities Using Radioactive Material," Safety Guide, No. WS-G-5.2, 2008.

[46] IAEA, "Safety Assessment for Facilities and Activities', General Safety Requirements,," No. GSR Part 4 (Rev. 1), 2016.

[47] IAEA, "Selection and Use of Performance Indicators in Decommissioning," Nuclear Energy Series, No. NW-T-2.1, July 2011.

[48] IAEA, "Safe and Effective Nuclear Power Plant Life Cycle Management towards Decommissioning," IAEA-TECDOC-1305, August 2002.

[49] CNSC, "Reactor Facilities Licence Application Guide: Licence to Operate a Nuclear Power Plant," REGDOC-1.1.3, September 2017.

[50] CNSC, "Public Information and Disclosure," REGDOC-3.2.1, May 2018.

[51] CNSC, "Indigenous Engagement," REGDOC-3.2.2, Version 1.1, August 2019.

[52] CNSC, "Financial Guarantees for Decommissioning of Nuclear Facilities and Termination of Licensed Activities," REGDOC-3.3.1, January 2021.

[53] CSA, "Effluent Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills," CSA N288.5.

[54] CSA, "Environmental Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills," CSA N288.4.

[55] IAEA, "Addressing Challenges in Managing Radioactive Waste from Past Activities," IAEA-TECDOC-2039, January 2024.

[56] CNSC, "Waste Management, Volume I: Management of Radioactive Waste," REGDOC-2.11.1, January 2021.

[57] OPG, "Nuclear Waste Management," W-PROG-WM-0001.

[58] Minister of Justice, "Transportation of Dangerous Goods Regulations," SOR/2001-286, Current to May 2021.

[59] IAEA, Monitoring Programmes for Unrestricted Release Related to Decommissioning Nuclear Facilities, Technical Report 334, 1992.

[60] Ontario Regulation 153/04: RECORDS OF SITE CONDITION - PART XV.1 OF THE ACT, Environmental Protection Act, R.S.O. 1990, c. E.19, Consolidation Period: From January 1, 2024 to the e-Laws currency date..

[61] OPG, "Segregation and Handling of Radioactive Waste," N-PROC-RA-0017.

[62] OPG, "Segregation and Handling of Low and Intermediate Level Radioactive Solid Waste," P-PROC-WM-0006.

[63] Kinectrics Inc., "Radionuclide Inventory Estimate for Ontario Power Generation's Decommissioning Waste," K-41586-001-RA-001-R00.

[64] OPG, "Characteristics and Radionuclide Inventories of Used Fuel from OPG Nuclear Generating Stations, Volume 3 – Radionuclide Inventory Data Decay Times 10 to 300 Years," 06819-REP-01200-10029-R00, Volume 3, July 2001.

[65] NWMO, "Choosing a Way Forward - The Future of Canada's Used Nuclear Fuel," May 2005.

[66] NWMO, "Moving forward together," Triennial report, 2008 to 2010.

[67] OPG, "Environment Health and Safety Managed System," OPG-PROG-0005.

[68] OPG, "Health and Safety Management of Asbestos-Containing Material," OPG-PROC-0124.

[69] OPG, "Asbestos Work Procedures," OPG-GUID-08963-0003.

[70] OPG, "Designated Substance Assessment – Lead," P-REP-08965-0412357-R000, December 2012.

[71] OPG, "PCB Waste Inventory Change for Pickering Nuclear," P-CORR-00541-00918, March 2021.

[72] DEC 22-H104, Record of Decision, CNSC/OPG Application for Acceptance of Ontario Power Generation's Revised Consolidated Financial Guarantee, December 6, 2022.

[73] Davey, E., "Incorporating Human Factors in Decommissioning Projects – Opportunities for Adapting Application," Canadian Nuclear Society Conference, May 2005.

[74] CNSC, "General Design Considerations: Human Factors," REGDOC-2.5.1, March 2019.

[75] CNSC, "Human Performance Management Human Factors," REGDOC-2.2.1, March 2019.

[76] CSA, "Human Factors in Design for Nuclear Power Plants," CSA N290.12.

[77] Nuclear Safety Agency, "Report on the CSNI Workshop on Nuclear Power Plant Transition from Operation into Decommissioning: Human Factors and Organisation Considerations," May 1999.

[78] IAEA, "Transition from Operatio to Decommissioning of Nuclear Installations, Technical Reports Series No. 420," Vienna, 2004.

[79] Occupational Health and Safety Act, Ontario Regulation 213/91, Construction Projects.

[80] OPG, "Training," N-PROG-TR-0005.

[81] OPG, "Predictive Effects Assessment for Pickering Nuclear Safe Storage - 2022 Addendum Report," P-REP-07701-00006 R001, March 31, 2023.

[82] OPG, "Predictive Effects Assessment for Pickering Nuclear Safe Storage," P-REP-07701-00002 R000, April 2017.

[83] Government of Ontario, "Occupational Health and Safety Act, R.S.O 1990," Consolidated: July 2020.

[84] OPG, Indigenous Relations Policy, OPG-POL-0027.

[85] Minister of Justice, "Nuclear Substances and Radiation Devices Regulations," SOR/2000-207.

Appendix A: Compliance Matrix with CNSC REGDOC-2.11.2

Table 14-1: Compliance Matrix between CNSC REGDOC-2.11.2 and this Plan

Section in REGDOC-2.11.2	Requirement in CNSC REGDOC-2.11.2	Section in This PDP
4	The licensee shall ensure that protection of health, safety, security and the environment is planned and optimized during decommissioning.	1.4 This pertains to the execution phase.
5	The licensee shall select a decommissioning strategy that will form the basis for planning for decommissioning and facilitate achieving the desired end state of the decommissioning project. For Class I nuclear facilities and uranium mines and mills, the decommissioning strategy shall be selected during the siting stage. For Class II nuclear facilities, the decommissioning strategy shall be selected during the construction stage. Prior to submitting an application for a licence to possess, manage, use or store nuclear substances at a location, the decommissioning strategy shall be selected. For existing facilities, uranium mines and mills, and nuclear substances and radiation device licensees who are required to have a decommissioning strategy and where there is no decommissioning strategy, the licensee shall select a suitable strategy for decommissioning as soon as possible.	3.4
5	If shutdown of a facility, location or site is sudden, the decommissioning strategy shall be reviewed on the basis of the situation that initiated the sudden shutdown in order to determine whether a revision of the strategy is required.	3.4.1
5.1	*In situ* decommissioning shall not be considered a reasonable decommissioning option for planned decommissioning of existing or future nuclear facilities and situations where removal is possible and practicable; nevertheless in situ decommissioning may be considered a solution only under exceptional circumstances (e.g., following a severe accident) or for legacy sites….. In a case where the end state for *in situ* decommissioning results in a waste disposal facility, location or site, the licensee shall satisfy all regulatory requirements for a radioactive waste disposal facility, location or site and demonstrate safety in a safety case and safety assessment of the disposal facility, location or site.	3.4.1 *In situ* decommissioning currently not applicable to OPG facilities.
6	Where required by a condition of the licence, a licensee shall maintain a financial guarantee for decommissioning that is acceptable to the CNSC.	5.3
6.1	The licensee shall prepare a PDP and submit it to the CNSC for acceptance with an application for a licence in respect of a nuclear facility or the conduct of a licensed activity, in accordance with the conditions of its licence. The PDP shall document the selected decommissioning strategy; main decontamination, dismantling and/or clean-up activities; end-state objectives; an overview of the principal hazards and protection strategies; a waste	This PDP addresses the requirements and revisions of the PDP are submitted to the CNSC for review and acceptance. 1.0 3.4.1 4.3 3.2

Section in REGDOC-2.11.2	Requirement in CNSC REGDOC-2.11.2	Section in This PDP
	management strategy; a cost estimate; and financial guarantee arrangements.	8.0 4.7 5.1 5.3
6.1	The licensee shall review and, as necessary, update the PDP and submit it to the CNSC every five years or as requested by the CNSC.	1.0
6.1	For licensed sites with more than one facility or location for which the licensee is responsible, the licensee shall submit an overarching PDP to ensure that interdependencies between planning envelopes or facilities, locations or sites are taken into account.	1.0
6.1.1	A PDP for a nuclear facility with a Class I or uranium mines and mills licence shall include, as applicable:	
	• a description of the location of the facility, including: • a map of the facility and its specifications • geographic information • details regarding the surrounding environment • land uses • illustrations and maps of the facility in relation to the municipality	Figure 2-1 2.1
	• the purpose and description of the facility, including: • primary SSCs • the building type and construction, including location of any hazardous building materials (e.g., asbestos, polychlorinated biphenyls) • the building services (e.g., power, heating, ventilation, sewer, water, fire protection) • laboratories and other hazardous handling areas • the type, quantity and form of radioactive and hazardous materials managed, stored, produced or used during operation • the design features used to reduce the spread of contamination and facilitate decontamination, dismantling and/or clean-up	2.0 4.7.1, 4.7.3.1
	• the anticipated post-operational conditions, including: • a summary of the shutdown process, including planned removal of stored inventories of hazardous or radioactive materials • the predicted nature and extent of contamination remaining in the primary SSCs (in list or table format with reference to applicable illustrations) the predicted nature and extent of contamination on floors, walls and work surfaces, in ventilation systems, etc. • an overview of the principal hazardous conditions anticipated	4.1.4, 4.1.4.5 3.6, Table 4-1, 4.1.4.6 4.7.3.1, 8.0

Section in REGDOC-2.11.2	Requirement in CNSC REGDOC-2.11.2	Section in This PDP
	• the identification of any separate planning envelopes	4.2.4
	• the decommissioning strategy, including: • the final end-state objective • the rationale for: • the decommissioning strategy selected • interim end states • periods of storage with surveillance • any institutional controls • the assessment of alternative strategies (or a rationale for why alternatives do not exist or do not warrant consideration)	3.2 3.4 3.2, 4.5 3.4.1 Not Applicable.: No long-term institutional controls will be established. 3.4.1
	• the plan of the decommissioning work, including: • a work breakdown structure • a summary of the main steps for decontamination, dismantling and/or clean-up, and removal of each of the SSCs, preferably grouped into work packages • for each work package, an identification of those types of activities that could pose a significant hazard to workers, the public or the environment • the role of existing operational standard procedures for radiation protection, hazardous materials handling, industrial safety, and environmental protection in managing hazards • the specific activities for which additional protection/mitigation procedures will be required at the detailed planning stage (preparation for decommissioning phase) • a summary of the final dismantlement of the structures • a conceptual schedule showing the approximate year of facility shutdown and the approximate sequencing and duration of the decommissioning work packages and, where relevant, storage periods	Included in [15] 4.0, 4.3.1 - 4.3.3, Table 8-1, 8.2, 8.3 4.1, 8.2, 8.3 4.2.2, 4.2.4, 4.2.4 4.3.6, 4.5 4.0 5.2
	• the hazardous monitoring and survey commitments, including: • a program for conducting periodic contamination surveys and the recording of contamination events during facility operation • a commitment to develop plans and protocols acceptable to the CNSC at the detailed planning stage for monitoring: • work hazards during decommissioning • personnel dosimetry • environmental emissions and effluents • materials, sites and structures to be cleared from regulatory control	3.6, 4.2.3, 4.4 4.1.1, 4.2, 8.0 8.1.1, 8.2.1 - 8.2.3, 8.2 4.1.2 4.3.5, 4.3.6, 4.5

Section in REGDOC-2.11.2	Requirement in CNSC REGDOC-2.11.2	Section in This PDP
	• a waste management strategy specifying: • the conservative quantities and characteristics of radioactive and chemically hazardous wastes expected to arise from the decommissioning (tied to specific work packages, if possible) • the anticipated final disposition of radioactive and chemically hazardous materials • a commitment to segregate as much material as possible for reuse and recycling	4.7, 4.7.2, 4.7.3, Included in [15] 1.6, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 4.7.2.3, 4.7.3.3 4.2.2, 4.7
	• a commitment to prepare a DDP for CNSC acceptance prior to decommissioning	1.1, 4.1.3, 4.2.4
	• a commitment to periodically review and update the PDP, in accordance with section 6.1	1.1
	• the physical state of the facility at: • the end of operations (permanent shutdown state) • the start of decommissioning (stable state for decommissioning)	3.6 4.0, 4.1
	• the records required for decommissioning, including a description of the facility's operational records that will be maintained to periodically update the PDP and prepare the DDP(s)	11.0
	• a public consultation plan, including a public information program and avenues for public participation as per the requirements and guidance of REGDOC-3.2.1, *Public Information and Disclosure*	12.0
	• an Indigenous engagement plan as per the requirements and guidance of REGDOC-3.2.2, *Indigenous Engagement*	12.0
	• the conservative cost estimate of decommissioning and a financial guarantee, as described in REGDOC-3.3.1, *Financial Guarantees for Decommissioning of Nuclear Facilities and Termination of Licensed Activities*, specifying: • an estimate of the total present- value cost of the decommissioning • a reasonable basis for how cost estimates were derived • a description of how the required funds will be provided Note: the cost estimate and financial guarantee could be maintained as part of the PDP or as a stand-alone document	5.1, 5.3 Included in [15]
6.2	The licensee shall prepare a waste management strategy that identifies the categories and estimated quantities of all waste streams that will be generated and managed during decommissioning, and the planned disposition path.	4.1.2, 4.2.2
7	During the preparation for decommissioning phase, the licensee shall review and revise its impacted program	4.1.2

Section in REGDOC-2.11.2	Requirement in CNSC REGDOC-2.11.2	Section in This PDP
	documents to ensure that they align with the decommissioning activities.	
7	The licensee shall inform the CNSC, in writing, prior to shutting down a facility, location or site permanently or ceasing to manage, possess, use or store nuclear substances. Prior to the permanent shutdown of a facility, location or site or ceasing to manage, possess, use or store nuclear substances, the licensee should discuss with the CNSC the timing of decommissioning, the proposed decommissioning actions, applicable regulations and guidance, and other considerations raised by the CNSC.	1.1
7	For nuclear facilities with a Class I or a uranium mines and mills licence, the licensee shall submit to CNSC staff, for acceptance, the following documents, in order to transition from operation to decommissioning: • a permanent shutdown plan – includes the steps to transition the facility from operation to a permanent shutdown state • a stabilization activity plan – comprises steps for the facility's transition from a permanent shutdown state to a stable state for decommissioning • a DDP – see section 7.1	1.1
7.1	Prior to the execution of decommissioning, the licensee shall submit a DDP to the CNSC for acceptance, where required by a condition of the licence. For a Class I nuclear facility, the licensee should typically submit a DDP to the CNSC two to five years prior to executing decommissioning. The DDP shall document the decommissioning strategy; decontamination, dismantling and/or clean-up activities; final end-state objectives; the principle hazards and protection plans; a waste management plan; a cost estimate; and financial guarantee arrangements. Once accepted by CNSC staff, the DDP will be incorporated into a licence authorizing decommissioning.	1.1, 4.1.3, 4.2.4
7.1	For immediate (prompt) decommissioning, the licensee shall detail, in the DDP and supporting documents (e.g., safety assessment for decommissioning), the decontamination, dismantling and clean-up.	Not Applicable as OPG has not selected the immediate (prompt) decommissioning strategy
7.1	For deferred decommissioning, the licensee shall detail, in the DDP and supporting documents (e.g., safety assessment for decommissioning), the activities that will be performed during the storage with surveillance period. Toward the end of the storage with surveillance period, the DDP and supporting documents shall be revised, detailing the decontamination, dismantling work and clean-up activities to be completed and submitted to the CNSC for acceptance.	1.1, 4.1.3, 4.2.4
7.1	For *in situ* decommissioning, the licensee shall detail, in the DDP, any decontamination, dismantling, clean- up and storage with surveillance activities, as applicable. In	Not Applicable as OPG has not selected the *in situ* decommissioning strategy

Section in REGDOC-2.11.2	Requirement in CNSC REGDOC-2.11.2	Section in This PDP
	cases where the end-state result is a waste disposal facility, location or site, the licensee shall submit, in addition to a safety assessment for decommissioning, a safety case and supporting post-closure safety assessment.	
7.1	Where decommissioning takes longer than five years, the DDP shall be reviewed and, as necessary, updated every five years or as requested by the CNSC.	4.1.3, 4.2.4
7.1	For licensed sites with more than one facility or location preparing to undergo decommissioning for which the licensee is responsible, the licensee shall submit an overarching site DDP to ensure that interdependencies between the individual DDPs (planning envelopes or facilities or locations) are taken into account.	Not Applicable – this will be addressed in [8]
7.1.1	A DDP for a nuclear facility with a Class I or uranium mines and mills licence shall include, as applicable:	4.1.3, 4.2.4
	• a description of, and diagram showing, the areas, components and structures to be decommissioned, grouped, where appropriate, into logical decommissioning planning envelopes	Not Applicable. This requirement pertains to the preparation phase.
	• the operational history, including incidents or accidents that could affect decommissioning	
	• the storage with surveillance stage, as applicable, and requirements of the: • functional building services • monitoring and surveillance activities • inspection activities • usage boundaries during storage with surveillance	
	• the final radiological, physical and chemical end-state objectives, and interim end-state objectives, as applicable	
	• a description of the requirements for any institutional controls	
	• comprehensive and systematic survey results of radiological and other potentially hazardous conditions, including identification and description of the remaining significant gaps or uncertainties in the measurement or prediction of such conditions	
	• a decommissioning strategy for each planning envelope that highlights any significant changes from the strategy identified in the PDP	
	• a description of the decommissioning work packages, including: • a step-wise technical approach • the nature and source of potential significant risks to workers, the public and the environment (including estimates of doses), as well as species at risk (refer to *Species at Risk Act*) • the procedures or technologies proposed to mitigate risks • the quantities, characteristics and disposition	

Section in REGDOC-2.11.2	Requirement in CNSC REGDOC-2.11.2	Section in This PDP
	methods of waste	
	• a schedule of the execution of decommissioning activities showing: • the start date of the proposed execution of decommissioning activities • the approximate duration and sequence of work packages (and periods of storage with surveillance, if applicable) • the anticipated date of completion of decommissioning activities	
	• a waste management plan (see section 7.4)	
	• a characterization of potential environmental effects and the measures to be employed to mitigate and monitor these effects	
	• a conservative cost estimate (based on the work packages), as described in REGDOC-3.3.1, *Financial Guarantees for Decommissioning of Nuclear Facilities and Termination of Licensed Activities*, for labour, materials, equipment, waste management, environmental assessment, monitoring and administration (e.g., training, safety, licensing, project management, government and public liaison)	
	• financial guarantee arrangements	
	• a summary report of any public and Indigenous consultations undertaken in preparing the plan, including issues raised and how they were considered and dispositioned	
	• the project management structure	
	• applicable programs (e.g., management system, emergency response, site security, radiation protection, environmental protection, fire, and personnel training) (Note: this includes programs applicable during storage with surveillance and decommissioning)	
	• a human factors program that includes: • human factors analysis • training provisions • use of contractors • procedural development • ergonomic issues	
	• conventional occupational health and safety issues and associated training and protection programs	
	• a list of federal and provincial regulatory agencies involved in the project	
	• the final survey program with interpretation criteria	
	• the operating and decommissioning records that will be retained, and the method of retention	
	• a table of contents for the final end- state report, outlining the topics to be covered	

Section in REGDOC-2.11.2	Requirement in CNSC REGDOC-2.11.2	Section in This PDP
	• operational experience and lessons learned from the decommissioning of similar nuclear facilities	
	• criticality safety assessment, as required, and planned actions involving fissile material	
7.2	The licensee shall perform a safety assessment to identify any radiological or non-radiological hazards to workers, the environment and the public from both routine decommissioning activities and credible potential accidents during decommissioning.	1.1, 4.1.3, 4.2.5
7.2	For a nuclear facility with a Class I or uranium mines and mills licence, the licensee shall ensure that the safety assessment:	Not Applicable. This requirement pertains to the preparation phase.
7.2	• identifies hazards to workers, the public the environment from planned decommissioning activities, accidents and natural events that may arise during decommissioning and potential initiating events	
7.2	• describes the relative importance of the hazards and identifies the methods for mitigating their risks	
7.2	• determines the safety functions necessary throughout decommissioning, and ensures that the related SSCs are suitable and will deliver these safety functions	
7.2	• demonstrates adequate defence in depth and defines limits, controls and conditions for managing hazards	
7.2	• demonstrates that adequate measures have been taken to prevent accident conditions and whether any consequences can be mitigated if accidents do occur	
7.2	• determines the site characteristics related to the safety of the facility	
7.2	• demonstrates that adequate measures have been taken to control hazards to an acceptable level, both in the present and in the long term, and to optimize protection and safety in decommissioning	
7.2	• considers the combined and additive effects of hazards	
7.2	• demonstrates that interdependencies between planned decommissioning actions are taken into account, and that any negative impacts of one action on another, as well as the possible generation of additional hazards, are properly taken into account.	
7.2	For in situ decommissioning resulting in a disposal facility, location or site, a post-closure safety case (see section 5.1) shall be provided, in addition to the decommissioning safety assessment.	Not Applicable as OPG has not selected the *in situ* decommissioning strategy.
7.3	For deferred decommissioning, Class I nuclear facility and uranium mines and mills licensees shall submit a storage with surveillance plan, in addition	1.1, 4.1.3

Section in REGDOC-2.11.2	Requirement in CNSC REGDOC-2.11.2	Section in This PDP
	to the DDP, to the CNSC for acceptance.	
7.4	The licensee shall prepare a waste management plan that considers the waste hierarchy, including preventing generation, reducing volume and radioactivity, reusing and recycling materials and components, and disposing of the waste.	4.2.2
7.4	The waste management plan shall identify the waste streams together with the estimated quantities and characteristics of the waste.	4.2.2
7.4	The waste management plan shall describe the systematic process for how the waste will be moved from the decontamination and dismantling areas to the areas for subsequent steps of waste management.	4.2.2
7.4	The licensee shall assess the potential for generating non- radiological hazardous substances and incorporate the necessary precautions and reporting into its programs and procedures.	4.2.2
8	During the execution of decommissioning, the licensee shall: • conduct decommissioning in accordance with the DDP and associated procedures • implement a decommissioning process and supporting programs to ensure safety • ensure that a methodology for issuing, modifying and terminating work procedures is established • maintain an up-to-date list of SSCs important to safety, as well as surveillance and maintenance plans for these SSCs	4.2, 4.3
8.1	For deferred decommissioning, during periods of storage with surveillance, the licensee shall ensure that the facility, location or site is maintained in a safe configuration so that subsequent decontamination, dismantling and/or clean-up can be carried out.	4.2
8.1	The licensee shall implement and maintain appropriate storage with surveillance programs to confirm that the SSCs needed to maintain safe storage are functioning as required.	4.2
8.2	Prior to the execution of decommissioning, the licensee shall ensure the availability of packages for radioactive waste, the disposition path of radioactive waste arising from decommissioning activities, and the ability of those disposition paths to accommodate the types and volumes of material.	4.2.2
8.2	The licensee shall characterize and manage all remaining operational waste from the facility, location or site and all waste from decommissioning.	4.7.1
8.2	The licensee shall ensure the traceability and maintain up-to-date records of the waste generated and managed at the facility, location or site or transferred to another facility, location or site, specifying its quantities, characteristics and destination.	4.7.1

Section in REGDOC-2.11.2	Requirement in CNSC REGDOC-2.11.2	Section in This PDP
9	Upon completion of decommissioning, the licensee shall demonstrate that the end-state criteria specified in the DDP have been met.	4.5, 4.6
9	The licensee shall submit an end-state report to the CNSC for acceptance.	4.6
9	For a nuclear facility with a Class I or uranium mines and mills licence, the end-state report shall include: • documentation (e.g., using actual survey results) that the planned end- state conditions have been met, and if not, why not	Not Applicable. This requirement pertains to the completion phase.
9	• any proposed further licence requirements or institutional controls for the site	
9	• the release criteria	
9	• the decommissioning work undertaken, noting any significant deviations from the DDP	
9	• any remaining SSCs	
9	• the final physical and radiological status, including any remaining hazards	
9	• a list of SSCs designated for restricted use	
9	• a summary of the waste quantities generated and managed, and disposition routes	
9	• an inventory of nuclear substances that will remain on site	
9	• a summary of the radiological doses received by workers during the decommissioning activities	
9	• a summary of any abnormal occurrences or incidents that took place during decommissioning activities	
9	• any lessons learned	
9	• references to decommissioning records	
9	• the future use of, or any restrictions on the future use of, the facility and remaining structures, including any institutional controls	
9	Where decommissioning of the facility will take place in discrete stages, an interim end-state report shall be prepared when each planned interim end state is achieved.	4.2.6
9.1	If institutional controls are required to be in place, the licensee shall prepare plans to address the completion of decommissioning and submit them to the CNSC for review. The licensee is responsible for implementing and maintaining the post- decommissioning plans and institutional controls unless that responsibility was transferred to a third party with their agreement and the Commission's approval.	Not Applicable.: No long-term institutional controls will be established.
9.1	If institutional controls are required, the CNSC expects the following actions to be taken by the responsible party, following completion of decommissioning: • implementation of a visual inspection plan for	Not Applicable.: No long-term institutional controls will be established.

Section in REGDOC-2.11.2	Requirement in CNSC REGDOC-2.11.2	Section in This PDP
	periodic examination of the facility, location or site to look for signs of deterioration of the facility, location or site (e.g., slumping of the ground), or erosion of the surface • operation and maintenance of a monitoring system to detect any radionuclide release within the site boundary • implementation of any active controls to prevent unrestricted access to the site	
10	The licensee shall perform radiological and non-radiological surveys throughout the various phases in the lifecycle to support decommissioning.	4.0, 4.4
10.3	Radiological and non-radiological conditions shall be monitored throughout decommissioning activities to confirm that radiation risks to workers, the public and the environment are being adequately controlled.	3.3, 4.1.2, 4.0
10.3	Surveys shall be performed throughout decommissioning to confirm the effectiveness of decommissioning activities used to reduce radiological and non- radiological risks (e.g., removal of excess radioactive material, decontamination of process equipment and immobilization of remaining contamination).	4.0
10.3	Surveys of hazards shall also be performed to support the safe performance of surveillance and maintenance activities during periods when decommissioning is deferred.	4.2, 4.2.1, 4.0
10.4	The licensee shall conduct a final end-state survey in accordance with a survey plan. The survey plan should define: • final survey objectives and established acceptance criteria • methodology for conducting the survey • sampling parameters and background levels • equipment, instruments, techniques and procedures • methodology for evaluating the final survey results	4.0

Appendix B: Compliance Matrix with CSA N294:19

Table 14-2: Compliance Matrix between CSA N294:19 and this Plan

Section in CSA N294:19	Requirement in CSA N294:19	Section in This PDP
4.1	The owner of a nuclear facility shall be responsible for planning, executing, and funding all phases of decommissioning.	1.4 5.3
4.2	Decommissioning activities shall be planned and executed in accordance with relevant regulations and standards and in keeping with relevant guides. Responsibilities for decommissioning, preparing documents, and recordkeeping shall be clearly established throughout the life cycle of a facility. Responsibility for the funding of the decommissioning shall be identified and financial guarantee shall be established to ensure adequate funding for decommissioning	1.3, 1.5 1.4, 4.1.3, 11.0 1.4, 5.3
4.3	The owner shall consider the requirements of CSA N286 when executing decommissioning works, including the following: (a) protecting the health and safety of workers and the public; (b) protecting the environment; (c) complying with requirements of the AHJ; (d) keeping radiation exposures as low as reasonably achievable (ALARA); (e) managing all radioactive and hazardous materials generated by the decommissioning; (f) security; and (g) safeguards	10.0 8.0, 8.1.2, 8.1.3, 8.2 7.0, 8.2.1 - 8.2.3, 8.3, 8.4 1.5 8.2 4.3.5, 4.7 9.0
4.4	Programs shall be developed and implemented to support decommissioning.	4.1.2, 4.1.4, 4.2, 4.2.3 This pertains to the execution phase.
5.1.1.3	A financial guarantee for decommissioning shall be established to ensure that adequate funding is available at the time of decommissioning. The financial guarantee for decommissioning shall be maintained throughout the life cycle of the facility.	1.4 5.3
5.1.6	The final end-state shall be considered reached when the end-state objectives as set in the DDP are verified to have been achieved (Annex F describes how to establish the end-state objectives).	4.5, 4.6
5.1.7	The party accountable for decommissioning shall identify the applicable institutional control requirements following decommissioning as well as the available administrative processes in the jurisdiction in which they are located.	This will be done as part of preparing the DDP (see Section 4.2.4) 4.6

Section in CSA N294:19	Requirement in CSA N294:19	Section in This PDP
5.2.5	Decommissioning records shall include, as applicable, a) the DDP(s); b) public and Indigenous engagement/communication records (as per CNSC REGDOC-3.2.2); c) if required by the AHJ, an impact assessment or environmental review in accordance with applicable legislation; d) licences and permits required for the decommissioning work; e) the plans and procedures used in decommissioning; f) reports and other documents that describe i) the criteria used to define radioactive and hazardous materials and to distinguish contaminated from uncontaminated materials; ii) the criteria used to define the final contamination status of the facility; iii) the principles and models used in deriving the criteria in Items i) and ii); iv) the residual radionuclide inventory after decontamination; v) the amounts of radioactive and hazardous materials removed and the disposition method; vi) waste management and transfer records; vii) the equipment and materials removed from the facility for recycling or use elsewhere, their treatment prior to removal from the site, and the disposition method; viii) the survey methods and the types of instruments used; ix) the equipment, nuclear and non-nuclear materials, and structures remaining at the end of decommissioning; and x) land remediation undertaken, results of verification analyses as compared to criteria used or derived for soil and water quality, and the disposition of affected media; g) reports, other documents, and photographs describing findings from inspections, modifications, and repairs to SSCs; h) reports and other documents that describe unplanned or unusual occurrences; i) results and interpretations of environmental monitoring programs; j) occupational dose records; k) deviations from plans and procedures; l) quality assurance records; m) storage-with-surveillance plans; n) facility inspection, maintenance, and equipment records; o) the final radiological and hazardous materials surveys; and p) interim and final end-state reports.	11.0 This pertains to records following the completion of decommissioning.
5.4.2	The facility shall be characterized. See Annex G for guidance.	3.6 4.1.4.6, 4.0

Section in CSA N294:19	Requirement in CSA N294:19	Section in This PDP
5.4.3	All radioactive waste generated shall be characterized as per the CSA N292 series of Standards.	4.3.5
5.5.1	A strategy shall be developed for the management of all radioactive, hazardous, and conventional waste that will be generated throughout the course of the decommissioning.	4.1.2, 4.2.2, 4.7
5.6	A hazard assessment commensurate with the tasks to be performed shall be completed prior to decommissioning.	8.1
5.8.1	A quality assurance program shall be implemented.	10.0
6.1.1	The owner shall demonstrate that, under the strategy selected, the facility will be maintained in a safe configuration at all times.	3.4.1 4.2.6
6.1.2.2	In such cases where the end-state for in-situ decommissioning results in a waste disposal site, an applicant shall satisfy all regulatory requirements for a radioactive waste disposal facility and demonstrate safety via a safety case and post-closure safety assessment of a disposal facility.	Not Applicable.
6.2.1	For sites with more than one facility, a site decommissioning plan shall be developed to ensure that interdependencies are taken into account.	1.0
6.2.3	Cost estimates shall include all decommissioning activities from operations, during shutdown to the final release from regulatory control. The cost estimate for decommissioning shall address the cost of the following principal activities, if applicable: a) preparation for final shutdown; b) site characterization, site surveys; c) facility shutdown activities; d) additional activities for safe enclosure; e) decontamination and dismantling activities; f) processing, storage and disposal of all waste including used fuel; g) project management, engineering, and site support; h) site clean-up, landscaping, and restoration; i) long-term management of radioactive waste and used fuel; j) long-term monitoring and maintenance of the site and institutional control; k) licensing costs; and l) miscellaneous expenditures.	5.1 Included in [15]

Section in CSA N294:19	Requirement in CSA N294:19	Section in This PDP
7.1.1	Preparation for decommissioning shall include a) an assessment of the records from the previous life cycle stages and the state of the facility (e.g., baseline configuration) at the time of shutdown; b) an impact assessment or environmental review in accordance with applicable legislation, if required; c) a safety assessment for decommissioning; d) ensuring that there is a sufficient number of qualified staff to ensure safe operation during the approach to shutdown; e) further development of the PDP into the DDP; f) placing a facility in a permanent shutdown state; and g) any additional requirements specified by the AHJ.	3.6, 4.1 11.0 N/A 3.7, 4.1.3, 4.2.5, 8.1 4.1.3 1.1, 3.3 4.1 (4.1.1 - 4.1.4) 1.3, 4.1
7.1.2	The owner shall ensure that processes, systems, and personnel are in place to maintain the facility in a safe state during the transition to decommissioning.	4.1, 8.2.1
7.4.1.1	To ensure a smooth transition from operation to decommissioning, the facility shall be prepared to complete stabilization activities as soon as practical after the permanent shutdown date.	4.1.4
7.4.3	During the transition period between shutdown and decommissioning, monitoring and maintenance activities shall be conducted to ensure the health and safety of persons and the protection of the environment.	4.1.1, 4.1.2, 4.1.4
7.5.1	An assessment of the state of the facility shall be performed to provide baseline information for condition of the building and SSC, and evaluation of the hazards to be controlled during decommissioning. A thorough survey shall be performed and supplemented by a review of existing records, as applicable.	3.7, 4.1.2, 4.1.4.3, 4.0, 8.1 3.6, 4.1.4.4, 4.1.4.6, 4.0, 8.2.1, 11.0
7.5.2.1	The following hazards shall be investigated and assessed: a) radiological hazards; b) biologically, chemically, and physically hazardous materials; c) hazards from concealed or hidden services; and d) structural hazards.	8.0, Table 8-1
7.5.2.2	Historical information shall be preserved that is relevant to the eventual decommissioning of the facility.	11.0
7.6.1	A DDP shall be developed for nuclear facilities, in accordance with Annex C and regulatory requirements, and submitted to the AHJ for acceptance.	1.1, 4.1.3, 4.2.4 These requirements pertain to the preparation for the Dismantling & Demolition phase. Relevant for the DDP not the PDP
7.6.2.1	The DDP shall meet the content provisions of Annex C.	4.1.3, 4.2.4

Section in CSA N294:19	Requirement in CSA N294:19	Section in This PDP
7.6.3	If deferred decommissioning is the preferred decommissioning strategy, in addition to a DDP, a SWS plan shall be developed. If a SWS plan is standalone, it shall be submitted to the AHJ.	1.1, 4.1.3
7.6.4	A safety assessment shall be performed to identify potential hazards to workers, the public, and the environment, from both routine decommissioning activities and credible accidents during decommissioning. The assessment shall describe the relative importance of the potential hazards and identify the methods for mitigating the risks associated with such hazards. If fissile material is involved, a criticality safety assessment and the planned actions involving fissile material shall be included. The assessment shall also address the residual risks to the public, if any, after decommissioning is completed. In situ decommissioning may result in a waste disposal site. In such a case, an applicant shall satisfy all regulatory requirements for a radioactive waste disposal facility and demonstrate safety via a safety case and post-closure safety assessment of a disposal facility.	3.7, 4.2.5, 8.0 Table 8-1 Not Applicable.
7.6.5.1	The strategy for managing all wastes from decommissioning shall include a management plan covering both the short term and, where possible, the long term.	These requirements pertain to the preparation for the Dismantling & Demolition phase. Relevant for the DDP not the PDP 4.2.2, 4.2.4
7.6.5.2	The waste management program shall cover the following processes, as applicable: a) characterization; b) classification; c) minimization; d) segregation; e) clearance; f) handling; g) volume reduction; h) treatment; i) packaging; j) storage; k) transportation; and l) final disposition. Transportation requirements and the waste receiver's acceptance criteria shall be reviewed to ensure that the waste is appropriate for shipment and acceptable to the waste receiver.	These requirements pertain to the preparation for the Dismantling & Demolition phase. Relevant for the DDP not the PDP 4.2.2 4.2.4 4.7

Section in CSA N294:19	Requirement in CSA N294:19	Section in This PDP
8.1.2	The work to be performed during the decommissioning shall be described in a DDP.	1.1, 4.1.3, 4.2.4
8.1.3	The physical work to be carried out shall be defined in terms of work packages and work procedures to the level of detail required for safe, effective, and efficient decommissioning.	These requirements pertain to the execution phase and are, as such, not applicable for this PDP. 4.2.2
8.1.7.1	Where decontamination is being used as part of decommissioning, the following shall be identified: a) the areas, locations, and equipment to be decontaminated; b) the objectives of the decontamination (e.g., decontamination of equipment for salvage and reuse, decontamination of metals for recycling, decontamination of building foundations that are to remain in place, decontamination for clearance of materials to be disposed of as non-radioactive); c) the decontamination methods to be employed; and d) the residual level of radioactivity that is to be achieved.	4.0, 4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 4.5
8.1.8.1	A demolition plan shall be prepared. The equipment and structures to be dismantled or demolished shall be identified. The equipment and structures that are to remain at the completion of decommissioning shall also be identified. Procedures for dismantling and demolition shall take into account the associated hazards.	4.2.4 4.3.1 - 4.3.4
8.1.8.2	The following factors shall be considered when selecting dismantling/demolition methods: a) availability of professional competence associated with the operations of the chosen equipment; b) the equipment should be simple to operate, decontaminate, and maintain; c) remaining structural elements shall be kept in a physically stable state; d) measures to prevent unintentional releases to the environment; e) planned discharges to the environment shall be controlled as per licence conditions and previous commitments; f) when underwater dismantling and cutting is used, provisions shall be made to process the water to promote and assist in effluent treatment; g) the effect of dismantling tasks on adjacent systems and structures and on other work in progress shall be evaluated; h) waste containers, handling systems, and routes shall be defined before the start of dismantling work; and i) federal, provincial/territorial and/or municipal requirements.	These requirements are relevant for detailed decommissioning planning and execution, as such, not applicable for this PDP 4.2.2, 4.2.4

Section in CSA N294:19	Requirement in CSA N294:19	Section in This PDP
8.1.9.1	Surveys during decommissioning shall be performed to comply with a) worker occupational safety and radiation protection limits; b) environmental monitoring criteria; and c) processes to release materials and equipment from the site.	4.0
8.1.9.2	At the completion of a decontamination or dismantling work package, a survey shall be performed, if required, to demonstrate that the planned end-state has been achieved. The results of the survey shall be documented in a report that includes a) the criteria used to define the end-state; b) the methods and procedures used to ensure that the criteria were met; and c) the measurement data, including appropriate statistical analysis and systematic approaches.	4.0
8.2	Where decommissioning of the facility is to take place in discrete stages, an interim end-state report shall be prepared when each planned interim end-state is achieved.	4.1.4, 4.2.5, 4.3.4
8.3	A plan for surveillance, monitoring, physical protection, and maintenance of the facility during such periods shall be developed and implemented to a) maintain the facility in a safe state; b) control the release of materials to the environment; c) prevent access by unauthorized persons; and d) mitigate infestations of vermin and other organisms.	4.1, 4.2, 4.3
8.4	Lands associated with a facility or a standalone site that might have been impacted by previous nuclear activities shall be remediated to the degree required to meet the end-state criteria.	4.3.6, 4.5
8.5	At the completion of this phase, final surveys of residual radioactive and hazardous materials shall be performed and documented to demonstrate that the final end-state for remaining equipment, structures, and the site has been achieved in accordance with the criteria specified in the DDP. The results of the final survey shall be documented in a report that includes a) the criteria used to define the end-state; b) the methods and procedures used to ensure that the criteria were met; and c) the measurement data, including appropriate statistical analysis and systematic approaches.	4.4

Section in CSA N294:19	Requirement in CSA N294:19	Section in This PDP
9.1	Following the completion of decommissioning, a final end-state report shall be prepared and retained. Where a decommissioning program involves completing a number of separately approved decommissioning projects, interim end-state reports shall be submitted for each project.	4.1.4, 4.3.4, 4.5

Table 14-3: Compliance Matrix between CSA N294:19 Annex I and this Plan

Item	CSA N294:19 Annex I	Section in this Plan
I.2.2	When the decision is made to permanently shut down and physically decommission the reactor, a planned process shall be followed to render the reactor to a predetermined final end state condition, release the reactor from licence control, and implement any required institutional controls.	1.1, 4.0
I.3.2	The management accountable for each life-cycle phase shall (a) consider the impact of their activities on the eventual decommissioning; (b) ensure that the reactor conforms to the design basis; and (c) preserve documents and records relevant to decommissioning.	4.0 11.0
I.4.3.1	The level of planning detail builds up through the life cycle. During operation a stand-alone plan is required. Management shall perform the necessary planning, based on the results from assessments, the design and the safety analysis, to establish the objectives, the strategies and the cost estimates for the decommissioning of the reactor.	3.2 3.4 3.4.2.1, 5.0
I.4.3.2	In addition to Clause 6.2.1, the plan shall include a) a description of the site, including all of the facilities on the site and adjacent to the site; b) a description of the reactor and its auxiliary facilities; c) a description of the common and interdependent SSCs and work; d) identification of i) the planning assumptions; ii) proposed end-state criteria; iii) uncertainty and degree of conservatism; and iv) the planned decommissioning strategy; e) an outline of the proposed scope of work and schedule to complete the decommissioning. This includes a description of the proposed start date, end date, and milestones. There should be a broadly scoped and generally described work breakdown structure that will require further detailed planning as described in Clause I.4.4; and f) identification of the expected inventory of waste and surplus items that will result from decommissioning and their final disposition.	2.0 1.6 4.5 3.7 3.4 4.0, Figure 5-1 4.7.2.1, 4.7.3
I.5.1.1.2	The reactor shall be safely shut down and its SSCs shall be placed in a safe state in preparation for decommissioning.	4.1, 4.2
I.5.1.1.2	During final shutdown, the following actions shall be performed: (a) Implementing the defueling, dewatering and waste management plan; (b) Establishing operating controls for the SSCs that will remain in operation during the remaining stages of decommissioning (e.g., the used fuel system); (c) Placing each SSC in a pre-defined interim end-state.	4.1 (4.1.1 - 4.1.4)
I.5.1.1.4	Additionally, programs in place during operations shall be reviewed, revised, and/or eliminated to ensure that requirements for the remaining stages of decommissioning are covered. Such examples include, but are not limited to, environmental monitoring, emergency response, and fire protection.	4.1.2 4.2

Item	CSA N294:19 Annex I	Section in this Plan
I.5.1.2.1	SWS (sometimes referred to as "safe storage") shall include the period when the reactor is under surveillance while the radioactivity decays and/or until the prerequisites for dismantling and demolition are achieved.	4.2
I.5.1.2.2	During this stage, the following actions shall be performed: a) conducting planned surveys; b) removing the nuclear fuel from the spent fuel bay to dry storage; c) placing the spent fuel bay and auxiliaries in a pre-defined end-state for future decommissioning; and d) ongoing removal of radioactive waste.	4.2 4.2.1 4.2.2
I.5.2	During this stage, the reactor shall be subjected to the planned decontamination, dismantling and demolition, and any resulting materials will either be a) decontaminated to meet release criteria; or b) disposed of into a waste facility.	4.3, 4.3.4 4.3.1 4.3.2 4.3.3 4.3.5, 4.7.2.1, 4.7.2.2, 4.7.2.3
I.5.3	Site restoration shall include a) disposing of hazardous substances; b) restoring the topography (for example, by restoring the landscape); c) restoring vegetation; d) removing the licence and making the site available for other use; and e) preparing the final end-state report in accordance with Clause 9.1 and Annex E.	4.7.3.3 4.3.6