ONTARIO POWER GENERATION

Plan

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Bruce Nuclear Site Preliminary Decommissioning Plan

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Revision Summary

Revision Number	Date	Comments
R003	January 2022	• Revised to update information for CNSC quinquennial review. • Entire document – Revised to reflect OPG's current planning assumptions, strategy for decommissioning the BNGSs, CNSC staff recommendation regarding timeline for DDP submission and TLG's Decommissioning Cost Study for BNGS A and B. • Entire document – Consistent terminology used throughout for Storage With Surveillance and remove reference to OPG's L&ILW DGR. • Revised to be in compliance with CSA N294:19. • Section 1.0 – Revised to highlight the scope change to a site PDP that addresses interfaces with other facilities on the Bruce Nuclear Site. • Section 1.1 – Updated regulatory submissions required for transition to decommissioning and for the application for a licence to perform decommissioning activities. • Sections 1.2.1 and 1.2.2 – Updated licensing documents consistent with the latest BNGS A and B Licence and LCH. • Section 1.2.3 – Replaced the Canadian Environmental Assessment Act (CEAA) 2012 with the Impact Assessment Act (IAA). • Section 1.2.4 – Updated to the most current list of International Atomic Energy Agency Guides/Standards, consistent with CSA N294:19 references. • Section 1.3 – New Section to describe the applicable OPG programs relevant to decommissioning. • Section 1.5 – Updated planning assumptions for shutdown and decommissioning. • Section 2.1 – Updated access roads to the Bruce Power Site. • Updated Figure 2-3 and Figure 2-10 per the latest BNGS A and B Safety Reports. • Section 2.2.8 – Updated other facilities on the Bruce Nuclear Site. • Added Sections 2.2.8.1 to 2.2.8.2 to describe the interface of the BNGSs with the WWMF and small facilities owned by OPG. • Added Sections 2.2.8.3 and 2.2.8.4 on Douglas Point Waste Facility and assets owned by Hydro One, which are also located on the Bruce Nuclear Site. • Added Figure 2-15 – Location of other facilities within the Bruce Nuclear Site. • Section 2.3 (including: 2.3.1, 2.3.2.4, 2.3.3, 2.3.3.1, 2.3.3.2, 2.3.4) – Updated references and information related to the description of the surrounding environment. • Section 2.3.2.3 – Included updates on Bruce Power groundwater monitoring program and latest annual Environmental Protection Report. • Section 2.3.2.4 – Updated seismic data. • Section 2.3.3.1 – Updated total commercial fish harvest.

		• Section 2.3.3.2 – Updated Lake Ontario water level to latest Fisheries and Oceans Canada, water levels bulletin. • Section 2.3.4 – Updated current use of land adjacent to the BNGSs and revised to incorporate changes from the latest BNGS B Safety Report. • Section 2.3.5, including Table 2-1 – Population statistics updated and revised to incorporate changes from the latest BNGS B Safety Report. • Section 2.3.6 – Updated text and revised title to 'Indigenous Communities'. • Sections 2.3.7 – Updated to reflect latest community engagement, Bruce Power emergency response plan and emergency drills in the community surrounding BNGS. • Section 2.4 – Updated Bruce Power refurbishment program and plans for producing Lutetium-177. • Section 3.1 – Included scope that the BNGSs PDP is considered as the site PDP. • Table 3-1 – Updated per list of buildings considered in cost estimations for the BNGSs. • Section 3.3 and Figure 3-1 – Updated per CSA N294:19. • Section 3.4.1 – Revised the decommissioning strategies, consistent with CSA N294:19 and updated the list of major activation radionuclides and fission products based on latest decommissioning OPEX. • Section 3.4.2 (including 3.4.2.1 to 3.4.2.4) – Revised to be consistent with CSA N294:19 and align with Canadian OPEX for the phases of Storage with Surveillance. • Section 3.4.3.1 – Updated with OPG's decommissioning experience and CNL's progress with its decommissioning and site remediation projects. • Section 3.4.3.2 – Updated to latest statistics on International Decommissioning Strategies and Experience. • Section 3.5 – Revised timeline for conducting scoping and characterization surveys. Included updates on Bruce Power to provide hand back report to OPG annually. • Section 3.6 – Updated to reflect the elements of risk and uncertainty associated with decommissioning the BNGSs. • Section 4.0 and Figures 4-1, 4-2 – Modified for consistency with the BNGSs Costing Reports. Added interfaces with the other facilities on the Bruce Nuclear Site. Added a new Figure 4-3 to address the decommissioning interferences with the BNGSs. • Section 4.1, including subsections 4.1.1 to 4.1.4 – Revised per feedback from OPG's Safe Storage Project Group, updated the SWS Planning / Stabilization Activities and the regulatory submissions. • Section 4.2, including subsections 4.2.1 to 4.2.5 – Updated to reflect activities carried out during SWS. • Section 4.2.2 – Removed plans for preparing site abandonment plan as these will be carried out once Dismantling & Demolition is complete, i.e., at later stage of decommissioning.

		• Section 4.2.4 – Provided additional details on the structure of the DDP that will be prepared prior to Dismantling and Demolition. Added the purpose of the Decommissioning Safety Assessment. • Section 4.3 (including subsections 4.3.1, 4.3.2, 4.3.4, 4.3.5, 4.3.7 to 4.3.9) – Updated to OPG's planning assumptions and to meet new clauses of CSA N294:19. • Section 4.4 – New text to describe OPG's strategy for waste management and characterization. • Section 4.4.1.2 – Updated assumptions for management of high-level waste. • Section 4.4.1.3 – Updated assumptions for management of low- and intermediate-level waste. • Table 4-2 – Updated estimated volumes of L&ILW generated during decommissioning. • Section 4.4.2.1 and Table A-1 – Updated the inventory of hazardous materials at the BNGSs. • Section 5.1 – Updated to TLG 2022 cost estimates. • Section 6.1 – Added elements of risk associated with decommissioning activities and how these will be managed. • Section 6.3 – Updated text on staffing for each phase of decommissioning the BNGSs. • Section 6.4 – Revised per OPG's staffing plan for SWS. • Section 7.0 – Clarified need for an Impact Assessment (IA). • Section 7.1.1 – Updated text on air quality. • Section 7.1.2 – Added reference to Bruce Power latest annual Environmental Protection Report. • Section 7.3.2 – Revised to reflect changes from CEAA 2012 to Impact Assessment Act (IAA). • Sections 7.3.4, 7.3.5, 7.3.6, 7.3.7 and Table 7-1 – Revised to current decommissioning planning assumptions and the BNGSs Costing Reports. • Table 8-1 – Revised list of hazards, description / comments, as required. • Section 8.1.1 – Revised when the Occupational Dose Estimate for decommissioning of the BNGSs will be prepared. • Section 8.2 – Updated text to include qualified use of personnel throughout the decommissioning phases. • Section 9.1 – Revised to include compliance with licensing conditions in relation to security during decommissioning. • Section 10.0 – Added reference to OPG's Nuclear Management System. • Section 11.0 – Updated information regarding record keeping. • Section 12.0 – Updated the Public Involvement Program. • Section 13.0 – Revised title and text to reflect changes from CEAA 2012 to IAA. • Updated Section 14 – References.

		• Appendix A – Updated Types, Quantities and Locations of Hazardous Materials Stored at BNGSs. • Appendix B– Updated with revised decommissioning cost estimate and BNGS Costing Reports. • Previous Appendix C and Table C-1 on estimated workforce during the course of decommissioning of BNSG A and B – Deleted so as not to duplicate information in the BNGS A and B Costing Reports. • Appendix C – Updated compliance matrix against CSA N294:19. • Appendix D – new Appendix on OPG and Bruce Power Interface Documents and Services.

Acronyms

AECL - Atomic Energy of Canada Limited
ALARA - As Low As Reasonably Achievable
APM - Adaptive Phased Management
BEC - Bruce Energy Centre
BHWP - Bruce Heavy Water Plant
BNGS - Bruce Nuclear Generating Station
BPHPL - Bruce Power Health Physics Lab
CANDU - Canada Deuterium Uranium
CCNS - Centre for Canadian Nuclear Sustainability
CCW - Condenser Cooling Water
CEAA - Canadian Environmental Assessment Act
CMF - Central Maintenance Facility
CMLF - Central Maintenance and Laundry Facility (also referred to as CMF)
CN - Canadian National
CNL - Canadian Nuclear Laboratories
CNSC - Canadian Nuclear Safety Commission
CSA - Canadian Standards Association
CSF - Central Storage Facility
DDP - Detailed Decommissioning Plan
DGR - Deep Geologic Repository
DOC - Decommissioning Operations Contractor
DP - Douglas Point
DPWF - Douglas Point Waste Facility
DRL - Derived Release Limit
DSC - Dry Storage Container
EA - Environmental Assessment
ECI - Emergency Coolant Injection
EFADS - Emergency Filtered Air Discharge System
ESA - Endangered Species Act
ESDR - End State Determination Report
EWPSB - Emergency Water and Power Supply Building
G-1 - Gentilly-1
HF - Human Factors
HFEPP - Human Factors Engineering Program Plan
HSA - Historical Site Assessment
HWP - Heavy Water Plant
IA - Impact Assessment
IAA - Impact Assessment Act
IAEA - International Atomic Energy Agency
IFB - Irradiated Fuel Bay
ILW - Intermediate Level Waste
IPS - Isotope Production System
KI - Potassium Iodide
L&ILW - Low and Intermediate Level Waste
LLW - Low Level Waste

MAPLE - Multipurpose Applied Physics Lattice Experiment
MARSSIM - Multi-Agency Radiation Survey and Site Investigation Manual
MCR - Major Component Replacement
MECP - Ministry of the Environment, Conservation and Parks
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
NSCA - Nuclear Safety and Control Act
NWMO - Nuclear Waste Management Organization
ODWS - Ontario Drinking Water Standard
OH&S - Occupational Health and Safety
OPEX - Operating Experience
OPG - Ontario Power Generation
OWTP - Old Water Treatment Plant
PAPR - Powered Air Purifying Respirator
PARMS - Post Accident Radiation Monitoring System
PCBs - Polychlorinated Biphenyls
PDP - Preliminary Decommissioning Plan
PHT - Primary Heat Transport
PNGS - Pickering Nuclear Generating Station
PPE - Personal Protective Equipment
PTR - Pool Test Reactor
QA - Quality Assurance
RSSI - Radiation Survey and Site Investigation
RWOS1 - Radioactive Waste Operations Site 1
SAP - Stabilization Activity Plan
SAR - Species at Risk
SARA - Species at Risk Act
SCA - Safety and Control Area
SCR - Station Condition Record
SEIA - Socio-Economic Impact Assessment
SON - Saugeen Ojibway Nation
SOP - Sustainable Operations Plan
SSCs - Structures, Systems and Components
SSG - Specific Safety Guide
SSP - Storage and Surveillance Plan
SSR - Specific Safety Guide
SSS - Safe Storage State
SSTF - Spent Solvent Treatment Facility
SWS - Storage With Surveillance
TDG - Transportation of Dangerous Goods
TLG - TLG Services, LLC.
TPMB - Transportation Package Maintenance Building

VLLDS - Very Low Level Drain State
WBS - Work Breakdown Structure
WR-1 - Whiteshell Reactor
WTP - Water Treatment Plant
WVRB - Waste Volume Reduction Building
WWMF - Western Waste Management Facility
ZEEP - Zero Energy Experimental Pile

Abstract

This Preliminary Decommissioning Plan (PDP) describes the activities that will be required to decommission Bruce Nuclear Generating Stations A and B (or BNGSs collectively) and restore the sites for other Ontario Power Generation (OPG) uses. It is also referred to as the site PDP as it addresses the interfaces of the BNGSs with other OPG-owned facilities located on the Bruce Nuclear Site. This PDP demonstrates that decommissioning is feasible with existing technology and it provides the schedule as well as the basis for estimating the cost of the decommissioning.

1.0 INTRODUCTION

Bruce Nuclear Generating Stations A and B (BNGS A and BNGS B respectively or BNGSs collectively) are owned by Ontario Power Generation (OPG). OPG has leased BNGS A and BNGS B to Bruce Power and, as such, Bruce Power is the current operator of these two stations. BNGS A and BNGS B are four-unit Canada Deuterium Uranium (CANDU) Nuclear Generating Stations (NGSs), with BNGS A having an output of approximately 3200 MW and BNGS B an output of 3300 MW. The BNGSs are located in the Municipality of Kincardine near Tiverton, Ontario, approximately 250 km northwest of Toronto.

Portions of the Bruce Nuclear Site, including the Bruce A and B stations, are leased to Bruce Power. The stations will be returned to OPG in a defueled and dewatered state at the end of lease.

This Preliminary Decommissioning Plan (PDP) is the proposed plan for the decommissioning of the BNGSs. Since it also addresses the interfaces of the BNGSs with other OPG-owned facilities located on the Bruce Nuclear Site, i.e., the Western Waste Management Facility (WWMF) and the small facilities consisting of the Radioactive Waste Operations Site 1 (RWOS1), the Central Maintenance and Laundry Facility (CMLF)[1] and the Central Storage Facility (CSF), it is referred to as the site PDP. Details for the decommissioning of the WWMF and small facilities are provided in their respective PDPs [R-1], [R-2].

This PDP is prepared in accordance with the Canadian Nuclear Safety Commission (CNSC) Regulatory Guide G-219[2] [R-3] and the Canadian Standards Association (CSA) Standard N294 [R-5]. The purpose of this PDP is to define the areas to be decommissioned and the sequence of the principal decommissioning work for the BNGSs. This PDP also demonstrates that decommissioning is feasible with existing technology and it provides a basis for estimating the cost of decommissioning.

The PDP (and the associated cost estimate) will be revised, at minimum, every five years, unless specified otherwise by the CNSC.

1.1 Phased Approach to Decommissioning Planning

Planning for the eventual decommissioning of BNGSs is an ongoing process and the planning assumptions will evolve over time. This document describes the preliminary plan as it exists at the time of writing and it supersedes all previous versions of the PDP for the BNGSs. This plan will continue to be revised periodically throughout the life of the BNGSs to incorporate:

[1] The Central Maintenance Laundry Facility (CMLF) is also referred to as the Central Maintenance Facility (CMF). CMLF is used throughout the document.
[2] REGDOC-2.11.2, Decommissioning, was published January 2021 and supersedes G-219. OPG has communicated the timing for a gap analysis and implementation plan to REGDOC-2.11.2 in [R-4].

- Operational experience;
- Industry best practices;
- Technological advances;
- Changes in planning assumptions;
- Changes to site conditions;
- Changes to proposed decommissioning objectives and/or strategy;
- Changes in ownership or management structure;
- Modification of the facility;
- Updated cost and funding information;
- Changes in regulatory requirements;
- Changes in recordkeeping requirements; and
- Benchmarking reviews.

The transition to decommissioning of the BNGSs will be managed through the following regulatory submissions:

- A Sustainable Operations Plan (SOP) – The SOP will describe the approach for shutting down the BNGSs. Further details on the content of the SOP are provided in Section 4.1.3.
- A Stabilization Activity Plan (SAP) – The SAP will describe the plan for managing the arrangements and activities that will be conducted in support of the transition of the BNGSs from its final shutdown state to its Safe Storage State (SSS). Further details on the content of the SAP are provided in Section 4.1.3.
- A Detailed Decommissioning Plan (DDP) –The DDP will be submitted to the CNSC with the application for a decommissioning licence approximately two to five years prior to the Storage with Surveillance (SWS) period. The DDP[3] will cover the decommissioning activities for the entire period of the decommissioning and will either include details of the Storage and Surveillance Plan (SSP) or the latter will be submitted as a separate document. Towards the end of SWS, the DDP will be revised to describe OPG's detailed plan for

[3] Note that the DDP that will be produced and submitted to the CNSC prior to SWS will include details of the Storage and Surveillance Plan (SSP) or the latter will be submitted as a separate document.

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

1.2 Applicable Legislation, Standards and Regulatory Guidance

All decommissioning activities will be performed in accordance with the most relevant legislation, regulations, codes and standards.

The following subsections identify some of the current legislation applicable to OPG's decommissioning activities.

1.2.1 Canadian Nuclear Safety Commission

The CNSC was established under the Nuclear Safety and Control Act (NSCA) as Canada's independent nuclear regulator. The NSCA, 1997 and its regulations placed a requirement on operators/owners of nuclear facilities to make adequate provisions for their safe operation and decommissioning. With reference to decommissioning and waste management, the following regulations under the Act have relevance to the decommissioning of a nuclear facility:

- Class I Nuclear Facilities Regulations (SOR/2000-204);
- General Nuclear Safety and Control Regulations (SOR/2000-202); and
- Nuclear Substances and Radiation Devices Regulations (SOR/2000-207).

The CNSC identifies the regulatory basis for decommissioning, as defined in the following key references:

- 'Decommissioning Planning for Licensed Activities', Regulatory Guide G-219, June 2000 [R-3][2];
- 'Financial Guarantees for the Decommissioning of Licensed Activities', Regulatory Guide G-206, June 2000 [R-6][4];
- 'Public Information and Disclosure', REGDOC-3.2.1, May 2018 [R-7]; and
- 'Indigenous Engagement', REGDOC-3.2.2, version 1.1, August 2019 [R-8].

[4] REGDOC-3.3.1, Financial Guarantees for Decommissioning of Nuclear Facilities and Termination of Licensed Activities was published in January 2021 and supersedes G-206. OPG has communicated the timing for a gap analysis and implementation plan to REGDOC-3.3.1 in [R-4].

The operator/owner is required to prepare a PDP as soon as possible in the life cycle of the licensed activity. Additionally, the CNSC requires the development and updating of decommissioning plans throughout the facility's life cycle to:

- Identify the impacts of decommissioning and demonstrate that the planned decommissioning activities will remediate all significant impacts and hazards to persons and the environment;
- Ensure compliance with all applicable requirements and criteria; and
- Ensure that the financial responsibility for decommissioning is maintained by the licensee and that appropriate mechanisms are put in place to identify the costs of decommissioning, together with provisions and maintenance of adequate funding to carry out decommissioning operations.

1.2.2 Canadian Standards Association

In addition to the publications produced by the CNSC, the CSA has produced guidance on the decommissioning of facilities as follows:

- 'Decommissioning of facilities containing nuclear substances', CSA N294;
- 'Management of low- and intermediate-level radioactive waste', CSA N292.3; and
- 'Interim dry storage of irradiated fuel', CSA N292.2.

Other CSA standards that are relevant to decommissioning are:

- 'Management system requirements for nuclear facilities', CSA N286;
- CSA N288 series on environmental management for nuclear facilities – in particular:
    - 'Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills', CSA N288.4;
    - 'Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills', CSA N288.5;
    - 'Environmental risk assessments at Class I nuclear facilities and uranium mines and mills', CSA N288.6;
- 'General principles for the management of radioactive waste and irradiated fuel', CSA N292.0; and
- 'Fire Protection for CANDU NPP', CSA N293.

1.2.3 Other Applicable Legislation and Regulatory Guidance

Other key legislation and regulatory guides include:

- Environmental Protection Act;
    - Regulation 347: General – Waste Management;
- Ontario Water Resources Act;
- Occupational Health and Safety (OH&S) Act;
- Fisheries Act;
- National Pollutants Release Regulations; and
- Impact Assessment Act (IAA), if applicable[5].

1.2.4 International Atomic Energy Agency Guides/Standards

OPG will also consider the recommendations and guidance from the International Atomic Energy Agency (IAEA) relevant to decommissioning. Some of these include, but are not limited to, the following:

- Leadership and Management for Safety, General Safety Requirements (GSR), No. GSR Part 2, IAEA, 2016;
- Safety Assessment for Facilities and Activities, General Safety Requirements, No. GSR Part 4 (Rev. 1), IAEA, 2016;
- Predisposal Management of Radioactive Waste, General Safety Requirements, No. GSR Part 5, IAEA, 2009;
- Decommissioning of Facilities, General Safety Requirements, No. GSR Part 6, IAEA, 2014;
- Disposal of Radioactive Waste, Specific Safety Requirements (SSR), No. SSR-5, IAEA, 2011;
- Decommissioning of Nuclear Power Plants, Research Reactors and Other Nuclear Fuel Cycle Facilities, Specific Safety Guide (SSG), No. SSG-47, IAEA 2018;
- Release of Sites from Regulatory Control on Termination of Practices, Safety Guide, No. WS-G-5.1, IAEA, 2006;

[5] The Canadian Environmental Assessment Act (CEAA) 2012 [R-9] has been superseded by the IAA [R-10].

- Safety Assessment for the Decommissioning of Facilities Using Radioactive Material, Safety Guide, No. WS-G-5.2, IAEA, 2008;
- Storage of Radioactive Waste, Safety Guide, No. WS-G-6.1, IAEA, 2006;
- Safe Enclosure of Nuclear Facilities During Deferred Dismantling, Safety Report Series, No. 26, 2002;
- Safety Considerations in the Transition from Operation to Decommissioning of Nuclear Facilities, Safety Report Series, No. 36, 2004;
- Standard Format and Content for Safety Related Decommissioning Documents, Safety Report Series, No. 45, IAEA, 2005;
- Decommissioning Strategies for Facilities Using Radioactive Material, Safety Reports Series, No. 50, IAEA, 2007;
- Management of Project Risks in Decommissioning, Safety Report Series, No. 97, 2019;
- Monitoring Programmes for Unrestricted Release Related to Decommissioning of Nuclear Facilities, Technical Reports Series, No. 334, IAEA, 1992;
- Application of Remotely Operated Handling Equipment in the Decommissioning of Nuclear Facilities, Technical Reports Series, No. 348, IAEA, 1993;
- Radiological Characterization of Shut Down Nuclear Reactors for Decommissioning Purposes, Technical Reports Series, No. 389, IAEA, 1998;
- State of the Art Technology for Decontamination and Dismantling of Nuclear Facilities, Technical Report Series, No. 395, IAEA, 1999;
- Organization and Management for Decommissioning of Large Nuclear Facilities, Technical Report Series, No. 399, IAEA, 2000;
- Methods for the Minimization of Radioactive Waste from Decontamination and Decommissioning of Nuclear Facilities, Technical Report Series, No. 401, IAEA, 2001;
- Record Keeping for the Decommissioning of Nuclear Facilities: Guidelines and Experience, Technical Reports Series, No. 411, IAEA, 2002;
- Transition from Operation to Decommissioning of Nuclear Installations, Technical Report Series, No. 420, IAEA, 2004;
- Decommissioning of Underground Structures, Systems and Components, Technical Reports Series No. 439, IAEA, 2006;

- Dismantling of Contaminated Stacks at Nuclear Facilities, Technical Reports Series No. 440, IAEA, 2005;
- Management of Problematic Waste and Material Generated During the Decommissioning of Nuclear Facilities, Technical Reports Series No. 441, IAEA, 2006;
- Redevelopment of Nuclear Facilities after Decommissioning, Technical Report Series, No. 444, IAEA, 2006;
- Selection and Use of Performance Indicators in Decommissioning, Nuclear Energy Series, No. NW-T-2.1, IAEA, 2011;
- Policies and Strategies for Radioactive Waste Management, Nuclear Energy Series, No. NW-G-1.1, IAEA, 2009; and
- Policies and Strategies for the Decommissioning of Nuclear and Radiological Facilities, Nuclear Energy Series, No. NW-G-2.1, IAEA. 2011.
- Selection of Decommissioning Strategies: Issues and Factors, IAEA-TECDOC-1478, IAEA, 2005;
- New Methods and Techniques for Decontamination in Maintenance or Decommissioning Operations, IAEA-TECDOC-1022, IAEA, 1998;
- Safe and Effective Nuclear Power Plant Life Cycle Management Towards Decommissioning, IAEA-TECDOC-1305, IAEA, 2002;
- On-site Disposal as a Decommissioning Strategy, IAEA-TECDOC-1124, IAEA, 1999;
- Approaches relating to decommissioning of nuclear facilities, PDRP-2, IAEA, 1998;
- Managing the Unexpected in Decommissioning, No. NW-T-2.8, IAEA, 2016.

1.3 Applicable Programs

OPG's Nuclear Management System [R-11] 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 decommissioning of all of OPG's owned nuclear facilities. Decommissioning work will be conducted in accordance with the management system requirements and in compliance with OPG's Decommissioning Program [R-12], 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 [R-13] and conduct of decommissioning [R-14]. The Decommissioning Program describes the interface with the Nuclear Management System as well as other Interfacing Governance such as the Nuclear Waste Management program, Integrated Aging Management.

1.4 Regulatory Compliance with Applicable Standards

This document outlines the preliminary decommissioning planning work that has been completed. In accordance with the requirements described in CNSC Regulatory Guide G-219 [R-3] and CSA Standard N294:19 [R-5], it includes or references:

- A description of the facilities to be decommissioned;
- A description of the decommissioning strategy that will be employed;
- An outline of the work that will be required to complete the decommissioning;
- A discussion of the decommissioning cost estimate and financial guarantee;
- A proposed schedule for the decommissioning work;
- An estimated inventory of the radioactive wastes that will be generated during decommissioning;
- A preliminary assessment of the potential environmental and socio-economic impacts of decommissioning; and
- A preliminary assessment of the radiological and conventional safety issues involved in the decommissioning.

Appendix C refers to the specific requirements of CSA N294:19 and identifies the respective sections of the PDP that cover these requirements. With regards to compliance with CNSC Guide G-219 [R-3], this is inferred through the demonstration of compliance with CSA N294:19 [R-5]. The correspondence between the requirements set out in CSA Standard N294:19 and this plan are shown in Appendix C, Table C-1, Table C-2 and Table C-3.

1.5 Planning Assumptions

The assumed station 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 BNGSs is based on the following fundamental assumptions:

1. For financial and business planning purposes, it has been assumed that the individual reactor units at the BNGSs will be shut down in the following sequence:

   - At BNGS A [R-15]:

     (i) Unit 1 December 2043;

     (ii) Unit 2 December 2043;

     (iii) Unit 3 December 2061; and

     (iv) Unit 4 December 2062.

     Note: All dates are nominal. Any modifications associated with shutdown dates may impact these dates.

     These dates assume refurbishment for Units 3 and 4, due to take place from 2023-2027, and also assume a 30-year nominal operating life post refurbishment.

   - At BNGS B [R-16]:

     (i) Unit 5 December 2062;

     (ii) Unit 6 December 2058;

     (iii) Unit 7 December 2063; and

     (iv) Unit 8 December 2063.

     Note: All dates are nominal. Any modifications associated with shutdown dates may impact these dates.

     The dates for BNGS B assume refurbishment for Units 5-8, due to take place from 2020-2033, and also assume a 30-year nominal operating life post refurbishment.

2. The BNGSs are planned to be turned over to OPG in 2065.

3. Dismantling of the units will be staggered over a nominal 10 year period after SWS.

4. The refurbishment of the existing BNGSs is being considered as part of this PDP. The planning timelines provided above for BNGS A and B are assumed.

5. All other dates in this document are based on the above dates and are shown for financial planning purposes only.

6. OPG will retain ownership of the site throughout the course of decommissioning and subsequent restoration for other industrial use (commonly known as 'brownfield'[6] status).

7. Bruce Power will shutdown the units, and defuel/dewater according to the lease agreement. OPG will be responsible for Stabilization activities (other than defueling and dewatering) and the decommissioning program, although some specialized services may be provided by contractors working under OPG's supervision.

8. A Decommissioning Operations Contractor (DOC)[7], a company or consortium selected on the basis of experience, safety record, overall approach and cost, will perform all work during the Dismantling & Demolition and the Site Restoration stages. OPG will provide the necessary oversight.

9. Electric heating will be available while the BNGSs are 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).

10. Used fuel and high-level decommissioning waste will be removed from the site to a licensed long term-storage facility. Please refer to Section 4.4.1.2 for more details regarding management of high-level waste.

11. Low- and Intermediate-Level Waste (L&ILW) will be disposed of in long-term disposal facilities, as described in Section 4.4.1.3. Non-radioactive hazardous waste will be disposed of at approved disposal facilities.

12. Decontamination and dismantling activities are coordinated at each of the four units of BNGS A and B to optimize the project schedule and maintain continuity in the overall process.

13. 'Clearance Levels' based on guidance provided in CSA Standard N292.5 [R-17] will be developed prior to the 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.

14. 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.

[6] As per nuclear industry practice, a brownfield [industrial] is defined as a former industrial land that has the potential to be developed for new industrial uses.
[7] Decommissioning Operations Contractor (DOC) was used in the TLG LLC. (TLG) Cost Estimates [R-15] and [R-16] is equivalent to "Decommissioning Contractor(s)" terminology used throughout the PDP document.

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

16. 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.

17. Sub-surface structures will be surveyed for contamination, decontaminated if required and, consistent with international practices, dismantled to a 'nominal removal depth' of one meter below grade, back filled 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.

18. The site will be graded and made available for other OPG uses after completion of decommissioning.

2.0 DESCRIPTION OF THE BRUCE NUCLEAR GENERATING STATIONS A AND B AND SURROUNDING AREA

2.1 Location of the Bruce Power Site

BNGS A and BNGS B are located on the Bruce Power site at the east shore of Lake Huron between Kincardine and Port Elgin, near the Village of Tiverton, in the Municipality of Kincardine (see Figure 2-1).

The Bruce Power site is located within the traditional lands and treaty territory of the people of the Saugeen Ojibway Nation (SON), which includes the Chippewas of Nawash and Saugeen First Nations [R-18].

The Bruce Power site is leased by Bruce Power from OPG. All the facilities on the Bruce Power site together occupy 932 ha (2300 acres) on the east shore of Lake Huron, near the Village of Tiverton, midway between the towns of Kincardine (to the south) and Port Elgin (to the north). The Bruce Power site is located approximately 250 km northwest of Toronto, Ontario at a longitude of 81°30' west and latitude 44°20' north. The location of the Bruce Power site relative to the towns in the area is shown in Figure 2-1.

Figure 2-1: Map of Southern Ontario Showing Location of the Bruce Power Site

Figure 2-2 is an aerial photograph of the Bruce Power site. The locations of BNGS A and BNGS B on the Bruce Power site are shown in Figure 2-3. The region within 100 km of the stations is rural, containing small towns and villages as well as the city of Owen Sound. The communities of Tiverton, Inverhuron, Underwood, Zeph Pine Acres and Baie du Doré are within a designated 8 km population control zone surrounding BNGS A and BNGS B. New residential construction is limited in this area. The shoreline community of Inverhuron is within 4 km of the south property boundary of the Bruce Power site and comprises about 200 year-round residents and many regular seasonal cottagers.

BNGS A is located on the northernmost point and BNGS B on the southwest corner of the Bruce Power site. In 2001, OPG leased portions of the Bruce Power site (including both BNGS A and BNGS B) to Bruce Power. OPG retains ownership and responsibility for the eventual decommissioning of the two stations. In addition, OPG owns and operates the WWMF adjacent to the stations.

Figure 2-2: Aerial View Showing BNGS B in Foreground and BNGS A in Background

The Bruce Power site includes Lots 11 to 31, Lake Range, Municipality of Kincardine. OPG has obtained title to Inverhuron Provincial Park, which adjoins the southern boundary of BNGS B. A portion of the northern end of the park lies inside the exclusion radius of BNGS B.

Highway access to the Bruce Power site is provided by Provincial Highway No. 21 and two east to west concession roads, Nos. 2 and 4. These have been improved and extended to provide access to the facility [R-19]. There are no public roadways or railways on the site. The site was formerly serviced by a railway spur line track, but this was removed after the Canadian National (CN) rail line was abandoned.

Two docking facilities for barges were constructed on the shore of Lake Huron to service BNGS A and BNGS B.

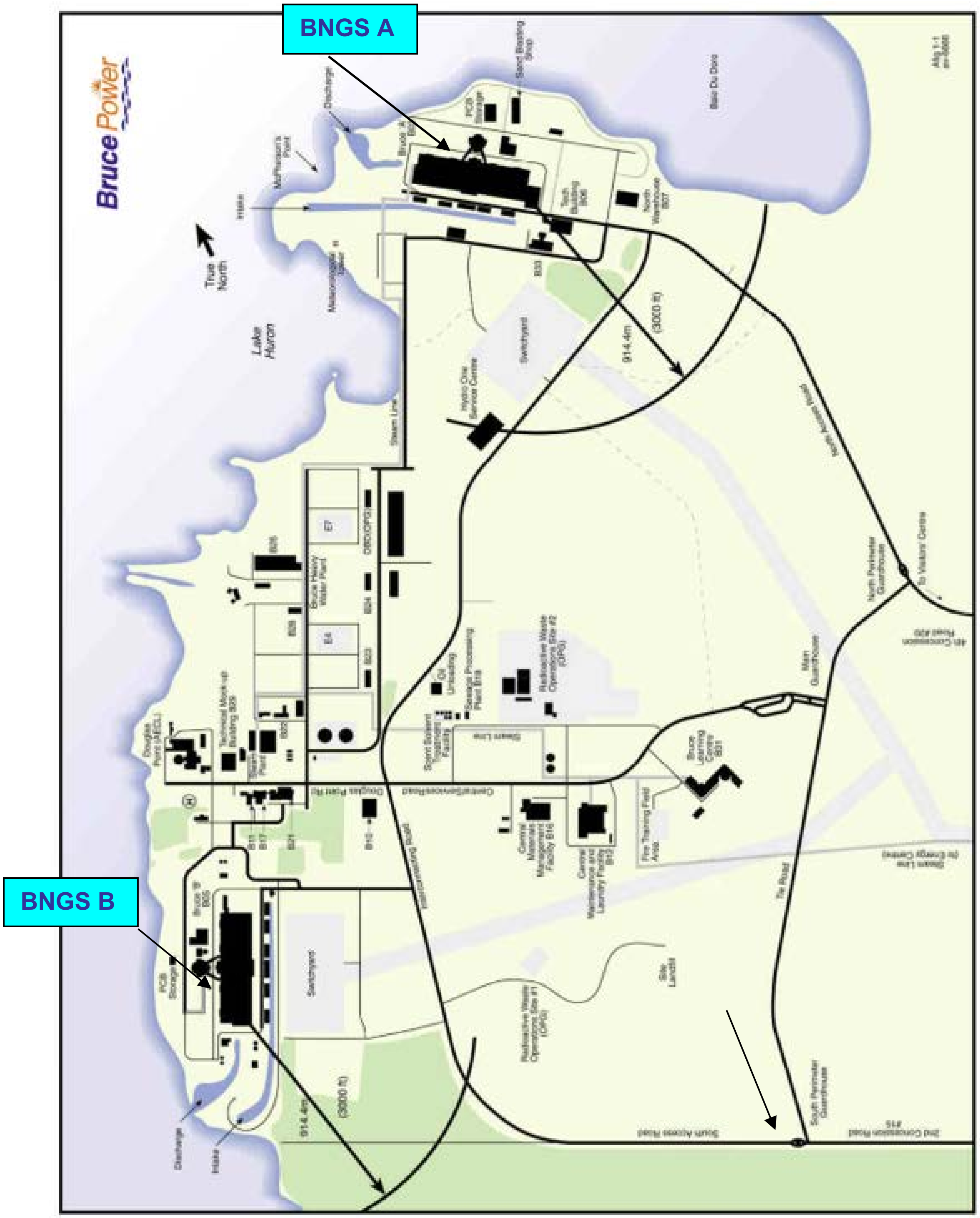

Figure 2-3: Plan of the Bruce Power Site

2.2 Description of Bruce Generating Stations A and B

2.2.1 Overview

BNGS A and BNGS B are described in detail in their respective Safety Report [R-19] and [R-20]. The stations are located close to the lake, with the nuclear portion of each station and the Vacuum Building facing the lake. The layout of the station is described in terms of a 'construction north' so that the descriptions can apply to either station. The construction north of BNGS A is close to geographic north and the construction north of BNGS B points toward the lake (west). Consequently, the nuclear portion of each station is the 'north' side of the station.

Both stations include four reactors, four turbine generators and associated equipment, along with central service and control centres and administrative offices. The layouts of BNGS A and BNGS B are shown in Figure 2-4 and Figure 2-5 respectively.

The main group of buildings at each station consists of:

- Four Reactor Buildings on the north side of each station, which house the reactor vault and the majority of the nuclear systems of each unit;
- Four Reactor Auxiliary Bays;
- A Powerhouse (including the Turbine Hall and Turbine Auxiliary Bay), running the entire length of the station;
- A Central Service Area;
- A Vacuum Building; and
- An Ancillary Services Building.

Later additions at BNGS A include the Construction Re-tube Building, the Water Treatment Plant (WTP), the Amenities Building and the Emergency Coolant Injection (ECI) Accumulator Building. Later additions at BNGS B include a Chemical Waste Storage Building, the Emergency Water and Power Supply Building (EWPSB) and the ECI Accumulator Building.

2.2.2 Reactor Building

The Reactor and its Heat Transport System are housed within the Reactor Building. The layout of the Reactor Building at BNGS A and BNGS B are shown in Figure 2-6 and Figure 2-7 respectively.

Each Reactor is enclosed in a rectangular reinforced-concrete vault, which is located within the Reactor Building. The Reactor Assemblies (Calandria Vessel and Shield Tank) at BNGS A and BNGS B are shown in Figure 2-8 and Figure 2-9 respectively.

The Heat Transport System includes the fuel channels, the headers, the feeder tubes that connect the fuel channels to the headers, together with the Steam Generators and the Primary Heat Transport (PHT) Pumps. A simplified process flow diagram showing the main components of the Reactor System is shown in Figure 2-10. The configurations of the Steam Generators at BNGS A and BNGS B are shown in Figure 2-11 and Figure 2-12 respectively. Figure 2-13 shows a PHT Pump and motor at BNGS B. The Steam Generators protrude through the top of the Reactor Vaults into two areas called the Boiler Rooms, which are located directly over the vaults. The Steam Generators are enclosed by shielding walls to permit access, during operation, to the central area directly above the reactor. Similarly, the PHT Pumps also protrude through the top of the Reactor Vaults to permit access to the pump motors during normal operations.

2.2.3 Reactor Auxiliary Bay

There are four identical Reactor Auxiliary Bays, one surrounding each Reactor Building. Each is a conventional steel-frame building with concrete floors and basement. The basement floor is at the same level as the one in the Reactor Building and the first floor is at grade. The external walls for the first lift above grade are pre-cast concrete panels and the upper levels are insulated metal sheeting. There is a solid partition between the Reactor Auxiliary Bays and the Powerhouse.

The Reactor Auxiliary Bays house the secondary circuits of the reactor auxiliary systems. The main passageways of the station run east and west through the Auxiliary Bays of each unit and through the Central Service Area at various levels.

2.2.4 Other Nuclear Systems and Structures

The Fuelling Duct, which runs the length of the station, connects the Reactor Vaults to the fuel handling and service areas located in the Central Service Area. It also connects to the two Pressure Relief Ducts, which in turn lead through the Pressure Relief Manifold and the Vacuum Ducts to the Vacuum Building. The Fuelling Machine rooms form an enlarged section of the portion of the Fuelling Duct within the Central Service Area. In these rooms, the Fuelling Machines receive new fuel and discharge irradiated fuel.

The Central Service Area, which serves the entire station, contains stores, laboratories, workshops and the Primary Irradiated Fuel Bay (IFB). The building is of steel frame construction with concrete floors. Its basement area is made of reinforced concrete construction.

The Primary IFB, designed for storage of irradiated fuel awaiting transfer to the Secondary IFB in the Ancillary Services Building, is located at the north end of the Central Service Area. Associated with the Primary IFB are lifting and loading facilities for shipping flasks. Adjacent to the Primary IFB is the Transfer Bay through which irradiated fuel is transferred to the Secondary IFB, located in the Ancillary Services Building.

The Main Control Room for the four units is located in the Central Service Area above the Primary IFB, maintenance shops and other service facilities. Administrative offices take up the top floor of the building. The Central Service Area also houses facilities for the treatment and storage of heavy water, spent ion exchange resins and active wastes. The south end of this building forms the turbine lay down area.

The Ancillary Services Building provides space for the following: waste management, heavy water cleanup, heavy water upgrading, and heavy water storage, the Secondary IFB including receiving bay, dry fuel transfer and irradiated fuel shipping facilities. The Ancillary Services Building is located to the east of the Vacuum Building. The west portion of the building is occupied by the receiving bay, the Secondary IFB and the irradiated fuel shipping facilities. The east portion of the building houses the remaining facilities. Access to the building is through a service tunnel from the Reactor Auxiliary Bay.

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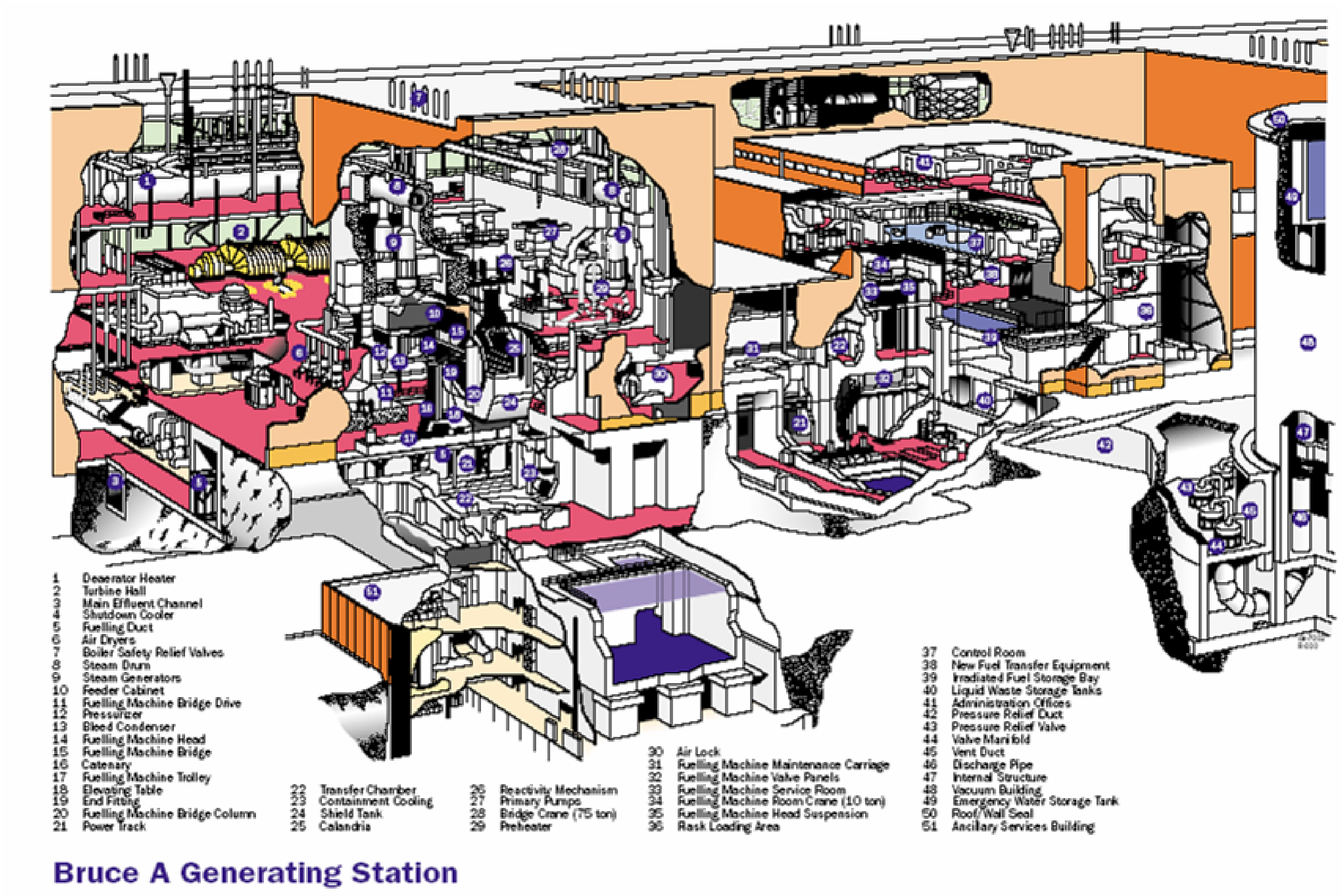


Figure 2-4: Layout of BNGS A

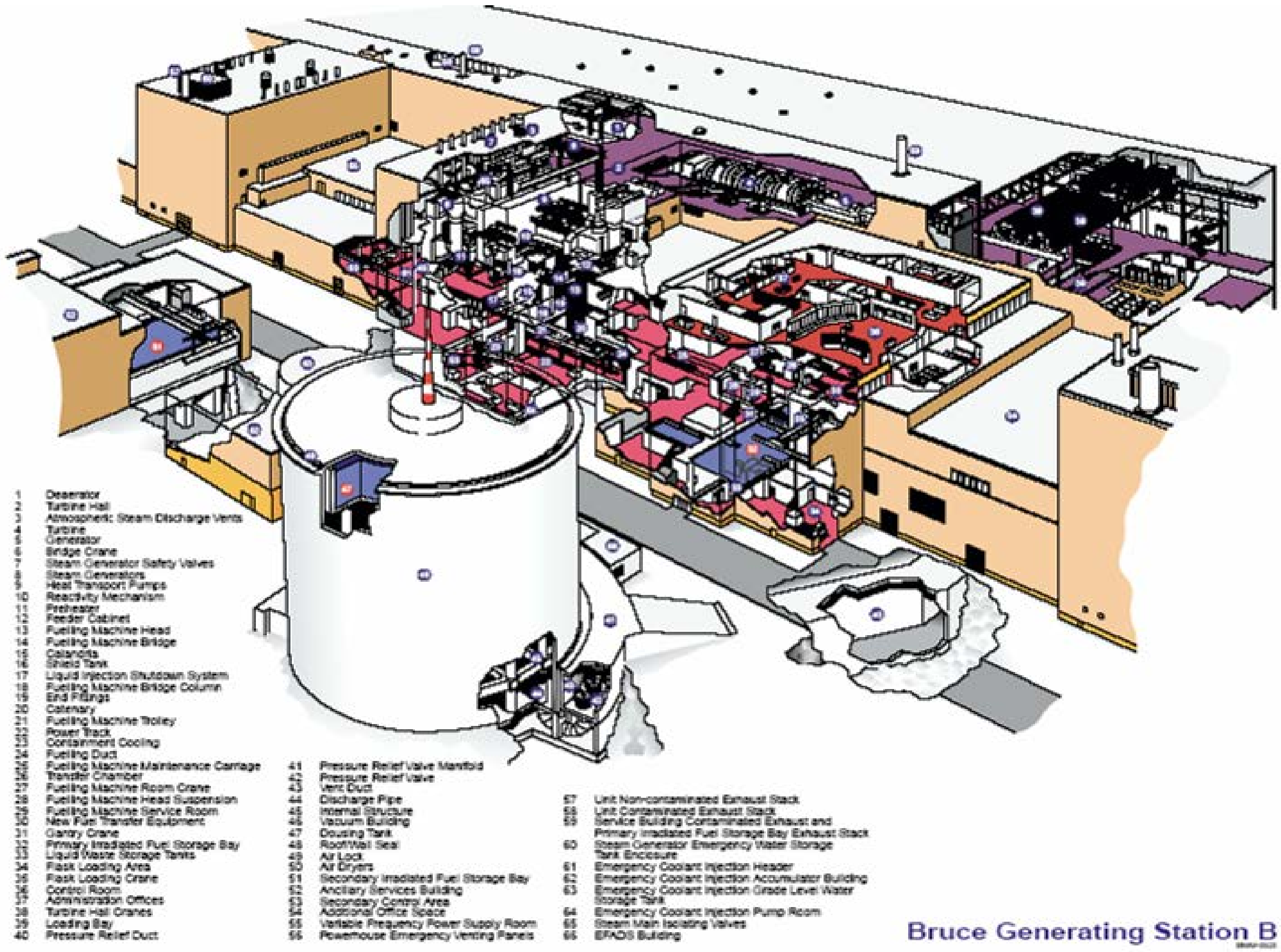
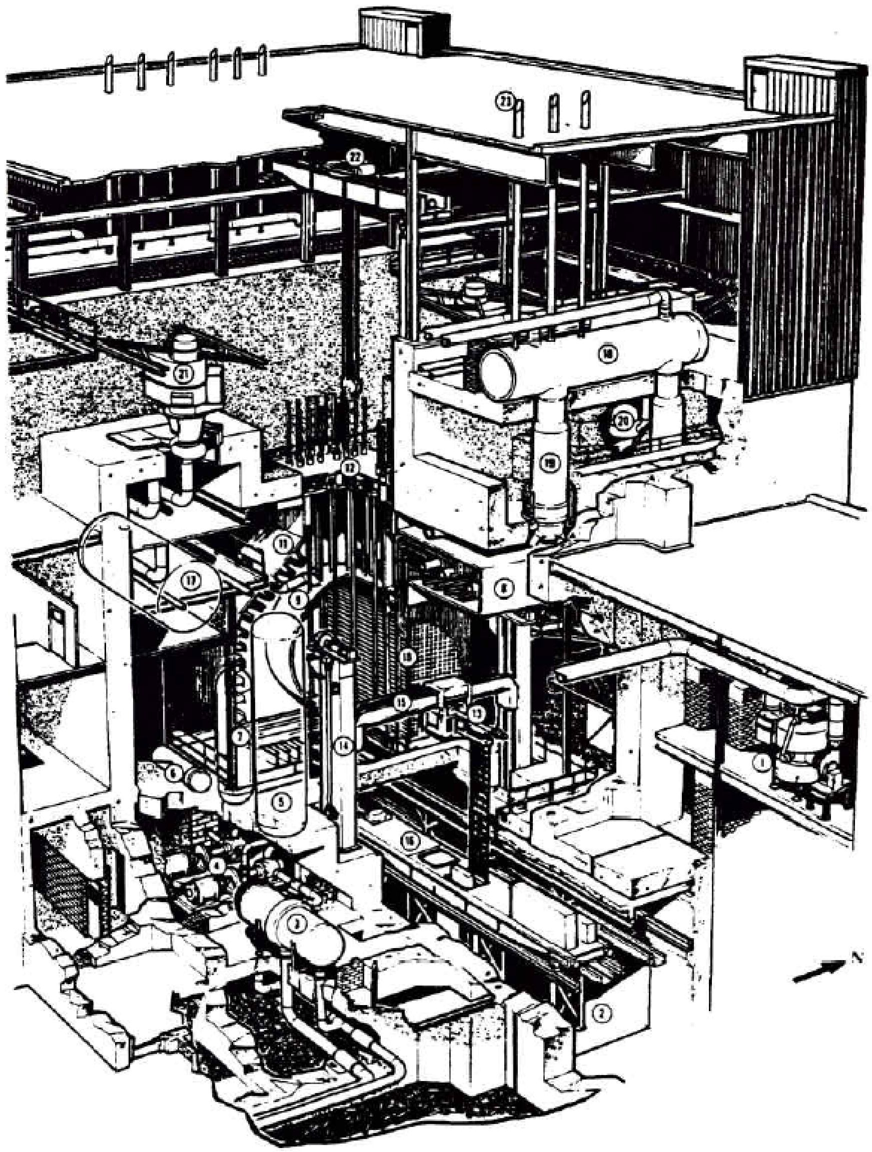
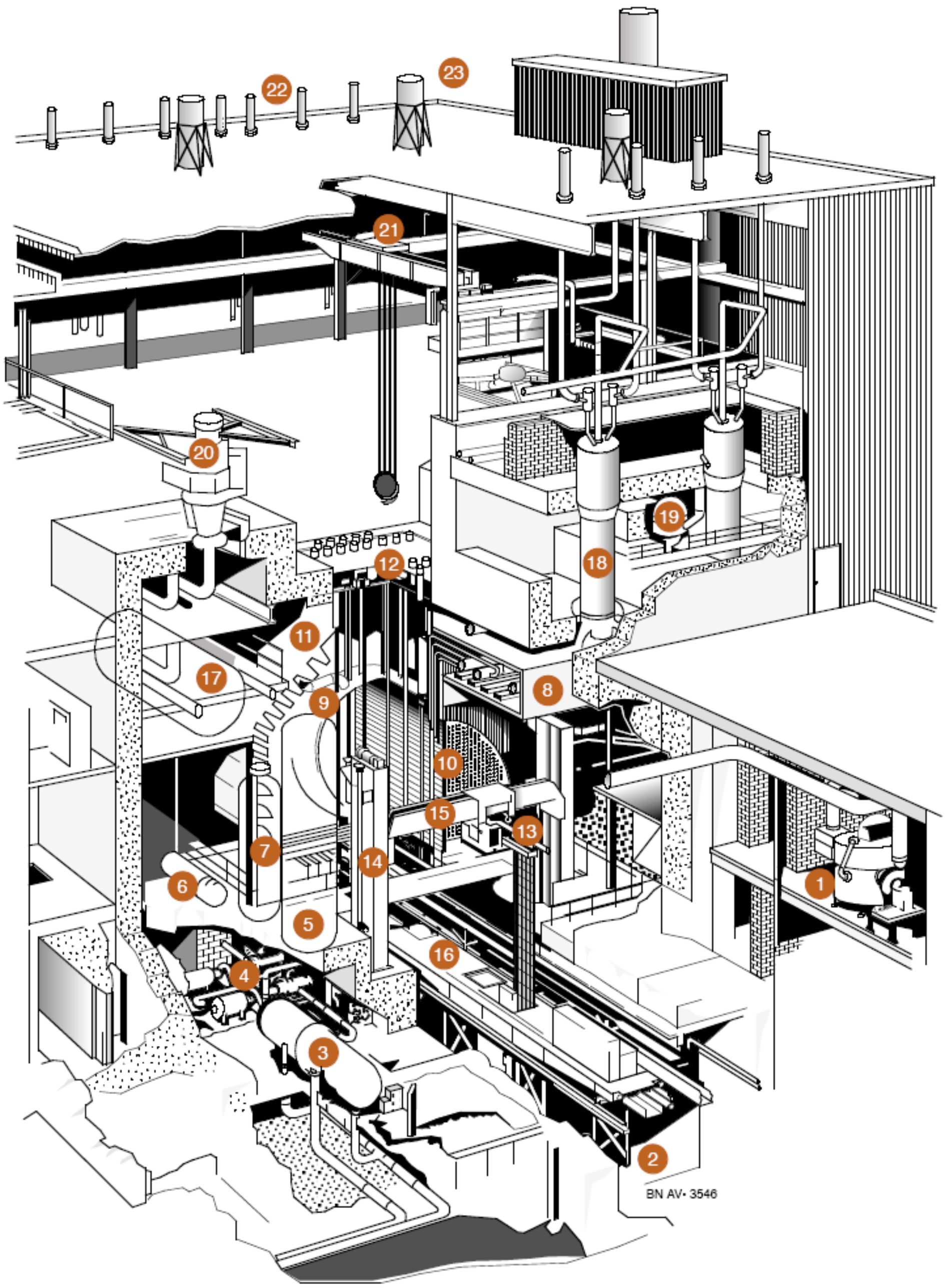


Figure 2-5: Layout of BNGS B



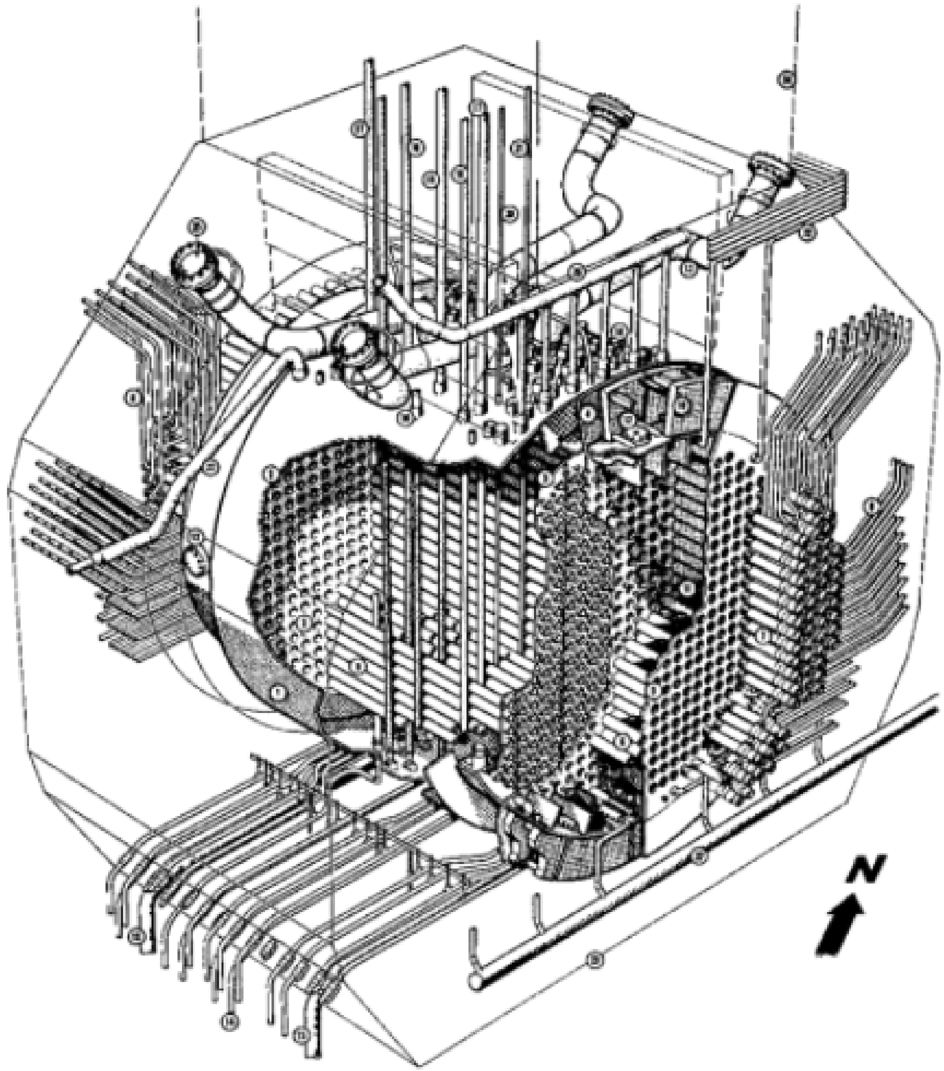
1. AIR DRYERS
2. FUELLING MACHINE DUCT
3. MODERATOR HEAT EXCHANGER
4. MODERATOR PUMPS
5. PRESSURIZER
6. BLEED COOLER
7. BLEED CONDENSER
8. FEEDER CABINET
9. CALANDRIA
10. ENDFITTINGS
11. SHIELD TANK
12. REACTIVITY MECHANISM
13. FUELLING MACHINE HEAD
14. FUELLING MACHINE BRIDGE COLUMN
15. FUELLING MACHINE BRIDGE
16. FUELLING MACHINE TRANSPORT TROLLEY
17. HEAVY WATER STORAGE TANK
18. STEAM DRUM
19. STEAM GENERATOR
20. PREHEATER
21. PRIMARY PUMPS
22. 68 Mg (75 TON) BRIDGE CRANE
23. SAFETY BLOW-OFF VALVES

Figure 2-6: BNGS A Reactor Building



1. Air Dryers
2. Fuelling Duct
3. Moderator Heat Exchanger
4. Moderator Pumps
5. Pressurizer
6. Bleed Cooler
7. Bleed Condenser
8. Feeder Circuit
9. Calandria
10. End Fittings
11. Shield Tank
12. Reactivity Mechanism
13. Fuelling Machine Head
14. Fuelling Machine Bridge Column
15. Fuelling Machine Bridge
16. Fuelling Machine Transport Trolley
17. Heavy Water Storage Tank
18. Steam Generator
19. Preheater
20. Heat Transport Pumps
21. Bridge Crane
22. Steam Generator Safety Valves
23. Atmospheric Steam Discharge Vents

Figure 2-7: BNGS B Reactor Building



1	Calandria	14	Moderator
2	Calandria Shell	15	Moderator Outlets
3	Calandria Side Tube Sheet	16	Reactivity Control Rod Nozzles
4	Baffle Plate	17	Booster Rod (no longer used)
5	Fuelling Machine Side Tube Sheet	18	Shutoff Rod
6	Lattice Tube	19	Zone Control Rod
7	Endfittings	20	Flux Monitor
8	Feeders	21	Flux Monitor and Poison Injection
9	Calandria Tubes	22	Endshield Cooling Piping
10	Shield Tank Solid Shielding	23	Shield Tank
11	Steel Ball Shielding (Endshield)	24	Shield Tank Extension
12	Manhole	25	Rupture Disc Assembly
13	Pressure Relief Pipes	26	Moderator Inlet Header
		27	Moderator Overflow

Figure 2-8: BNGS A Reactor Assembly

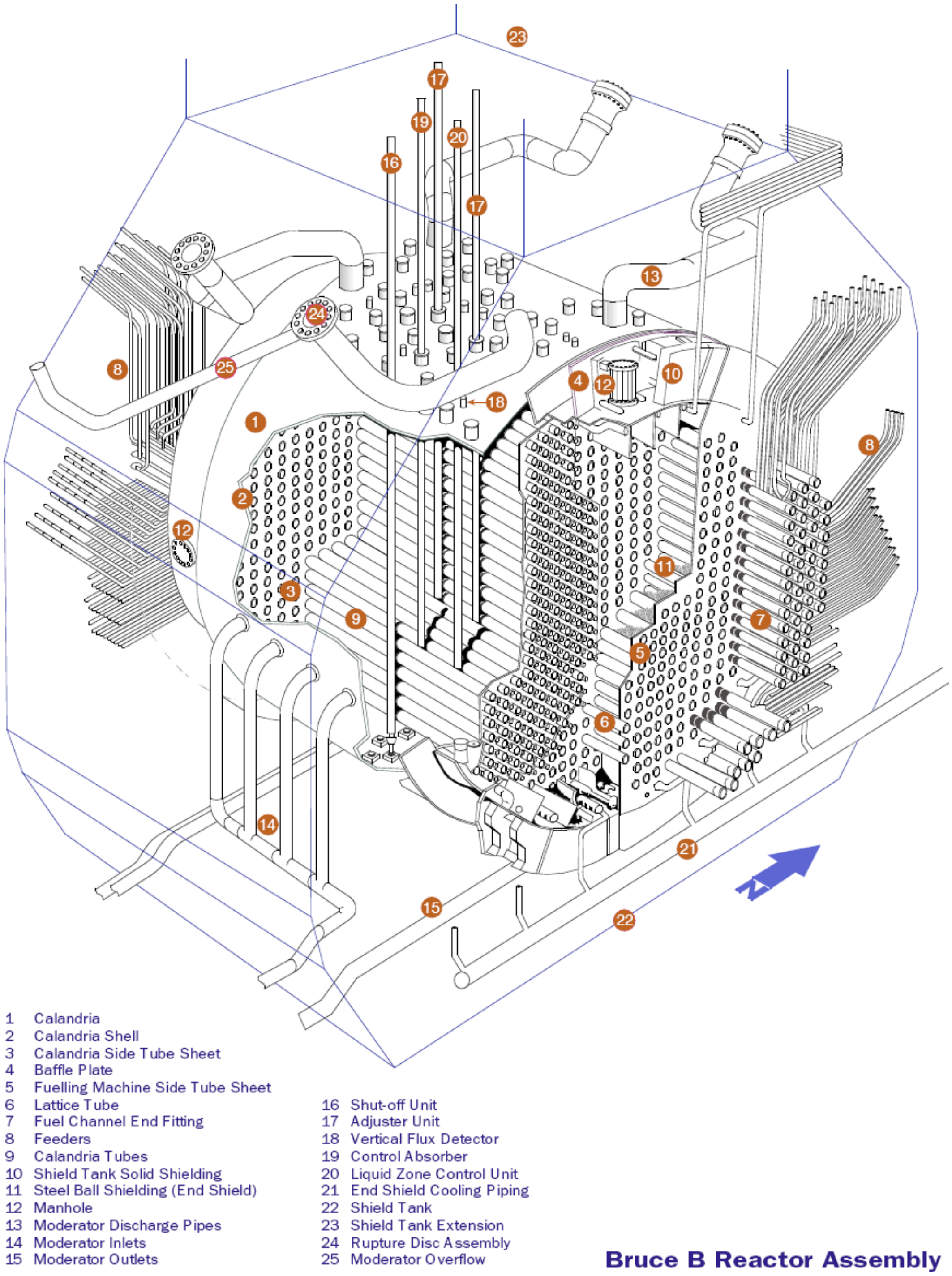


Figure 2-9: BNGS B Reactor Assembly

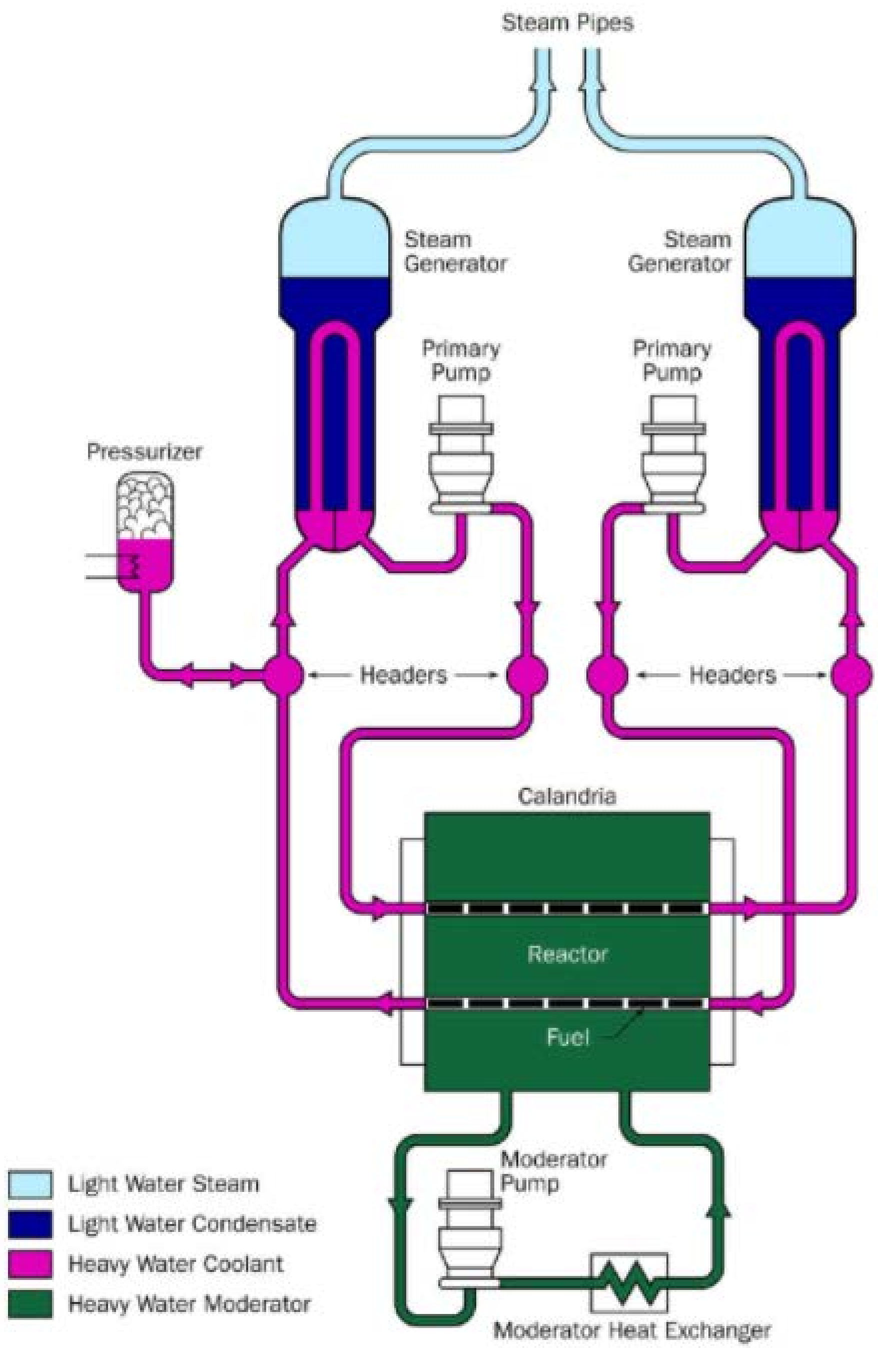
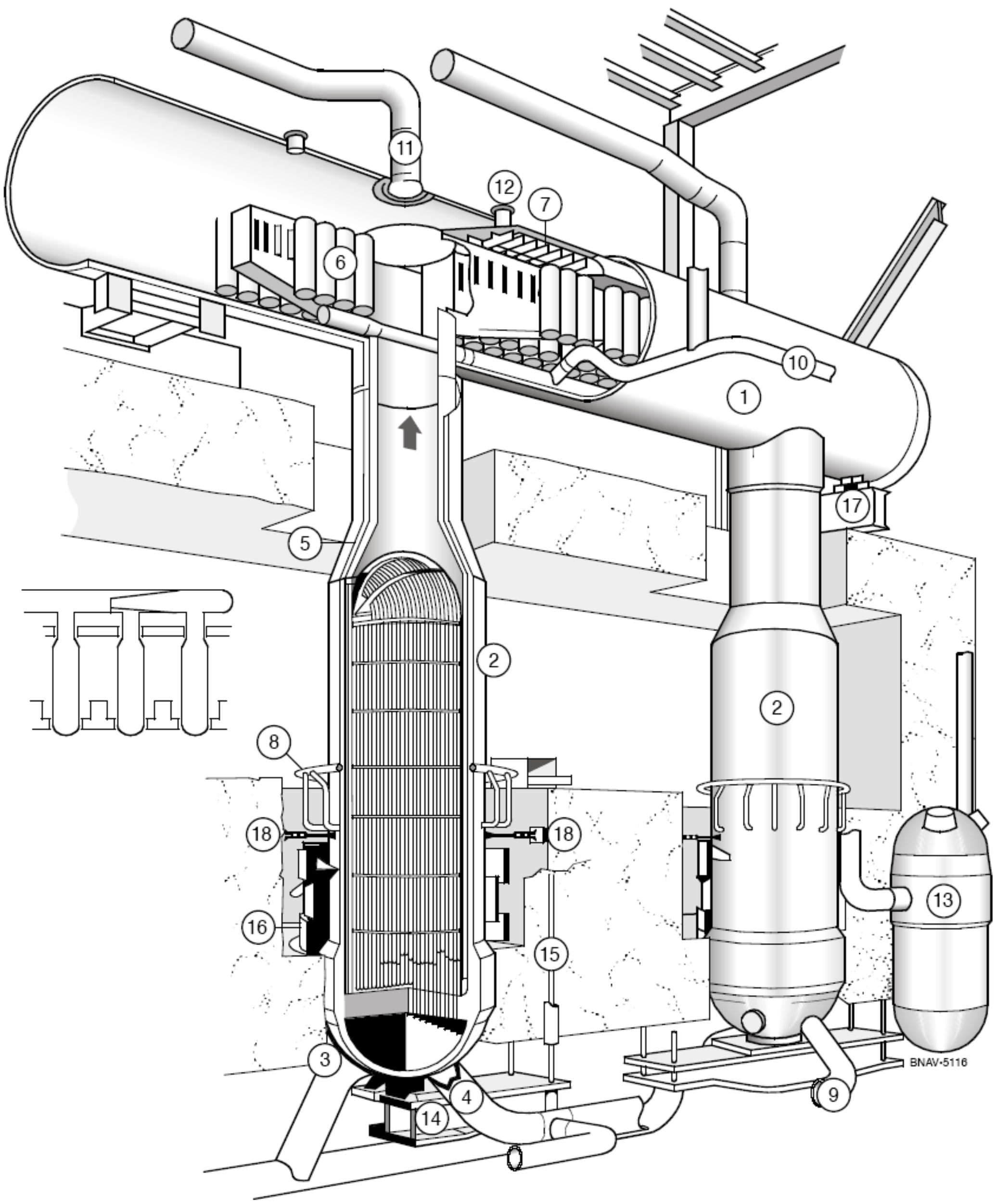


Figure 2-10: Simplified Reactor Systems Flow Diagram



1. Steam drum
2. Steam generator (boiler)
3. Heavy water inlet
4. Heavy water outlet
5. Downcomer Annulus
6. Cyclone separators
7. Steam scrubber
8. Blow-down piping
9. 16" manway
10. Feedwater inlet
11. Steam outlet
12. Safety valve nozzles
13. Preheater
14. Steam generator support
15. Support hangers
16. Steam generator vault seal
17. Drum seismic restraints
18. Steam generator seismic restraints

Figure 2-11: BNGS A Steam Generators

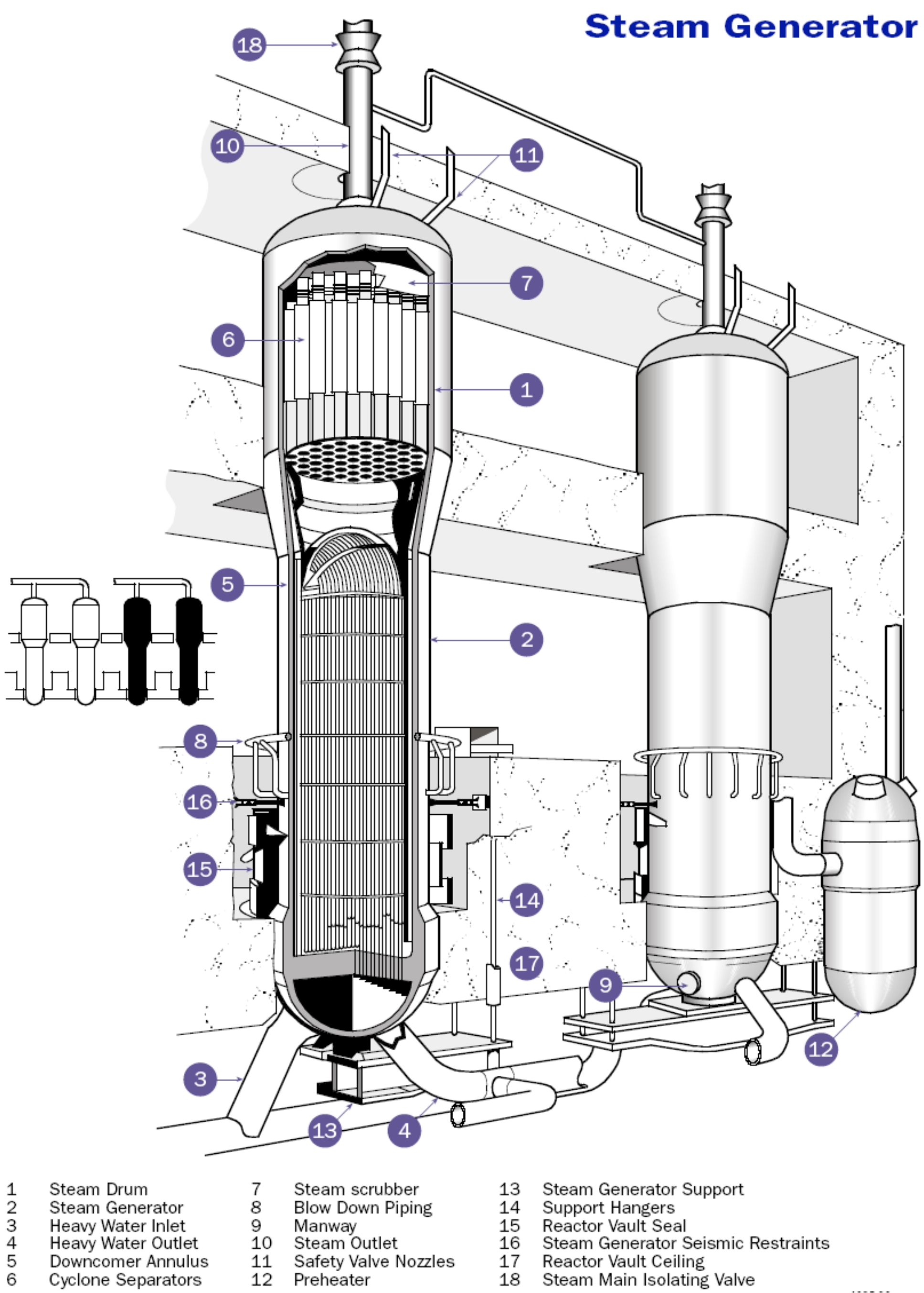


Figure 2-12: BNGS B Steam Generators

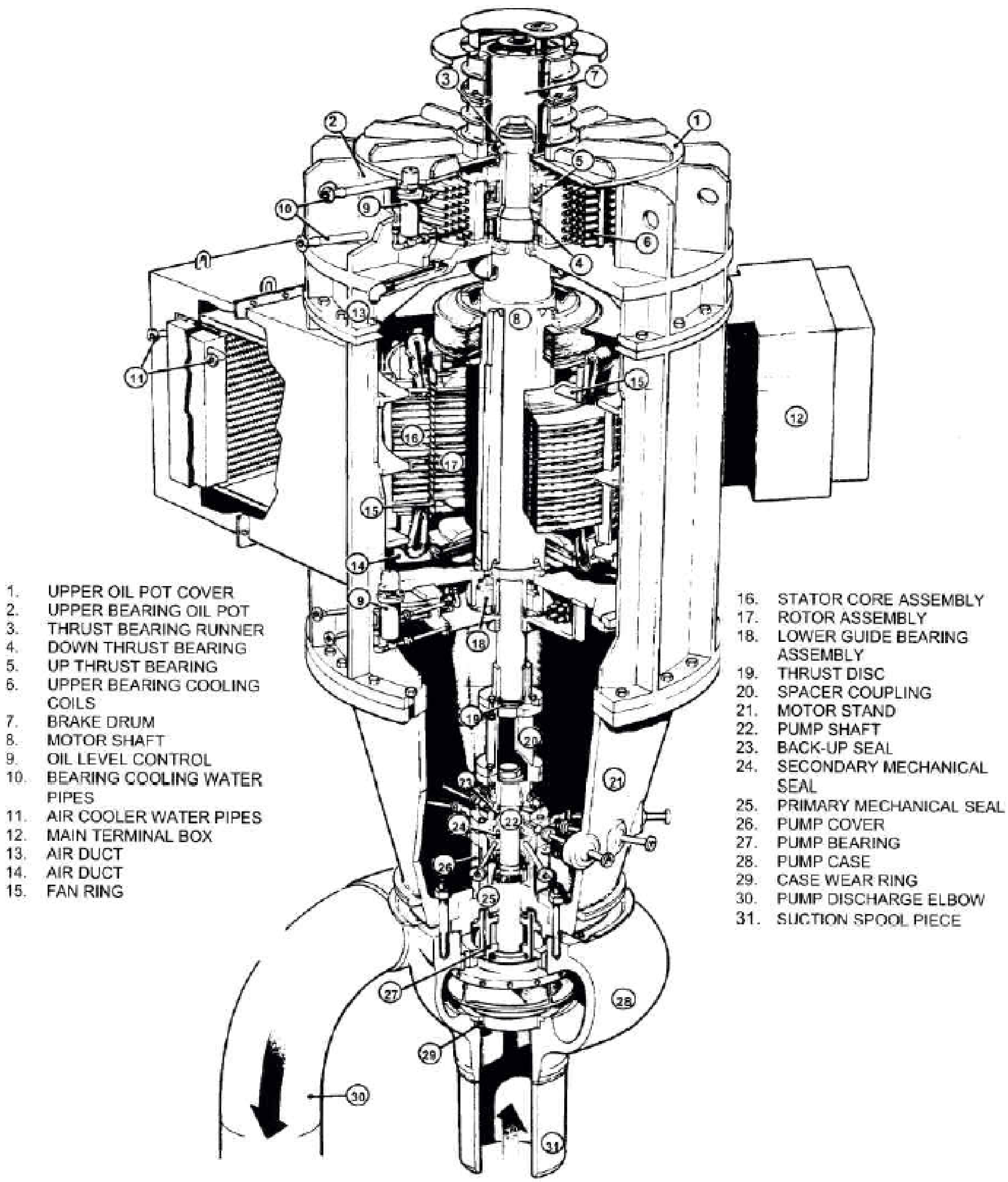


Figure 2-13: BNGS B PHT Pump and Motor

2.2.5 Containment

The station containment envelope includes the four Reactor Vaults, the Fuelling Duct (which runs beneath and interconnects these areas), the Fuelling Duct Extension, the ECI Recovery Sump, the Central Fuelling Area, the Pressure Relief Ducts, the Pressure Relief Manifold and the Vacuum Building. These areas are all interconnected.

The Vacuum Building is a containment formed by a cylindrical reinforced-concrete perimeter wall, a roof slab and a floor slab. Figure 2-14 shows a cut-a-way view of the Vacuum Building at BNGS A. The Water Storage Tank is contained in the vacuum chamber. The roof slab is of reinforced concrete and is connected to the perimeter wall by a flexible ring seal, which is secured in position by pre-stressed tendons. The perimeter wall is a reinforced, post-tensioned concrete cylinder. The upper vacuum chamber is formed of reinforced concrete and is mounted centrally on the roof. The chamber forms the dousing water displacement system. The Vacuum Building basement houses the vacuum ducts and some of the auxiliary equipment for the containment subsystems. A service tunnel connects the Vacuum Building basement to the Central Service Area basement and carries cabling and other services.

2.2.6 Powerhouse

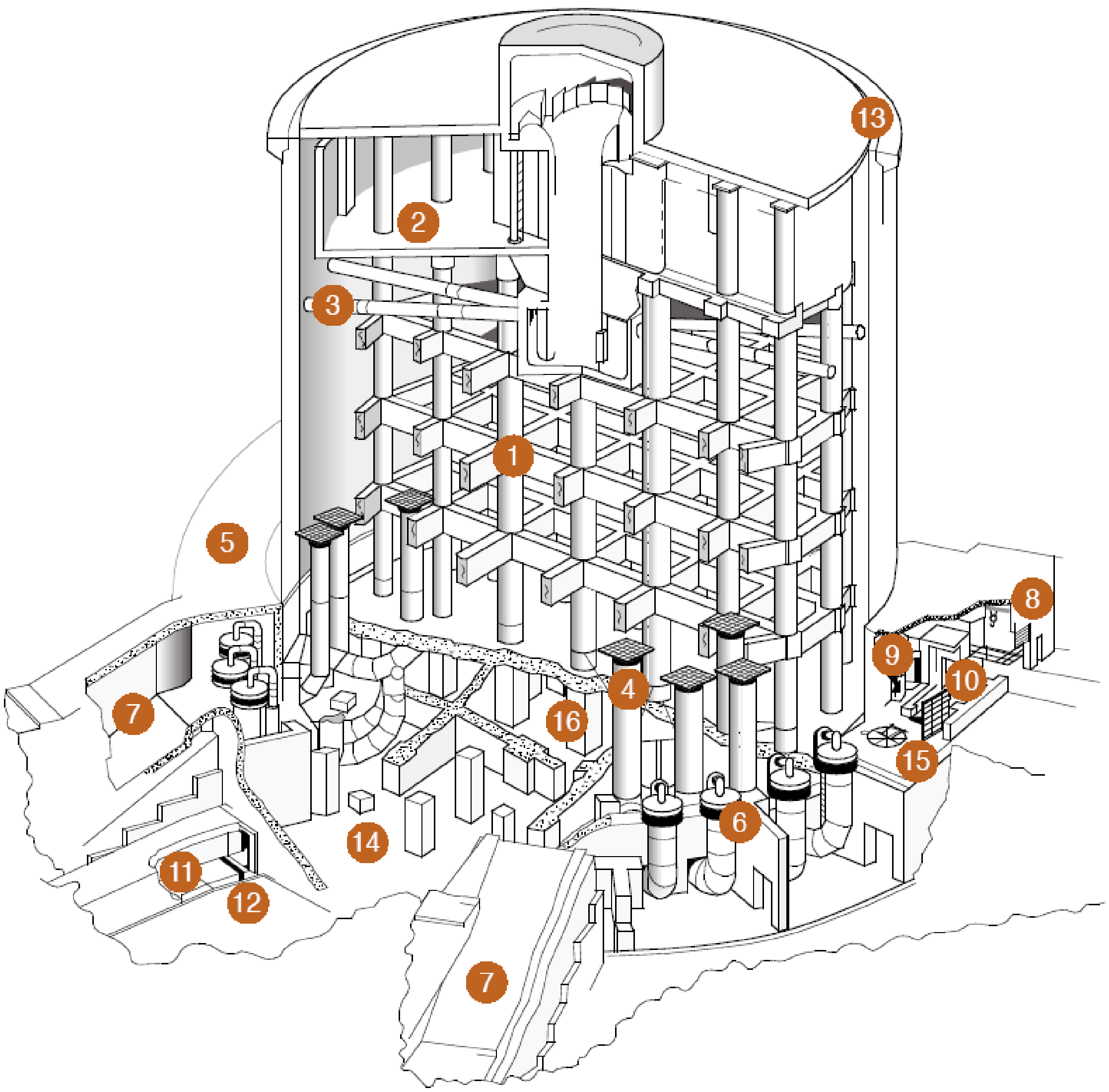
The Powerhouse includes the Turbine Hall and the Turbine Auxiliary Bay and is made up of four modules with a laydown and service area located in the Central Service Area between the second and third modules. It is a steel-frame structure with concrete floors and a metal roof. The external walls for the first lift above grade are pre-cast concrete panels and the upper levels are insulated metal sheeting. There is a solid partition between the Powerhouse and the Reactor Auxiliary Bays.

The Turbine Hall runs the full length of the building. It houses four Turbine Generators and some of their auxiliary systems. Two overhead cranes serve the Turbine Halls and the loading bay.

The Turbine Auxiliary Hall also runs the full length of the building. It houses auxiliary equipment and its centre portion forms a part of the service area in the Service Building.

2.2.7 Other Non-Nuclear Systems and Structures

Condenser cooling water and service water are supplied from Lake Huron by a submerged intake tunnel extending into the lake.



1. Internal Structure
2. Emergency Water Storage Tank
3. Distribution and Spray Headers
4. Vacuum Duct
5. Valve Manifold
6. Pressure Relief Valve
7. Pressure Relief Duct
8. Monorail and Hoist
9. Personal Airlock
10. Equipment Airlock
11. Service Tunnel
12. Catch basin
13. Roof/Wall Seal
14. Basement
15. Reverse Flow Valve
16. Equipment Room

Figure 2-14: BNGS A Vacuum Building Cut-A-Way

In addition to the major station buildings already described, there are four Pump Houses (at the south side of the Powerhouse) and a Water Treatment Building. Standby Generators are located at the west end of the Powerhouse for BNGS A and at the east and west ends of the Powerhouse for BNGS B.

For BNGS B, the EWPSB is located at the west end of the Powerhouse. The Emergency Water System draws water from the adjacent discharge channel and supplies water to the Reactor Building for emergency cooling purposes. The Bruce Power site Service Pump House is located on the east side of the Unit 8 Pump House. This Pump House serves the domestic and firewater systems for the site.

Portions of the ECI system are located in the following buildings and facilities: the Recovery Pump Room, the Service Bridge, the Accumulator Building, the Grade Level Water Storage Tank and the Central Service Area, with piping running east and west throughout the north end of the Reactor Buildings. The ECI Accumulator Building is located north of Unit 3 Reactor Building for BNGS A and north of Unit 7 Reactor Building for BNGS B, between the Vacuum Building and the Ancillary Service Building.

The Emergency Filtered Air Discharge System (EFADS) is housed in a building adjacent to the south side of the Vacuum Building.

The main and unit transformers are located south of the Powerhouse. The stations' switchyards (owned by Hydro One) are located on the south side of each station, convenient for connection from the transformers and to the transmission lines. The roads of the stations are laid out to serve the building arrangement.

Various upgrades have been added to both stations. Some of these include: a turbine building fire protection system, a powerhouse emergency vent system, seismic upgrades to block walls, reactor vault pre-heater platforms, a Construction Re-tube Building, a WTP, an Amenities Building at BNGS A and a Chemical Waste Storage Building at BNGS B.

2.2.8 Other Nuclear Facilities on the Bruce Nuclear Site

A number of other licensed nuclear facilities are located on the Bruce Nuclear Site in the immediate vicinity of the BNGSs. These include the following:

- OPG-owned operating waste management facilities, including the WWMF and RWOS1;
- Bruce Power supporting facilities, including the CMLF and the CSF;
- The Atomic Energy of Canada Limited (AECL) owned facility: Douglas Point Waste Facility (DPWF) (formerly the Douglas Point NGS)[8]; and

[8] Canadian Nuclear Laboratories (CNL) holds the licence to the facility.

- Hydro One's electric transmission and switchyards, located directly south (Construction South) of the BNGSs.

This PDP considers the interferences with the OPG-owned facilities (as described in the following subsections), their decommissioning timescale and any impact that the decommissioning of BNGSs may have on these facilities (see Section 4.0). Although the aforementioned OPG licensed nuclear facilities are located within the existing Bruce Nuclear Site boundary, the life cycle plans for these facilities are separate from the life cycle plan for the BNGSs. The details of the decommissioning plans for these facilities are provided in their respective PDPs.

Provision of the necessary services to these facilities following shutdown of the BNGSs will be assessed during preparation of the BNGSs DDP and assured at that time.

2.2.8.1 Western Waste Management Facility

The WWMF is owned and operated by OPG. It is located on the Bruce Nuclear Site, as shown in Figure 2-15, defined by the parcel of land designated for the management of OPG's radioactive waste and licenced for such use by the CNSC. This 19 hectare area currently contains the L&ILW storage area and the used fuel dry storage area. This area is situated inside the Bruce Site (formally known as the Bruce Nuclear Power Development).

The objectives of the WWMF are to provide safe material handling (receipt, transfers, and retrieval), treatment, and storage of radioactive materials produced at nuclear generating stations and other facilities currently or previously operated by OPG or its predecessor, Ontario Hydro. This facility also provides safe storage of used fuel from the BNGSs in Dry Storage Containers (DSCs) until it can be transported to a long-term used fuel disposal facility (i.e., Adaptive Phased Management (APM)). The used fuel dry storage area is a security-protected area located northeast of the L&ILW storage area, and consists of DSC processing and storage buildings.

The L&ILW storage area consists of various structures such as the Amenities Building, the Waste Volume Reduction Building (WVRB), the Transportation Package Maintenance Building (TPMB), above ground low-level and intermediate-level waste storage buildings, quadricells, in-ground containers, trenches, and tile holes. These structures are primarily used for storage and processing of the L&ILW from OPG's Pickering and Darlington Nuclear Generating Stations as well as Bruce Power operations [R-18].

Interfaces exist between OPG lands and operations and Bruce Power programs, structures and services. A detailed list of the OPG to Bruce Power interface documents and services relevant to the WWMF is provided in Appendix D. The services currently provided by Bruce Power include:

- Security services;
- Emergency response services;

- Electricity;
- Fire water and domestic water;
- Sewage;
- Storm water;
- Traffic management;
- Vehicle monitoring;
- Site access; and
- Public address system.

The WWMF PDP [R-1] describes the decommissioning of this facility in more detail.

The impact of BNGSs shutdown and decommissioning on the WWMF is further described in Section 4.0.

2.2.8.2 Small Facilities on the Bruce Nuclear Site

The CMLF (also referred to as the CMF) is owned by OPG and operated by Bruce Power [R-2]. It is designed to support the maintenance activities of the BNGSs and other site facilities. The main building of the CMLF has a total floor area of about 15,000 m^2 and includes a Mechanical Laydown Yard, a Transport and Work Equipment Yard, a Container Lay-Down Area and an area for vehicle washing and fuelling. The facility has the capacity for managing radioactive and non-radioactive materials and operations. The total CMLF property is about 7 ha. The CMLF interfaces include the following:

- **Electrical:** Power to the CMLF originates from Hydro One Networks at 230 KV at the Bruce Heavy Water Plant B Substation. It is then transformed down to 13.8 KV and feeds Switchgear #3. The Switchgear #3 then feeds the CMLF at 13.8 KV and is transformed down to 600 V by four transformers within the CMLF. There are four 13.8 KV feeds to the CMLF and through tie breakers, the feed has redundancy through four Motor Control Centers within the CMLF.
- **Domestic Water**: Domestic drinking water is fed to the CMLF through the Center of Site Domestic Water Distribution piping. This is a single feed that originates from the Bruce B Domestic Water Plant.
- **Fire Water**: CMLF Fire Water is supplied from the Center of Site Fire Water Pumphouse under normal operating conditions. A secondary fire water supply is available from the Bruce B Fire Water Pumphouse.
- **Fire Alarm System**: The CMLF fire alarm system consists of both heat/smoke detectors and fusible sprinklers. The fire alarm system is monitored by the Control Room and by the Emergency and Protective Services through a slave panel display.

- **Security**: Security to the CMLF is provided by the Emergency and Protected Services.

RWOS1, shown in Figure 2-15, was established to manage the L&ILW from the Douglas Point and Pickering Nuclear Generating Stations A. The perimeter of RWOS1 is outlined by a fence and access is granted through a gate. The site is comprised of a number of in-ground waste storage structures containing solid L&ILW. In the 1990s and early 2000s a portion of the waste was removed from some in-ground structures (trenches) and some in-ground structures (tile holes) were removed in their entirety; the associated waste was relocated to the WWMF. The site has not received waste since 1976 and the remaining storage structures remain in a caretaking mode. There are no permanent buildings or above-ground structures associated with RWOS1 site, with the exception of the small shed. The RWOS1 interfaces include:

- **Environmental monitoring:** The groundwater well network around RWOS1 is monitored by the OPG staff. The laboratory services are provided by Bruce Power Health Physics Lab (BPHPL) and results are provided to Performance Engineering. The surface water monitoring is also part of the environmental monitoring, similarly, completed by OPG staff, analyzed at BPHPL and results managed by OPG.
- Security Services, emergency response, traffic management, vehicle monitoring, facility access, public address system are provided by Bruce Power.

Bruce Power has constructed the CSF (also referred to as B44, as shown in Figure 2-15) for the purpose of receipt and storage of all clean and contaminated tools, materials and equipment from the BNGS Major Component Replacement (MCR) Project. Currently, the CSF is a stand-alone building, with an overall square footage of 120,000 ft^2 and has been constructed with separate zoned spaces for storage of tooling and materials in sea containers and for refurbishment of tools that have been used in the MCR Project. It has been licensed in November 2020. The CSF interfaces include:

- **Electrical:** Power to the CSF originates from Hydro One Networks at 230 KV at the BNGS B Main Substation. It is then transformed down to 13.8 KV and a dual supply feeds Vista Switchgear Bruce Unit 4 at the CSF. The Vista Switchgear Bruce Unit 4 through tie breakers then feeds the CSF at 13.8 KV and is transformed down to 600 V by a transformer within the CSF. There are two 13.8 KV feeds to the CSF and through tie breakers at the Vista Switchgear has a redundant feed to the CSF.
- **Domestic Water:** Domestic water is fed to the CSF through the Center of Site Domestic Water Distribution piping. This is a single feed that originates from the Bruce B Domestic Water Plant.
- **Fire Water:** CSF Fire Water is supplied from the Center of Site Fire Water Pumphouse under normal operating conditions. A secondary fire water supply is available from the Bruce B Fire Water Pumphouse.

- **Fire Alarm System:** The CSF fire alarm system consists of both heat/smoke detectors and fusible sprinklers. The fire alarm system is monitored by the BASS Control Room through a SCADA system and by the Emergency and Protective Services through a slave panel display.
- **Security:** Security to the CSF is provided by the Emergency and Protected Services.

The Spent Solvent Treatment Facility (SSTF), also located on the Bruce Nuclear Site, was formerly included among the small facilities but it has now been decommissioned (see Section 3.4.3.1) and will not be discussed further here.

The PDP for RWOS1, the CMLF and the CSF [R-2] describes the decommissioning of the small facilities in more detail.

The impact of BNGSs shutdown and decommissioning on the small facilities is further described in Section 4.0.

2.2.8.3 Douglas Point Waste Facility

The DPWF is owned by AECL and operated by CNL. It is located on land owned by AECL and consists of a permanently shut down, partially decommissioned prototype 200 megawatt CANDU® reactor and associated structures and ancillaries [R-18]. The facility is currently in the process of decommissioning. Services from Bruce Power include:

- Security services – These are expected to continue until at least the fuel is removed, which is post 2030. Controlled site access will still continue thereafter through the main Bruce Power site.
- Emergency response services – Bruce Power Emergency Response Plan provides direction for emergency evacuation, which applies to all staff at the DPWF site.
- Electricity – A new Class IV power system is currently being installed which will allow electricity to be directly obtained from Hydro One's switchyard.
- Fire water and domestic water – Supplies of fresh water and firewater are provided from the Bruce site to the DPWF.
- Storm water – Bruce Power's road and roof drains and the discharge from the external sump pump systems discharge into the main-site outfall that runs below the DPWF.

CNL maintains a systematic care, maintenance, monitoring and inspection program, and implements the surveillance and Life Management Program activities at the DPWF. These activities will be continued to ensure that the DPWF remains in a safe, sustainable, and secure state until such time that the facility reaches the currently planned final decommissioning end-state site suitable for other industrial or commercial use.

2.2.8.4 Hydro One's Assets

Hydro One owns and operates a number of assets within the Bruce Nuclear Site. These include, but are not limited to office and workshops for maintenance, switchyards at Bruce A and Bruce B (shown in Figure 2-15), switching stations and transformer stations, and transmission corridors [R-18].

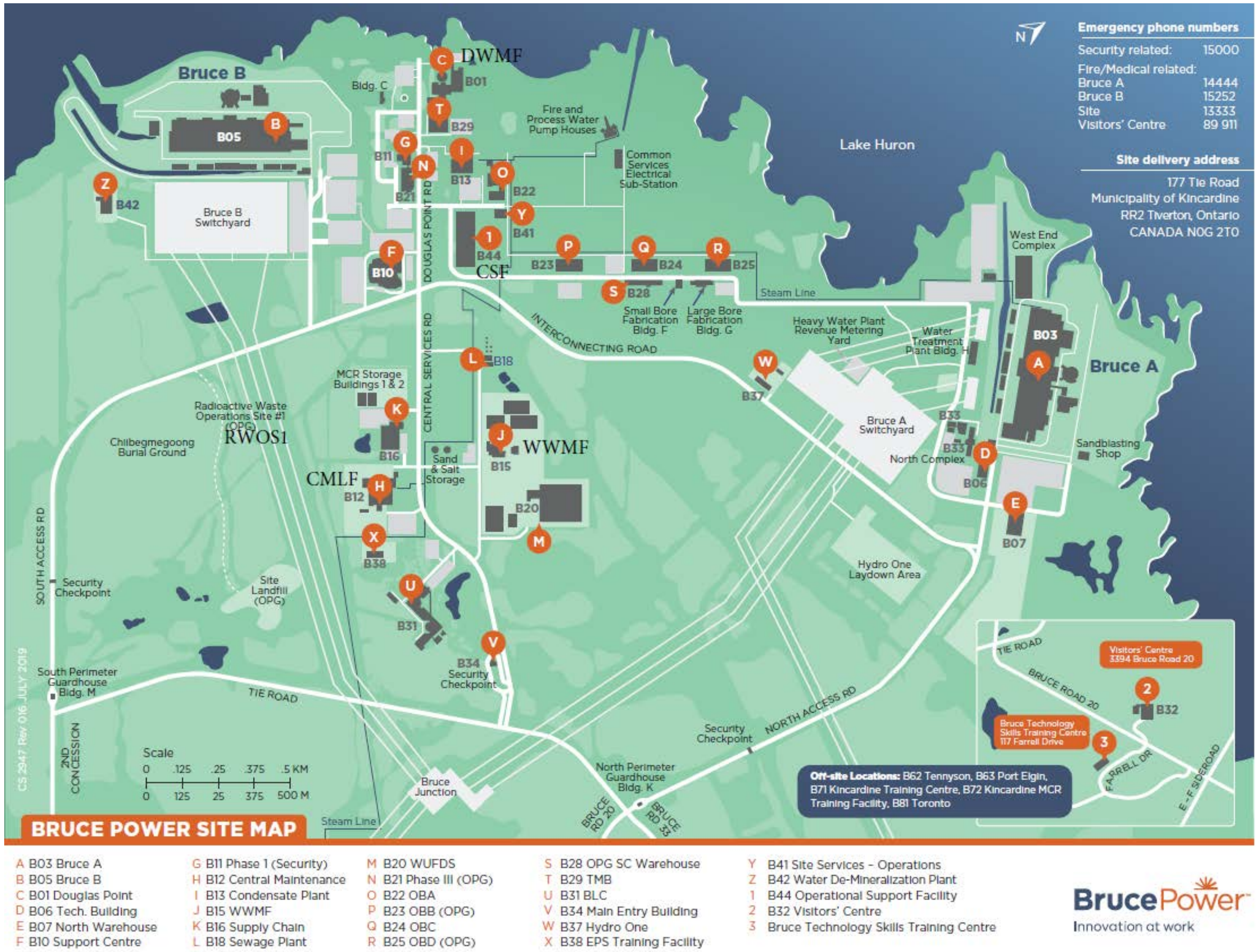


Figure 2-15: Location of WWMF, Small Facilities, DPWF and Switchyard in Relation to BNGS A and B

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2.3 Description of the Environment

2.3.1 Natural Environment

The topography in the area of the Bruce Power site is classified as smooth to gently undulating with a gradual rise from the lake water level, about elevation 176.4 m along the shore to an elevation of about 195 m above mean sea level approximately 3.2 km inland. Beyond that point, the ground rises steeply to about 221 m above mean sea level and then more slowly to about 244 m above mean sea level over the next 3.2 km [R-19].

There are no major rivers or lakes in the vicinity other than Lake Huron. However, there are two small drainage courses running east to west adjacent to the site. Underwood Creek empties into the Baie du Doré, north of the site, and the Little Sauble River empties into Inverhuron Bay, south of the site. Historic land use changes redirected a former tributary of the Little Sauble, named Stream C, through the Bruce site to drain into the southwest corner of Baie du Doré [R-21]. It provides important fish and mammal habitat and flows all year-long. Surveys of Stream C since 2017 demonstrates there is high water quality and fish habitat in this stream [R-18].

There is a narrow strip of beach shingles and sand along the shore of Lake Huron. Beyond this strip, the land is considered poorly drained bog plain due to the flatness of the land and the lack of any surface drainage system.

The Douglas Point swamp, located at the eastern end of the Bruce Power site and extending further east to the former lake shoreline, supports a high diversity of vegetation and provides habitat for deer and waterfowl that frequent the Bruce Power site. The Douglas Point swamp has been designated as an environmentally significant wetland area [R-21].

The Douglas Point headland is a natural geographic transition point along the whole eastern Lake Huron shoreline. The shoreline configuration changes at Douglas Point from smooth shoreline (to the south) to rough (to the north). There are no major embayments along the whole eastern shoreline of Lake Huron to the south of Douglas Point. Baie du Doré is the first protected embayment, the next one being 40 km north (Chiefs Point Bay) at the base of the Bruce Peninsula [R-21].

The Baie du Doré wetland immediately adjacent to the Bruce Power site is a provincially significant wetland, which supports both provincially rare and endangered species, along with fish spawning and rearing [R-21].

Four hundred and ten (410) vascular plant taxa have been identified on the site and associated lands. Sugar maple and beech associated with red and white ash, yellow birch and red, white and bur oaks characterize the general Bruce Power site region. Frequently hemlock, white pine and balsam fir occur within the tolerant hardwood types and eastern cedar is present in swampy depressions [R-21]. Two plant Species at Risk (SAR) were recorded within the vicinity of the site [R-22]. The butternut tree have been observed around the site [R-21], [R-22] and are listed as Endangered under the Ontario Endangered Species Act (ESA) of 2007 [R-23] and the Federal Species at Risk Act (SARA) of 2002 [R-24]. The dwarf lake iris has also been observed in the vicinity of the site and is listed as Special Concern under the ESA [R-23] and listed federally (SARA, Schedule 1) as well as considered as Threatened by the Committee on the status of Species at Risk in Ontario.

Five different frog species were identified in 2020, of which the Spring Peeper, an early breeding frog, was the most common and abundant species. There was one observation of a Spotted Salamander, which is not listed as a SAR. Overall, taking into consideration the expected natural variation in amphibian abundance and diversity, the diversity of species and trends through time of frog populations in the local area is very good and has remained consistent across monitoring sites and years. Focused turtle monitoring campaigns were not completed in 2020, however incidental observations were made of Snapping Turtle, Midland Painted Turtle, and an additional turtle species. Five different snake species were observed in 2020, of which the Eastern Ribbonsnake is a listed SAR in Ontario and Canada with a conservation status of Special Concern [R-18].

Overall, surveys in 2019 and 2020 have demonstrated that there are diverse populations of local and migrant waterfowl and shorebirds inhabiting the lands nearby Bruce Power, with the highest density in Baie du Doré. Canada Geese and Double-Crested Cormorant were the most abundant birds observed in 2020. Birds of prey are abundant in the waterfowl survey areas. A total of 97 Bald Eagles (currently listed as a SAR in Ontario), a single Merlin, and a single Broad-Winged Hawk were observed in 2020. Overall, across the whole Bruce Nuclear Site, counts have increased in the last four years indicating an increase in the abundance of the local overwintering Bald Eagle population. Of the breeding birds observed, the most species were the Red-Eyed Vireo and American Goldfinch. There were also observations of four SAR bird species (3 showed evidence of breeding): Eastern Wood Pewee, WoodThrush, Eastern Meadowlark, and Bobolink. Two Sedge Wren were observed and this bird is not locally common [R-18].

Smallmouth Bass nesting surveys to monitor local bass populations have occurred annually since 2009 (Bruce A and Bruce B discharge channels) and 2010 (Baie du Doré). These areas provide excellent Smallmouth Bass nesting habitat as there is abundant spawning conditions present (adequate depth, gravel/sand substrate and shelter from prevailing winds/wave action) [R-18].

The Bruce Power site and the surrounding areas continue to provide prime habitat for large flocks of migrating shorebirds and waterfowl. Also, the wetland habitat of Baie du Doré and the surrounding area continue to be important habitat, including for over-wintering [R-21].

2.3.2 Geophysical Environment

2.3.2.1 Soils

The soils consist of a surface layer that contains organic material, beach shingle and poorly graded sand and gravel. The surface layer is generally less than 300 mm thick. Beneath the surface layer, the overburden consists of five principal units. In descending order from the ground surface, these units are:

- Surface sand and gravel;
- Weathered silty glacial till;
- Upper unweathered glacial till;
- Middle sand/layered till; and
- Lower unweathered silty glacial till.

The overburden stratigraphy is complex with drift thicknesses ranging between 14 m and 19 m. The complexity within the stratigraphy is attributed to the laterally discontinuous middle sand/layered till unit. This unit is comprised of well-sorted fine to medium sand that, at several locations, coarsens and is interbedded with thin horizontal layers of silty till (layered till). The geometry of the layered till/middle sand unit is irregular, varying in thickness and elevation.

2.3.2.2 Bedrock

The bedrock underlying the quaternary deposits is formed by the Middle Devonian Amherstburg Formation of the Detroit River Group. The bedrock surface beneath the Bruce Power site dips 2 percent in an easterly direction. The upper few metres of the bedrock surface are fractured and highly weathered [R-21]. Below this surface-weathered zone, subsurface investigations and excavations indicate generally stable rock conditions [R-19].

2.3.2.3 Groundwater

Groundwater movement within the site area is generally toward the lake. The groundwater level is close to the surface. Two groundwater aquifers exist in the area. One is at the base of the loose sand/gravel layer overlying the dense till layer or bedrock. The other is in the bedrock, which generally has a moderate permeability.

Powerhouse foundation drainage systems create localized hydraulic sinks in the groundwater flow systems. In this situation, the foundation drains act as “hydraulic traps” that would tend to prevent sub surface contaminant releases. Water drawn into the foundation drains is discharged to Lake Huron through the Condenser Cooling Water (CCW) duct [R-19].

Recently, Bruce Power implemented CSA N288.7-15, Groundwater Protection Programs at Class I Nuclear Facilities and Uranium Mines and Mills for its groundwater monitoring program. Bruce Power monitors the foundation drainage system on a monthly basis and the tritium concentrations are used to estimate tritium loading. All waterborne tritium results in 2020 were well below regulatory limits and associated reportable action levels.

Tritium trends in the foundation sumps are monitored and actions taken to identify any significant increases in effluent. Variability may be attributed to atmospheric tritium in the powerhouse which accumulates in low lying areas and concentrates in collection sumps over time (this effect is particularly elevated during outage maintenance activities when systems are opened and there are periods of higher tritium concentrations in the station).

Waterborne effluent was reported to contain radionuclides that can build up in environmental media, and trace levels of plant related radionuclides have been detected in the sediment samples. Environmental monitoring data previously indicated that fission products, activation products and fuel related radionuclides were detected in various effluents [R-25]. The results of the samples collected and analyzed, as documented in the latest environmental protection report [R-18], did not show elevated levels of radionuclides.

The groundwater monitoring program will continue to track, monitor, and report on the groundwater quality on site. It is evident from the trends indicated in the 2020 groundwater results that the potential implications and impacts on the environment are low, as indicated by monitoring on two fronts: (1) CCW tritium measurements remain very low, and (2) tritium concentrations at Bruce A and Bruce B multi-level wells remain well below the Ministry of Environment, Conservation and Parks (MECP) Ontario Drinking Water Standard (ODWS) of 7,000 Bq/L. Additional sampling for tritium in wells near the Transformer and Standby Generator areas at Bruce A and Bruce B also resulted in levels well below the ODWS which is protective of human health [R-18].

2.3.2.4 Seismicity

Southwestern Ontario and the Regional Study Area lie within the tectonically stable interior of the North American continent. This stable interior region of North America is characterized by low rates of seismicity. Most recorded events up to December 2010 have a Richter magnitude of less than 3.0 magnitude (M), with rare occurrences of larger events within a 150 km radius from the Bruce Power site. The local magnitude scale is the Nutti magnitude (mN), which is an extension of the Richter scale, and is the magnitude scale used for reporting of seismic activity in regions of North America to the east of the Rocky Mountains [R-20] and [R-19].

Forty one (41) events have been detected within 120 km in this region between 1985 and July 2021. The event with a maximum magnitude of M4.3 was felt in Owen Sound in 2005, at a focal depth of about 11 km [R-26].

Monitoring of regional seismicity by the Geological Survey of Canada and by OPG's Southern Ontario Seismic Network since 1991 has confirmed the historical record and has not indicated significant activity on fault systems potentially affecting the Bruce Power site. Aside from the 2005 event, regional seismic monitoring has recorded only low-level seismic activity (on the order of 1 to 3 on the Richter scale) along the structure that extends from Georgian Bay into Lake Huron. The current and historical monitoring data confirm that the Bruce Nuclear Site is located in a seismically quiet area [R-21].

2.3.3 Aquatic Environment

Lake Huron is the major water body near the Bruce Power site. Although there are extensive networks of small rivers and creeks feeding into Lake Huron in the region, there are no major rivers near the Bruce Power site. The nearest river is the Little Sauble, a small river. There are two small east-to-west drainage courses entering the lake adjacent to the Bruce site. Underwood Creek empties into the Baie du Doré to the north and the Little Sauble River, which forms the southern boundary of Inverhuron Provincial Park, empties into Inverhuron Bay to the south. To the west and northwest, Lake Huron stretches uninterrupted for approximately 128 km. There is also Stream C, mentioned in Section 2.3.1, that runs through the site, originating off-site near the Bruce Eco Industrial Park, emptying into Baie du Doré. The nearest land across the lake is Port Hope, Michigan, USA, 98 km southwest of the Bruce site [R-21].

2.3.3.1 Fish

The Baie du Doré wetland adjacent to the Bruce Power site provides habitat suitable for fish spawning and rearing. Baie du Doré is open to Lake Huron and faces the dominant wind direction. There are typically frequent water changes due to wind, wave and minor variations in lake level.

The waters of Lake Huron are used for sport and commercial fishing. The modestly warmer waters from the cooling water discharges from BNGSs provide seasonal sport fishing opportunities. Sport fishing, in the lake itself as well as the tributary streams and lake bays, is consistent with the tourist activity and the quality of beach facilities. The Chippewas of Saugeen First Nation and the Chippewas of Nawash Unceded First Nation share the same Indigenous and treaty rights, including rights to fish commercially in the waters around the Bruce Peninsula [R-21].

The annual commercial fish harvests in Lake Huron's three basins have averaged nearly 3 million pounds, between 2014-2018, representing about 14 percent of Ontario's Great Lakes' harvest [R-27]. In 2019 and 2020, the harvest from Lake Huron was approximately 1.9 million pounds and 1.7 million pounds, respectively [R-28].

2.3.3.2 Lake Water Levels

The reference point for measuring Great Lakes water levels, chart datum for Lake Huron, is 176.0 m above sea level. The mean water level in Lake Huron at Goderich is at an elevation of 176.4 m [R-19]. The approximate daily maximum and minimum mean levels have been reported at 177.2 m and 175.6 m, respectively [R-29]. However, seiches built up by atmospheric pressure differentials across Lake Huron may cause the lake level to vary up to 0.6 m from the extreme levels reported.

2.3.4 Current Use of the Adjacent Land

The Bruce Power site is located within the Municipality of Kincardine in the County of Bruce. The 932-hectare Bruce Power site has been undergoing development on a continuous basis since the initial clearing of land in 1960 for the building of the Douglas Point NGS. The Bruce property, with the exception of certain retained lands, was leased to Bruce Power by OPG in May 2001. The entire Bruce property is fenced and access to the Bruce Power site is restricted and controlled by Bruce Power security personnel [R-21].

Within the Bruce Power site boundaries, existing land uses consist of buildings, structures and transportation access required to operate and support BNGS A and B, and OPG's various waste operations. Douglas Point NGS, the first NGS built at the Bruce Power nuclear site, has ceased commercial operations, although it is still a licensed facility [R-21]. The Bruce Heavy Water Plant (BHWP) and SSTF, both located on the Bruce Nuclear Site, were shut down and decommissioned (see also Section 3.4.3.1).

Buildings and structures on the site include a variety of low rise office, warehouse, maintenance, and storage facilities, as well as structures designed specifically for the technical functions required for the generation and transmission of electricity. A fire fighting training area and a firing range used by security personnel for training are also located on the site. About one half of the property remains covered with vegetation ranging from open fields to second growth woodland. There are no other land uses within the Bruce Power site boundary [R-21].

There are 394,065 ha of land in Bruce County. Land use in the surrounding area falls into two general classifications. Along the shoreline, the land is a vacation area while inland it is primarily used for agriculture. Of the agricultural land, 68% was used for crop production (primarily grain and oilseed) and about 21% was used for pasture [R-19].

There is a non-residential boundary around the site. Land use adjacent to the Bruce Power site is consistent with the rural development within the township, consisting of agriculture, recreation and rural residential development. OPG owns a considerable amount of land adjacent to the Bruce Power nuclear site, creating a non-resident buffer consisting of mainly unoccupied bush and/or swamp and, to the south, the Inverhuron Provincial Park.

A privately owned industrial development of 240 hectares is located 2 km east of the Bruce Power site at the Bruce Eco Industrial Park, previously referred to as the Bruce Energy Centre (BEC).

Lake Huron is used locally for sport and commercial fishing, as well as recreational swimming and boating. Cottages, campgrounds, beaches and marinas are located along the shoreline. The lake provides the water supply for the adjacent municipalities.

A significant number of wind turbines are located in the Bruce County. However, these wind turbines have no major implication on the operation of the BNGSs [R-19].

2.3.5 Local Communities

The population of nearby communities in 2016 is presented in Table 2-1 [R-19], [R-30]. Today's diverse community has a population of over 63,000 and the main industries are energy, tourism and agriculture. The 2016 Census data shows a slightly increasing population in the vicinity of the station; the rate of change in population was 3.0% during the period (2011-2016) [R-19].

In 1999, Tiverton, Bruce Township, Kincardine and Kincardine Township were amalgamated to become the Municipality of Kincardine. In addition, as of January 1, 1999, Port Elgin, Saugeen Township and Southampton were amalgamated to become the Municipality of the Town of Saugeen Shores.

The permanent population in the Town of Saugeen Shores is expected to increase by nearly 50 percent or 17,000 people over the 20-year planning period (2021 to 2041) [R-31]. A slight increase in the number of seasonal residents in the Town is also expected, and there is potential for significant growth in the Town's tourist population [R-32]. Within a 5 km radius of the Bruce Power site, there are approximately 60 homes (permanent and seasonal cottages) located around the Scott Point area, and approximately 450 permanent and seasonal residences (only about 200 are permanent) located in Inverhuron [R-21].

On January 1, 1999, the Townships of Arran and Elderslie, the Villages of Paisley and Tara and the Town of Chesley became the Corporation of the Municipality of Arran-Elderslie. The Municipality of Arran-Elderslie is located in southern Bruce County, along the eastern boundary separating Grey and Bruce. The Municipality contains some of the best farmland that the County has to offer [R-33].

The Township of Huron-Kinloss was created in January 1999 through the amalgamation of the Township of Huron, the Township of Kinloss, the Village of Lucknow and the Village of Ripley. The Township is primarily an agrarian community; yet substantial urban type development is located along the shore of Lake Huron. In the geographic centre of the Township is the (former) Village of Ripley and along its south border is the (former) Village of Lucknow. The community of Ripley, one of two urban centres within the municipality, provides a range of retail and commercial services [R-34].

The Municipality of Brockton in Bruce County was formed on January 1, 1999. In 2016, the population was 9,461 [R-35]. It includes the former township of Brant, former township of Greenock and the community of Walkerton. Brockton's name was formed as an acronym of the three merged municipalities (Brant, Greenock & Walkerton). Since 1900, the community has remained relatively stable in size; however, the industrial base has changed from an agricultural-based local economy with related manufacturing to a more diversified local economy based on manufacturing and government administration [R-36].

In the 1960s, Atomic Energy of Canada Limited established Canada's first commercial CANDU reactor (Douglas Point) in Bruce Township. This created an economic boom, providing the skilled work force with steady, high paying jobs.

The economy of Bruce County is diverse and includes agriculture, tourism, recreation, services, small manufacturing and some resource extraction. Bruce County has approximately 3,750 farms that generate more than $255M in gross sales annually [R-21]. Agriculture operations include growing of corn, soybeans, string beans, canola and winter wheat. County farms also produce beef, lamb, pork, elk, bison and emu. In addition, Bruce County is home to horse breeding and training as well as wine production. Agriculture is complemented with a variety of support and processing industries, making the agriculture sector not only a significant economic activity for Bruce County but an important contributor to overall farm production in Ontario [R-37].

Table 2-1: Population of Nearby Communities

Community	2016 Population
Kincardine	11,389
Arran-Elderslie	6,803
Huron-Kinloss	7,069
Brockton	9,461
Saugeen Shores	13,715
Saugeen 29	1,041
South Bruce	5,639
South Bruce Peninsula	8,416
Total	63,533

The largest industry in the Bruce County is tourism, contributing about $327M annually from 2.5 million visitors in 2019 [R-38]. Bruce County is recognized for its diverse natural beauty with over 850 km of Great Lakes shoreline, the Saugeen River and many other inland lakes and rivers. The tourism industry in Bruce County employs more than one in seven of the working population. Local service clubs, agriculture societies and community non-profit groups organize over 700 events annually that attract tourists [R-21].

Bruce County has a thriving manufacturing, retail and service industry, which contributes significantly to Ontario's total Gross Domestic Product of $848B in 2020 [R-39]. The manufacturing sector of the economy employs approximately 2,215 people in Bruce County [R-40]. The majority are employed by small manufacturing businesses with fewer than 10 employees. The largest sector by labour force is the utilities industry, with approximately 4,530 employees [R-40]. One of the major industrial developments within Bruce County is the Bruce Eco Industrial Park, which is an industrial and agricultural park, established in 1986 by a consortium of private companies, together with (former) Ontario Hydro and the Ontario Energy Corporation. It is located immediately southeast of the Bruce Power site. The Bruce Eco Industrial Park was designed as an industrial ecopark, where waste and by-products of one industry could become the feedstock for a neighbouring industry. As of 2021 June, 11 companies operate in the Bruce Eco Industrial Park [R-41].

The waters of Lake Huron are used for sport and commercial fishing. Sport fishing, in the lake itself as well as the tributary streams and lake bays, is increasing with the growth in tourist activity and the improvement of beach facilities. The commercial fish production varies from year-to-year (see 2.3.3.1); almost all of the catch is exported to the northeastern United States [R-21]. Lake Huron also provides the municipal water source for several of the municipalities along the shore.

Cottages, resorts, beaches and marinas are located along the shoreline focused around the communities of Kincardine and Port Elgin. Within a 5 km radius of the Bruce Nuclear Site, there are approximately 60 homes (permanent and seasonal cottages) located around the Scott Point area, and approximately 450 permanent and seasonal residences (only about 200 are permanent) located in Inverhuron. Farm and non-farm residents are also dispersed along concession roads. Hunting is a popular activity in the area surrounding the Bruce Site. Typically, hunters from the local population and some hunters from outside the area hunt within 5 km of the Bruce Site [R-19].

The south Bruce County area enjoys a full range of services and facilities, including health and education facilities. The South Grey Bruce Health Centre (Kincardine Hospital) provides in- and out-patient services. Along with a number of public secondary and elementary schools, the area has one of two nuclear teaching facilities in Ontario, which trains Bruce Power staff in operation, maintenance and safety aspects of CANDU reactors [R-21].

Following the Fukushima incident in 2011, the Bruce Nuclear Site is the largest energy production centre in the world. Since the early 1980s, major construction activity has declined and the level of employment on the site has varied. Although the site’s dominance in the local economy has decreased, operations at the Bruce Nuclear Site remain the major economic influence in the area. The Bruce Nuclear Site is Bruce County’s single largest employer. In 2021, employment at the Bruce Nuclear Site included approximately 4,000 Bruce Power employees [R-42]. Approximately 150 people are employed at the WWMF site. Approximately 90 percent of the workers employed at the Bruce Nuclear Site live in Bruce County, and more than 75 percent of employees reside in the Municipality of Kincardine or the Town of Saugeen Shores [R-21].

Contracts are also issued to businesses across Canada and internationally for a wide variety of goods and services that are required at the Bruce Power site. Although an important source of revenue, most local suppliers to the Bruce Power site are not dependent on the site for the majority of their annual revenues. The majority of local business operators credit the Bruce Power site as contributing positively to local economic stability and growth, largely in terms of employment and the spin-offs associated with employee spending. The population growth in certain townships and the resulting positive effects on these communities can be attributed to Bruce Power's plans for extending the operating lives of its units.

OPG pays taxes to the Municipality of Kincardine for the Bruce Power site. In 2020, OPG paid $5.1M in Property Tax (to the Municipality of Kincardine) and an additional $6.8M in Proxy Tax (to the Province of Ontario). This excludes municipal taxes paid by OPG for the WWMF.

2.3.6 Indigenous Communities

The traditional territory of the Ojibway in the Saugeen region covers the watersheds bounded by the Maitland River to the south and the Nottawasaga River east of Collingwood on Georgian Bay. The area includes the Bruce Peninsula, all of Grey and Bruce Counties, and parts of Huron, Dufferin, Wellington and Simcoe Counties. The Bruce Nuclear Site is located within this traditional territory [R-21]. The SON is the collective name for the two First Nations communities with reserve lands in the area. The Chippewas of Saugeen First Nation and the Chippewas of Nawash Unceded First Nation share the same Indigenous and treaty rights, including rights to fish commercially in the waters around the Bruce Peninsula.

The Chippewas of Saugeen First Nation is located adjacent to the town of Southampton, about 30 km north of the Bruce Power site. In April 2021, the population of this reserve was estimated at 797, many within the traditional territory in Bruce County [R-43].

The Chippewas of Nawash First Nations is located on the east shore of the Bruce Peninsula, north of the Town of Wiarton. In April 2021, the population on this reserve was estimated at 721 [R-44], many within the traditional territory in Bruce County.

Métis peoples in Ontario are distinct Indigenous people with a unique history, culture, language and territory that includes the waterways of Ontario, surrounds the Great Lakes and spans what was known as the historic Northwest. The Métis people do not comprise one settlement; rather they are mobile regional communities that are not tied to a land base.

The Métis people have traditionally lived alongside the SON, hunting, fishing, harvesting and trading. According to the 2016 Census information from Statistics Canada, 690 Métis persons reside in Bruce County [R-45] and 1005 reside in Grey County [R-46]. The Métis people participate fully in the community, and are integrated into the regional population.

The First Nations and the Métis make significant use of Lake Huron for traditional and commercial harvesting of fish. The First Nations' economies also rely on tourism, agriculture, construction, cottage rental, native craft manufacture and sale. Both the

Saugeen and Nawash First Nations have developed a wide range of community services. They obtain water from on-reserve wells, from the lake or nearby communities. Their ongoing use of their traditional lands and waters includes personal and communal commercial harvesting of traditional foods and medicines [R-21].

OPG has a board-level Indigenous Relations Policy [R-47] and active community relations program that focuses on:

- Community relations and outreach;
- Building support with communities;
- Employment and business contracting opportunities; and
- OPG staff education.

Building positive, community-minded relationships with Indigenous communities is important to OPG with respect to both current operations and decommissioning planning.

2.3.7 Community Relationships

Since the 1970s, there has been a mostly positive working partnership with the local communities. The community impacts that resulted from the large construction workforce and the construction-related activities were recognized and impact grants were institutionalized in 1975. These continued until the end of 1998. Liaison committees were established and issues have been resolved within a joint planning approach since that time. Many employees from the Bruce Power site have been active in civic affairs over the last 30 years, contributing to the local community.

Integrated communications and regular community liaison activities are conducted. The purpose of the external communications program is to maintain and improve community relationships and build general community awareness of the nuclear operations. The program includes education, outreach, corporate citizenship and emergency preparedness. A range of communications vehicles are used, including e-newsletters, social media, tours, open houses, regular meetings, presentations and displays at the Bruce Power Visitor’s Centre.

Bruce Power has a long history of engaging and supporting local communities surrounding the Bruce Nuclear Site. Bruce Power’s engagement with local communities and Indigenous groups is supported by its Public Disclosure Protocol, its Indigenous Relations Policy, and its relationship/engagement agreements with the three Indigenous groups: the SON, the Georgian Bay Métis Nation of Ontario and the Historic Saugeen Métis [R-18]. OPG also supports developing good community relationship and believes in open and transparent communication in a timely manner, in accordance with CNSC REGDOC-3.2.1 [R-7]. As such, OPG regularly and proactively provides information to the public on operations and projects. As mentioned in Section 2.3.6 OPG Nuclear also has an active indigenous relations program.

Both the Chippewas of Saugeen and the Chippewas of Nawash First Nations have described their traditional territories to include the land and waters surrounding the Bruce Power site and extending in both directions along the Lake Huron shoreline, out into the lake and inland. They have also indicated their intent to continue use of their traditional lands and waters.

Through joint processes with the First Nations, OPG has resolved issues with lands affected by the expansion of the WWMF to accommodate the Used Fuel Dry Storage Project and provide protection and access to the Indigenous peoples burial ground within the Bruce Power site. In the early 1970s, Ontario Hydro identified an 'Indian Burial Ground' within the Bruce Power site. As a result of joint council meeting with the Chippewas of Saugeen in 1998, it was resolved that the site be known as 'Jiibegmegoong' (Spirit Place). OPG reached agreement with First Nations for the on-going care of the burial ground within the Bruce Power site and access to the ground for ceremonies.

While leasing the stations from OPG, Bruce Power also continues to reach out to Indigenous communities, collaborates on important agreements that signify an unwavering commitment to communicate, respect and learn about each other's values, and continuously improves this growing relationship. Bruce Power hired a Director, Indigenous Relations and Business Partnerships in 2018 to lead its engagement with Local Indigenous communities and this includes developing economic activity that will benefit Indigenous people with the stability, health care opportunities, prosperity and growth that supports their ongoing Indigenous employment programs.

In 2019, Bruce Power entered into a collaboration agreement with SON to explore ways of jointly marketing new isotopes in support of the global fight against cancer, while also working together to create new economic opportunities within the SON territory. The partnership will use the made-in-Ontario Isotope Production System (IPS) installed into Bruce Power's nuclear reactors to produce Lutetium-177 (Lu-177) and other isotopes used in the diagnosis and treatment of cancers in hospitals around the world.

Bruce Power has had Indigenous policy in place since April 2012 that identifies its commitment for positive relationship with Indigenous groups and communities [R-48].

Bruce Power is focused on maintaining and enhancing open and honest dialogue with its First Nation and Métis partners with a focus on communicating the company's plans, seeking paths that benefit all parties, and enhancing its already-strong environmental practices to ensure the safety of the land, water and natural resources that are integral to the Indigenous communities. OPG also carries out these types of communications and liaison activities, building awareness of the separate OPG waste management operations.

In addition, joint studies of the Lake Huron whitefish population traditional food fishery diet study have been carried out to create a common scientific understanding of these fishery issues and, if necessary, create a foundation from which to develop an ongoing monitoring plan for the future.

The Indigenous Relations Policy, OPG-POL-0027 [R-47], describes OPG's commitment to work with Indigenous communities and peoples, proximate to OPG's present and future operations, and to develop positive and mutually beneficial relationships that will create social and economic benefits through partnership and collaboration. This policy governs OPG's engagement with Indigenous peoples with respect to decommissioning planning for BNGS.

The Nuclear Public Information and Disclosure Standard, N-STD-AS-0013 [R-49], identifies Indigenous communities and peoples as one of the target audiences, among others, for regular and targeted communication through the Public Information protocol.

OPG's Centre for Canadian Nuclear Sustainability (CCNS) is focused on community and stakeholder communications and relationships specifically related to decommissioning. The CCNS communication program is integrated into OPG's existing public information program and focuses on research and development, innovation and collaboration in decommissioning. It holds meaningful interaction with CCNS partners, committees, Indigenous communities and the broader community through a variety of channels including social media, Neighbours Newsletter, community presentations and events, and collaboration with the Community Advisory Council. The CCNS also has its own website, www.theccns.com, which provides online access to the general public about CCNS projects and opportunities to engage with the CCNS team.

Every year Bruce Power runs at least fifty (50) drills, including a CNSC evaluated exercise. The CNSC has consistently rated Bruce Power's emergency response capabilities as fully satisfactory. Every three years, Bruce Power also prepares, coordinates and participates in a provincial nuclear emergency exercise, which includes internal and external stakeholder participation to test Bruce Power's emergency response capability as per the Provincial Nuclear Emergency Response Plan. The most recent provincial exercise was Exercise Huron Resilience in October 2019. The next provincial exercise is Huron Endeavour is planned for October 2022. The Community Emergency Management Coordinator for Kincardine maintains a call-down list for all households (approximately 35-40) within a three-kilometre radius of the site perimeter in case emergency response action is necessary. The area is also served by warning sirens which are fully tested annually. People in this area are provided information regarding the required response should these sirens sound and given annual reminders. Under CNSC's mandate, Bruce Power, in partnership with the Grey Bruce Health Unit and regional municipalities, made Potassium Iodide (KI) tablets available to all residents, schools and businesses within a 50 km radius of Bruce Power in 2015. Those within a 10 km radius received the tablets, while those further from the facility received coupons and information on KI [R-50].

2.4 History and Future Outlook

Construction of BNGS A started in 1969 on a site about 1.5 km from the current location. Work was soon stopped and the station was relocated to its current site. Construction resumed the following year. The first two units (Units 1 and 2) went into commercial service in September 1977, followed by Unit 3 in February 1978 and Unit 4 in January 1979.

In the late 1990s, the former Ontario Hydro made a business decision to temporarily lay-up BNGS A. Unit 2 was shut down in October 1995, followed by Unit 1 in October 1997, Unit 4 in March 1998 and Unit 3 in April 1998. The station was placed in a state consistent with the Electric Power Research Institute specifications for plant lay-up. The nuclear systems were maintained in a standard state for shutdown reactors, with essentially all of the systems left in service. Unit 4 returned to service on October 7, 2003, and Unit 3 returned to service on January 8, 2004. Units 1 and 2 have been refurbished and were returned to service in 2012.

Construction of BNGS B started in 1975. The first unit (Unit 6) went into commercial service in September 1984, followed by Unit 5 in March 1985, Unit 7 in April 1986 and Unit 8 in May 1987. The four BNGS B Units are in service.

Bruce Power is currently planning a refurbishment program, also referred to as Major Component Replacement, that will take place from 2023 to 2027 for BNGS A (Units 3 and 4) and from 2020 to 2033 for BNGS B (Units 5-8).

Bruce Power is also expecting to start Lutetium-177 (Lu-177) production using the IPS within the next few years subject to obtaining appropriate regulatory approvals. The radionuclide Lu-177 produced using the IPS will be transported to an offsite processing facility and then distributed to medical facilities to treat advanced cancers. Initially, operation of the IPS is planned for a single unit, beginning with production of Lu-177. The same or very similar systems may additionally be installed in other units, and the IPS(s) may be used to produce additional isotopes in the future, in accordance with business needs.

The End of Life of BNGS A and B Units are provided in Section 1.5, with the assumption that these units are refurbished and are expected to remain in service 30 years post refurbishment.

3.0 PRELIMINARY DECOMMISSIONING PLAN

3.1 Scope of the Decommissioning Plan

This plan describes the preliminary plan for the decommissioning of BNGS A and BNGS B, along with all of the associated buildings and structures located within the nuclear licensed area of the station. This includes but is not limited to the following groups of buildings:

- The Reactor Buildings;
- The Reactor Auxiliary Bays;
- The Vacuum Building;
- The Pressure Relief Duct;
- The Powerhouse (including the Turbine Hall and the Turbine Auxiliary Bay);
- The Central Service Area;
- The Ancillary Service Building;
- The Pumphouses, the Old Water Treatment Building (BNGS A) and the Water Treatment Building (BNGS B);
- The Standby Generator Buildings; and
- All other small buildings, including the ECI Accumulator Building, aboveground storage tanks and structures located inside the fenced area.

A full list of buildings that has been considered when developing the cost estimates for decommissioning (as detailed in Section 5.0) is provided in Table 3-1. This plan is considered as the site[9] PDP as it takes into account the interfaces of the WWMF and the small facilities with the BNGSs, as described in Sections 2.2.8.1 and 2.2.8.2 respectively. The impact of decommissioning the BNGSs may have on these facilities are further described in Section 4.0, while the details for decommissioning of the WWMF, or any buildings associated with the operation of this facility, and the small facilities are provided in their respective PDPs [R-1], [R-2].

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

[9] Per CSA N294:19 [R-5], a site is defined as: “the immediate area containing the nuclear facility including the exclusion zone (if any) and under the control of the operating organization”.

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

Location Str #	Bruce A Building Name
n/a	Powerhouse Units (1,2,3,4,0A)
100	Construction Retube
101	Vacuum
102	Ancillary Services
103-106	Pumphouse 1,2,3,4
107	Old Water Treatment Plant
108	New Water Treatment Plant
110	Amenities Building
111	East Services Area Building
114	EFADS/ Post Accident Radiation Monitoring System (PARMS) Bldg
121	Accumulator Building
126	Active Liquid Waste Tank
128	High Pressure ECI Grade Level Tank & Building
129	Fuel Oil Storage Tanks (2)
130	U4 Standby Generator Building
131	U3 Standby Generator Building
132	Standby Generator Fuel Oil Pumphouse
133	U2 Standby Generator Building
134	U1 Standby Generator Building
137-152	Transformers
153	N_2 Storage Tank
154	Lube Oil Storage Tanks
155	CO_2 Storage Building
156	H_2 Storage Cylinders
157	Demineralized Water Tanks
159-161	Spare Transformers
165	Main Security Building
167	Emergency Vehicle Garage
112	Women's Change Room Building
884.1, 884.2	New 14,000 sqft warehouses near B16
995	New 120,000 sqft storage and industrial workspace
-	New security guardhouse at Bruce A (in addition to the existing one)

Location Str #	Bruce B Building Name
n/a	Powerhouse Units (5,6,7,8,0B)
200	Vacuum Building
201	Ancillary Services Building
203	ECI Water Storage Tank & Building
204	ECI Accumulator Building
206	EFADS Building
207-210	U5-8 Pumphouse
211	FO Storage Tank (2)
212	FO Storage Tank (2)
213	Emergency Water & Power Bldg
214	Compressed Gas Storage
215	U5 Standby Generator Building
216	U6 Standby Generator Building
217	Units 5 & 6 FO Pumphouse
218	Chemical Waste Storage
219	Water Treatment Building
220	Bruce Nuclear Power Development Site Pumphouse
221-236	Transformers
239	H_2 Storage Cylinders
240	Unit 0 Demin Water Tanks (2)
241	Spare Transformer
247	East Service Area Building
248	Unit 7 Standby Generator Building
249	Unit 8 Standby Generator Building
250	Units 7 & 8 FO Pumphouse
254	Spare Dist Transformers
255	FO Storage Tanks (2)
246	Main Security
266	Security Garage
884.1, 884.2	New 14,000 sqft warehouses near B16
278	New building adjacent to Bruce B - Replaced the U8 Annex
277	New security guardhouse at Bruce B (in addition to the existing one)
-	Reconfiguration of the Bruce B security fence

3.2 Objective of the Decommissioning Program

The objective of the decommissioning program is to permanently retire BNGS A and BNGS 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 use.

3.3 Decommissioning Phases

According to CSA N294:19 [R-5], 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 BNGSs and results in the preparation of a decommissioning strategy (Section 3.4) and a PDP (i.e., this document). The BNGSs are currently considered to be in ‘Phase 1 – Planning for Decommissioning’, per CSA N294:19 [R-5].

(b) **Phase 2, Preparation for Decommissioning:** For planning purposes, it is expected that each unit at BNGS will be shut down per the schedule in Section 1.5. After all the units at BNGSs are permanently shutdown, they will be defueled and dewatered. OPG will then make all the necessary modifications to the Structures, Systems and Components (SSCs) to prepare for the subsequent SWS period; this phase will end when the units enter into SWS stage. 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 licence to perform decommissioning activities will have been received from CNSC and the DDP that was prepared in Phase 2 will be implemented. The BNGSs 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 stations 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 and Dismantling & Demolition of the facility) and the site restoration.

(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 takes place and release from regulatory control is requested from the CNSC.

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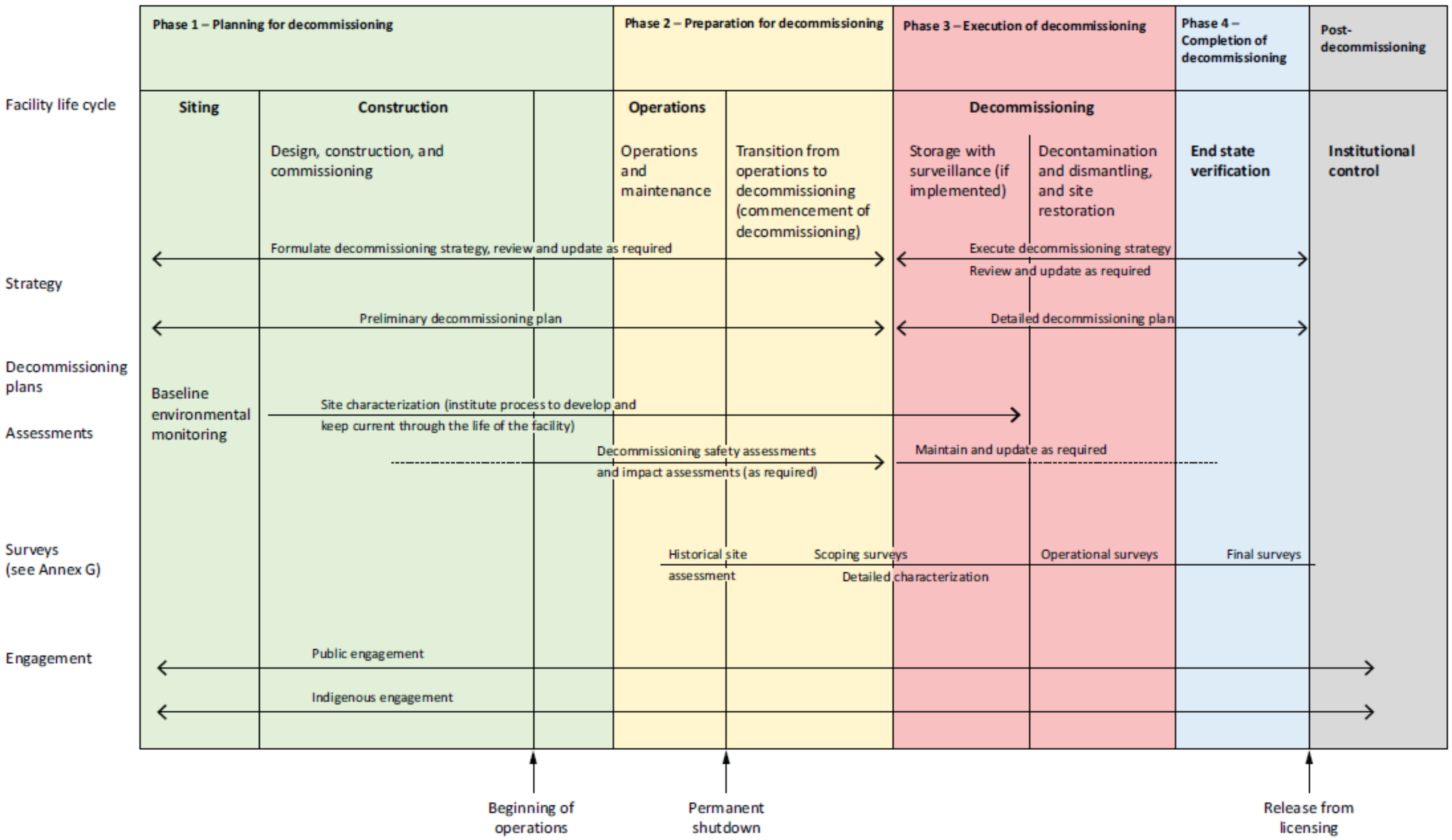

Time interval shown denotes the applicability of the plans and not the time when they are developed

Legend:

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

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

Figure 3-1: Phases of Decommissioning [R-5]

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3.4 Decommissioning Strategy

3.4.1 Decommissioning Strategy Adopted by Ontario Power Generation

OPG has chosen a decommissioning strategy that is considered to minimize both the occupational radiation dose to staff and the potential exposure of the public and the environment. It is known as the 'Deferred Decommissioning' strategy.

The main feature that distinguishes the decommissioning of a nuclear station from that of any other large industrial plant is the radiological hazard. At shutdown, major activation radionuclides such as H-3, Fe-55, Fe-59, Ni-63, Ni-59, Nb-95, Zr-93, Zr/Nb-95 and Co-60 will be present in the systems and equipment subject to neutron flux, but also carried to other portions of the systems not subjected to the flux (such as throughout the heat transport and moderator system). Contamination fission products will also be present in the reactor cooling systems from defect fuel and tramp uranium: radioiodines, xenons, Sr-90, Tc-99, Ru-106 and Cs-137 typically. Additionally, actinides may be present in the PHT from defect fuel particulate and tramp uranium. Whereas the activation radionuclides in the fixed structure of the reactors may be estimated by calculation, the contamination nuclides will need to be measured via sampling and in-situ measurements to complete the inventory.

Co-60, Zr/Nb-95 and Sb-124 are the principal gamma emitters associated with reactor surfaces. Co-60 is usually the dominant contributor to radiation levels during operation and into shutdown. Co-60 is found in activated steel structures (reactor core) and as a corrosion product in nuclear process systems. Co-60 is a strong gamma radiation emitter with a relatively short half-life of 5.3 years and remains the dominant radiological hazard for several decades after shutdown. After about 30 years of decay, the level of Co-60 activity would be reduced by a factor of approximately 60 and its contribution to the radiation fields would also be reduced.

Dismantling the radioactive parts of the stations are considered to be the most challenging and labour and cost intensive activities involved in decommissioning. Hence, reducing the amount of radiation exposure to workers, public and the environment was one of the most important factors considered when OPG was developing the strategy for decommissioning.

Three decommissioning options were considered, consistent with CSA N294:19 [R-5]:

(a) **Prompt Decommissioning**, where the reactors and stations would be decontaminated and dismantled and the site restored promptly after shut down.

(b) **Deferred Decommissioning**, where the reactors and stations would be safely stored for several decades after shut down 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.

CSA N294:19 also allows a combination of the above strategies. A combination of options (a) and (b) will result in a phased decommissioning strategy, where decommissioning proceeds according to a sequence of dismantling activities and periods of SWS, according to the prevailing conditions, e.g., resource availability, safety, environmental and stakeholder conditions.

Deferred decommissioning strategy was selected on the basis of decommissioning planning studies that OPG started in the 1980s. This strategy was chosen based on the following considerations and benefits:

- Minimizes dose/radiation exposure to workers consistent with the As Low As Reasonably Achievable (ALARA) principle. This in turn reduces cost of dismantling activities due to substantially lower radiation levels. Reducing the amount of radiation exposure to workers, public and the environment was one of the most important factors considered when OPG was developing the strategy for decommissioning.

- Gives time to implement long-term disposal strategies for used fuel and L&ILW.

- Allows continued growth of the decommissioning fund to help moderate price of power as a result of future expenditures vs. expenditures in the present.

- Lower classification of radioactive waste is achieved through natural radiation decay. The reduction in dose allows the ALARA goal to be met. This additionally lowers waste management costs associated with handling, packaging, shielding, transporting and disposing of waste.

- Efficiencies as a result of technological development in the area of decommissioning and nuclear waste management, and benefit from industry decommissioning experience.

Studies performed by OPG showed that the Prompt Decommissioning option would incur higher costs and result in higher occupational dose. The studies also showed that dismantling costs and occupational dose would fall over time, thus favouring the other two options: Deferred Decommissioning and In-situ decommissioning. However, the current post decommissioning plans for the Bruce Nuclear Site are for OPG's re-use, therefore In-situ decommissioning strategy was not considered further. The following subtle strategy modifications to the Prompt Decommissioning option (a) and Deferred Decommissioning option (b) were also evaluated but was not pursued further [R-51]:

- Immediate Dismantling of the Units, Deferred Dismantling of the wet bays after used fuel is transferred; and

- Deferred Dismantling where dismantling of the unit starts immediately after the removal of all used fuel from the station.

When the three options (a) - (c) described above were compared, it was concluded that Deferred Decommissioning, entailing a SWS period, was currently the most suitable option for decommissioning OPG's NGSs. The duration of the SWS period was determined by balancing the reduced decommissioning cost and occupational dose achieved by allowing the residual activity to decay, against the increased social and economic costs of a longer storage period. OPG has determined that a SWS period of nominally 30 years offers a reasonable time to defer dismantling, and the available funding assumes a Deferred Decommissioning strategy for BNGSs [R-52]. This decision will be reassessed periodically in light of experience, cost, changing technology and the possible requirement of the site for other purposes.

3.4.2 Stages in Deferred Decommissioning Strategy for BNGSs

Applying the 'Deferred Decommissioning' strategy, the BNGSs will pass through four distinct stages:

(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))

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

3.4.2.1 Stage 1 – Preparation for Safe Storage

During the Preparation for Safe Storage, OPG will plan and execute the safe transition of the BNGSs from their current (electricity generating) state, to a predetermined SSS. This will take place in two sub-stages:

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

(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 the scheduled shutdown of BNGSs, 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 shutdown of BNGSs. The reactors will be defueled, and each unit will be dewatered, thereby reducing the radioactivity in the reactors by approximately 99 percent. Following defueling, used fuel transfer operations from the IFBs will resume. 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 Stage 2 – Storage with Surveillance

The Safe Storage stage (also referred to as Storage with Surveillance) allows time for the decay of the short-lived fission and activation products that remain in plant components. The specifics of the SWS stage will be outlined in the SSP (refer to Section 1.1 and 4.1.3). During this stage used fuel transfer operations from the IFBs will continue until all the used fuel has been transferred to the WWMF. As such there will be two distinct phases of SWS: SSS (pools) when the used fuel are still in the IFBs and SSS (dry) when the IFBs have been emptied of all used fuel.

3.4.2.3 Stage 3 – Dismantling & Demolition

Following the SWS stage, Dismantling & Demolition are scheduled to occur over a nominal 10-year period. 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.

3.4.2.4 Stage 4 – Site Restoration

During the fourth stage surveys will be conducted to verify that the site meets the release criteria agreed with the CNSC before the remaining buildings and structures are demolished. The site will be restored to a condition suitable for other OPG use. At the conclusion of this work, OPG will apply to the CNSC for release from regulatory control.

3.4.3 Domestic and International Decommissioning Strategies and Experience

3.4.3.1 Domestic Decommissioning Strategies and Experience

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

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

The Bruce HWP was in continuous operation from April 1973 until March 1998, for the purpose of producing reactor-grade heavy water [R-53]. 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 HWP facility boundaries and the remaining structures, equipment and grounds were free of significant radiological contamination. In order to demonstrate that this end state criterion was met, a final radiological survey was performed in 2012 using the MARSSIM methodology [R-54]. This survey found no radioactive contamination on the HWP site [R-55], [R-56] and a licence to abandon the facility was granted by the CNSC in 2014 [R-57].

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 [R-54]. 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 [R-58], [R-59] and [R-60]. This resulted in CNSC acceptance of OPG's request to remove the SSTF from licensing control [R-61]. 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.

Gentilly-2 Nuclear Power Plant (NPP), owned by Hydro-Québec, was shut down in 2012 and is currently in the SSS 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 [R-62]:

- 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 and 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 [R-62]:

- 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).

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.

Canadian Nuclear Laboratories 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 of these but changed to In-situ decommissioning for NPD and WR-1. This strategy has been adopted for small reactors in several countries but has generally not been used for a large power reactor. 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 [R-63]. 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 [R-64]. 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 [R-65], [R-66]. 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.

Within the last 5 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 NPD and WR-1, CNL continues to plan for in-situ disposal of the reactor 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 Calandrias.
- At Chalk River (NRX, NRU, MAPLE-1, and MAPLE-2), decommissioning strategies are being explored to support the revitalization of the site. Where feasible, a prompt decommissioning strategy is preferred to support construction of new Science and Technology research facilities.

OPG has an active decommissioning planning program and maintains links with other utilities on the topic of decommissioning to gain experience on other decommissioning projects.

3.4.3.2 International Decommissioning Strategies and Experience

Decommissioning strategies adopted by the operators of other nuclear facilities around the world vary from Prompt Decommissioning (also 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 [R-67], [R-68] and [R-69]. In summary, some of the reasons to choose Prompt Decommissioning may include:

- Regulatory requirements;
- Government subsidies;
- Costs for maintaining a site in SWS;
- Retention of staff and related expertise;
- Availability of waste disposal facilities;
- Public acceptability;
- Desire for re-use of the sites; and
- Risks related to future uncertainty.

Reasons to choose Deferred Decommissioning may include:

- Unavailability of waste disposal facilities;
- Unavailability of immediate funding and allows time for growth of the decommissioning fund;
- Continued operation of other reactors on site;

- Continued growth of the decommissioning fund to help moderate price of power as a result of future expenditures versus expenditures in the present;

- Reduction in radiation levels during a deferral period that will likely reduce dose to decommissioning workers and the associated cost savings with decreased complexity of the decommissioning due to the likely use of less complex robotic and remote dismantling technologies; and

- Potential for making use of newly developed technologies and taking advantage of additional operating experience.

A review of international practices in decommissioning [R-70] has indicated that Belgium, Germany, Italy, Spain, France and Switzerland are planning for Prompt Decommissioning, whereas Canada, Netherlands and the United Kingdom are planning for Deferred Decommissioning. Japan, Sweden, Finland and the United States are using both strategies for their reactors, with strategy selection dependent upon the site-specific constraints. On average, SWS periods range from a low of 10 years (Japan) to a high of 85 years (United Kingdom) with most nations falling into a 25 to 40 year timeframe.

In the United States, the choice of decommissioning strategy is made by the station owner. Many utilities with multiple units on site choose to delay decommissioning until the final unit has ceased operation. Decommissioning may not occur until 25 to 30 years after the first unit has been shut down. This practice is similar to the OPG strategy. Owners with only one unit tend to start decommissioning within a few years after the end of operation.

Internationally, several small and some full-size power reactors have been successfully decommissioned and the sites made available for other uses. As of December 2019, 186 power reactors worldwide had been permanently shut down. Of these, 19 power reactors have been fully decommissioned and their licences terminated. Decommissioning strategies for these 7 power reactors were as follows: 3 Deferred Decommissioning, 2 Prompt Decommissioning, 1 In-situ decommissioning, and 1 adopted a different decommissioning strategy. Of the remaining 179 power reactors, 63 opted for Deferred Decommissioning, 54 opted for Prompt Decommissioning, 2 opted for In-situ decommissioning, 23 opted for ‘Other decommissioning strategy’ and 37 had not commenced decommissioning and/or did not have a specified decommissioning strategy [R-71].

These industry experiences indicate that the strategy adopted for the decommissioning of BNGSs is technologically feasible and can be completed in a manner that protects the health, safety and security of workers, the public and the environment, consistent with current international practice.

3.5 Predicted Characteristics of the BNGSs at Shutdown

As each station is shut down, it will be transitioned from operations to Stabilization (Preparation for Safe Storage), then SWS, followed by Dismantling & Demolition, and subsequent Site Restoration. The actual station conditions will be characterized, as required, prior to each stage. 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 shutdown is outlined below and more details can be found in Section 8.0 and in Appendix A.

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 IFBs, the activated and contaminated sections of the reactor internals and the components of the 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 IFBs, in the ion exchange resin and columns used in purification of the PHT and moderator systems 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.

In preparation for the decommissioning of BNGSs, a Historical Site Assessment (HSA) is planned 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 stage of decommissioning as per the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) [R-54].

As mentioned in Section 4.1.4.4, post-operational/scoping surveys will be performed when the station is shut down. Characterization surveys will be performed during the Preparation for Safe Storage or during the SWS period, prior to the start of the Dismantling & Demolition stage. 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 will begin by preparing an HSA, and will include various surveys and sampling to assess site radiological conditions. The RSSI will conclude with a Final Status Survey, 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 an electronic database known as the Radiation Hazard Information System. 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. A 'Station Condition Record' (SCR) is used to document, evaluate and correct an adverse condition related to personnel performance, procedure, or programs, and an adverse condition causing or identified as a result of an event. The SCRs are recorded in an electronic database that will also be available for use during the preparation for decommissioning.

Most of the hazardous materials stored on the site (flammable, cryogenic gases, oxidizers, corrosives, etc.) will be consumed during routine station 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 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.

Prior to the lease agreement with Bruce Power, OPG maintained and operated the stations' SSCs in a manner that minimized their deterioration. During the term of the lease, Bruce Power is committed to operating and repairing the station SSCs in accordance with good utility practices, as defined and specified under the lease and in accordance with Applicable Law, conforming to all regulations in respect of radioactive and hazardous substances. In addition, OPG's requirement on Bruce Power is to produce a minimum hand back report annually, which is independently review by experts every 3 years. As a result, it is anticipated by OPG that these SSCs will be in an acceptable condition at the time Bruce Power elects to cease operation and shuts down the unit(s). Individual component condition assessments will be conducted prior to station shutdown.

3.6 Uncertainty and Degree of Conservatism

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

- Planning assumptions;
- Physical, radiological and non-radiological state of the facility;
- Regulatory framework;
- Technical strategy/approach for decommissioning;
- Waste disposition; and
- Stakeholder concerns.

Any 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 also based on a well-established methodology and takes into account a risk contingency to address problems that are likely to occur beyond the project scope (i.e., unknown unknowns), as described in Appendix B. To further address uncertainties, relevant Operating Experience (OPEX) from other sites being decommissioned, industry best practices and the cost estimator's judgement were used for preliminary decommissioning planning.

As mentioned in Section 3.5, a comprehensive site characterization 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 [R-72]:

- Understanding of the conditions of the 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;
- 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, will take into account all identifiable uncertainties and address them as the decommissioning activities progress. The safety assessment should be conservative though not normally unduly, unless this allows the safety assessment to be simplified and gives overall benefit to the decommissioning project. Typical sources of uncertainty as identified in the IAEA Safety Guide WS-G-5.2 include [R-73]:

- 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 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 [R-74].

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 the 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 given in [R-73].

In terms of any uncertainty related to the regulatory framework, OPG maintains good communication protocol with the CNSC and ensures that the PDP meets the regulatory requirements in its licence and Licence Condition Handbook, as described in Section 1.4 and Appendix C.

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

Up until January 2020, the L&ILW Deep Geologic Repository (DGR) has been the long-term disposal strategy for OPG's L&ILW decommissioning waste. The facility was planned to be expanded in 2045 to accommodate the L&ILW generated from decommissioning activities. The L&ILW DGR was planned to be in-service for the purpose of receipt of decommissioning waste in 2050. On January 31, 2020, the SON members voted not to support the L&ILW DGR project. Since then, OPG is not proceeding with the DGR at the Bruce site without SON support. Therefore, OPG is working on alternative long-term disposal strategies for L&ILW decommissioning waste as described in Section 4.4.1.3.

To manage uncertainty related to stakeholder perception for BNGS decommissioning, extensive public and stakeholder engagement activities take place, as described in Section 2.3.7 and 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 the 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 [R-75].

It is also expected that the level of uncertainty of knowledge relevant to decommissioning will decrease with maturity of the decommissioning planning [R-72], 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 BNGSs in respect to each of the four stages described in Section 3.4.2.

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

BNGS A

The anticipated major project milestones for decommissioning BNGS A are shown in Figure 4-1[10] [R-13]. More detailed schedules of decommissioning activities will be submitted to the CNSC as part of the DDP.

Note: Stage 3 in Figure 4-1 combines both Stage 3 (Dismantling & Demolition) and Stage 4 (Site Restoration), as described in Section 3.4.2. Also, planning for dismantling will be done during the SWS stage before dismantling starts.

[10] In both Figure 4-1 and Figure 4-2, Safe Storage is referred to as SWS, which is the terminology that has been used in this document.

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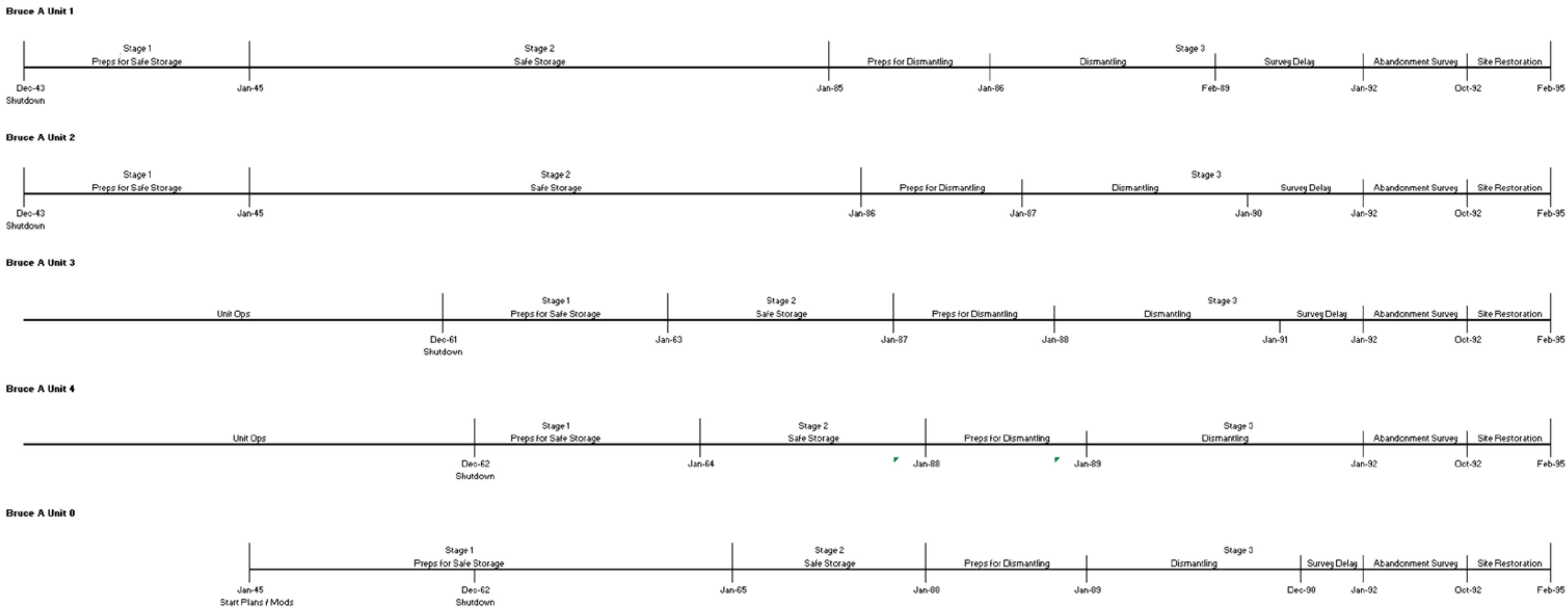

Figure 4-1: Planned Project Milestones Related to the Decommissioning of BNGS A

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For BNGS A, it is assumed that Unit 1 and Unit 2 will be shut down in 2043, followed by Unit 3 in 2061 and Unit 4 in 2062 [R-15].

The Preparation for Safe Storage stage will begin before shutdown. OPG will prepare and submit a DDP or a separate SSP to the CNSC approximately two to five years, prior to the SWS period as part of OPG's application for a licence to perform decommissioning activities. Similar to Pickering Nuclear Generating Station (PNGS), it is anticipated that one year will be required to complete execution of Stabilization for the BNGSs once they have been shut down.

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 and Site Restoration period to nominally 30 years for each unit.

OPG will prepare and submit an updated DDP approximately two to five years to the CNSC, according to the applicable regulatory requirements, prior to the commencement of Dismantling & Demolition, for acceptance. This revised DDP will include a description of the planned Dismantling & Demolition and Site Restoration activities, a corresponding schedule and an estimate of the expected costs. It will also address outstanding environmental impacts associated with the proposed decommissioning scenario – see Section 13.0.

The preparation for Dismantling & Demolition work for the first unit (Unit 1) is expected to begin in 2085 and the execution of Dismantling & Demolition work itself is expected to begin in 2086. Work on the other units will begin at intervals of approximately 1 year. A total of about 3 years will be required to complete the dismantling and removal work for each unit.

As shown in Figure 4-1, the final survey for BNGS A Units 0, 1 to 3 will be initiated in 2092, corresponding to when the last unit at BNGS A, i.e., Unit 4, has been dismantled.

Site restoration of BNGS A will take place from 2092-2095 and is expected to be complete by the year 2095 [R-15].

<u>BNGS B</u>

The anticipated major project milestones for decommissioning BNGS B are shown in Figure 4-2[10] [R-14]. More detailed schedules of decommissioning activities will be submitted to the CNSC as part of the DDP.

Note: Stage 3 in Figure 4-2 combines both Stage 3 (Dismantling & Demolition) and Stage 4 (Site Restoration), as described in Section 3.4.2. Also, planning for dismantling will be done during the SWS stage before dismantling starts.

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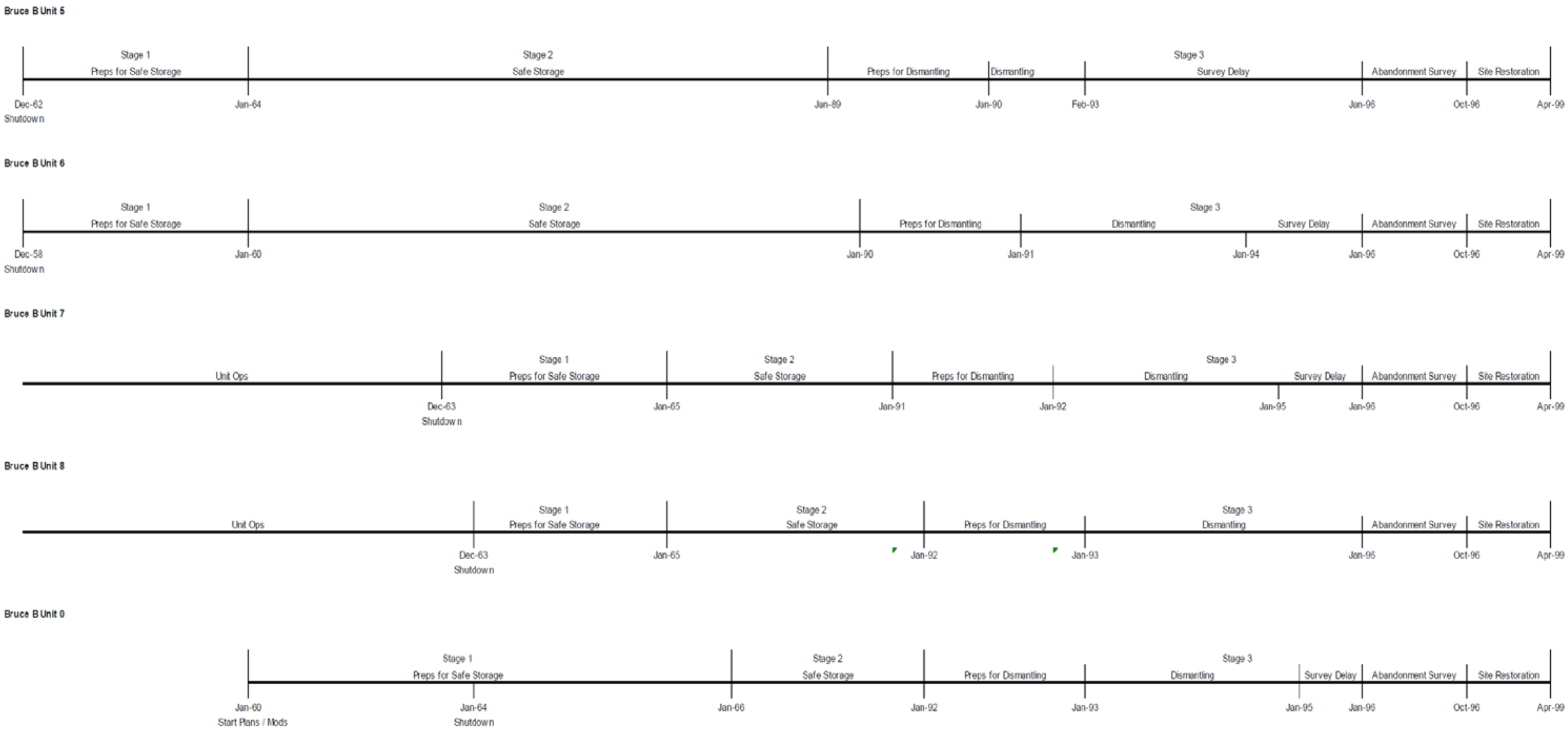

Figure 4-2: Planned Project Milestones Related to the Decommissioning of BNGS B

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BNGS B Unit 6 will be the first unit to be shut down in 2058, followed by Unit 5 in 2062 and Unit 7 and Unit 8 in 2063 [R-16].

The Preparation for Safe Storage stage will begin before shutdown. OPG will prepare and submit a DDP or a separate SSP to the CNSC approximately two to five years, prior to the SWS period as part of OPG's application for a licence to perform decommissioning activities. It is anticipated that one year will be required to complete execution of Stabilization for each of the BNGSs units, except for BNGS A and BNGS B Unit 0 for which two years will be needed, once they has been shut down.

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 and Site Restoration period to nominally 30 years for each unit.

OPG will prepare and submit an updated DDP approximately two to five years to the CNSC, according to the applicable regulatory requirements, prior to the commencement of Dismantling & Demolition, for acceptance. This revised DDP will include a description of the planned Dismantling & Demolition and Site Restoration activities, a corresponding schedule and an estimate of the expected costs. It will also address outstanding environmental impacts associated with the proposed decommissioning scenario – see Section 13.0.

The preparation for Dismantling & Demolition work for the first unit (Unit 5) is expected to begin in 2089 and the execution of Dismantling & Demolition work itself is expected to begin in 2090. Work on the other units will begin at intervals of approximately 1 year. A total of about 3 years will be required to complete the dismantling and removal work for each unit.

As shown in Figure 4-2, the final survey for BNGS B Units 0, 5 to 7 will be initiated in 2096, corresponding to when the last unit at BNGS B, i.e., Unit 8, has been dismantled.

Site restoration of BNGS B will take place from 2096-2099 and is expected to be complete by the year 2099 [R-16].

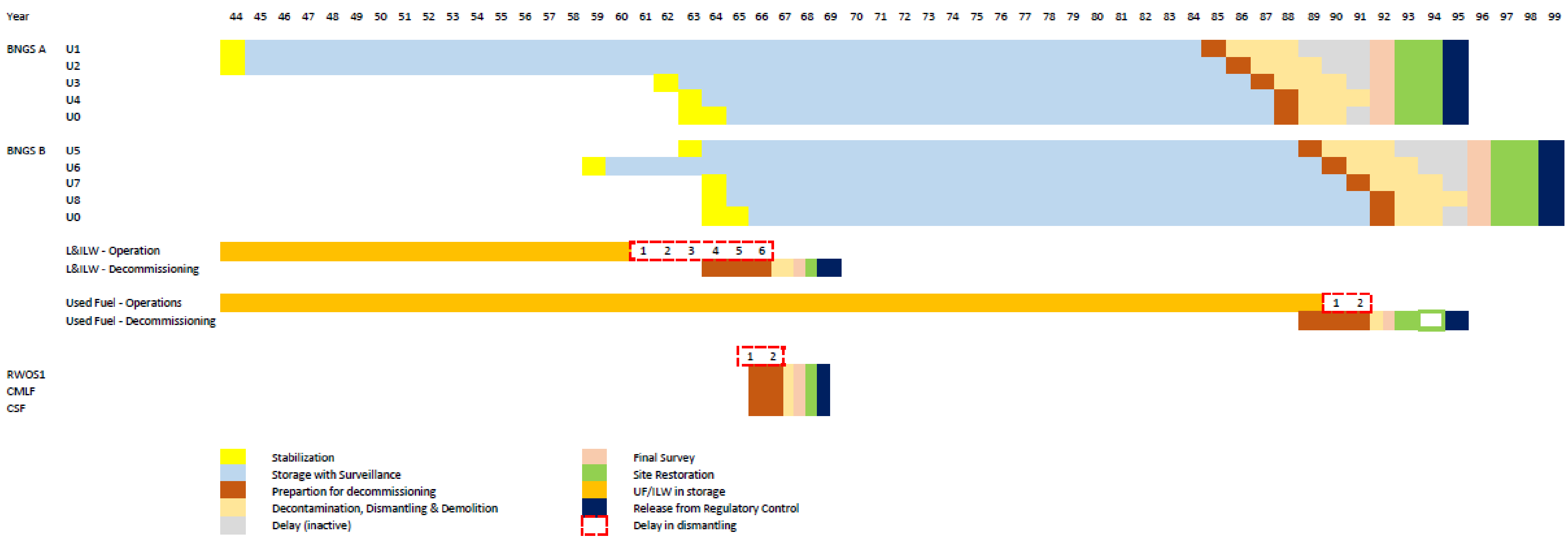
<u>Other Nuclear Facilities on the Bruce Nuclear Site</u>

Figure 4-3 shows the overall decommissioning timeline of the BNGSs, the WWMF and the small facilities (i.e., RWOS1, the CMLF and the CSF).

The L&ILW facility in the WWMF is planned to be decommissioned when most of the BNGSs will still be in operation. Any common services from the BNGSs, as described in Section 2.2.8.1 and 2.2.8.2, are expected to be isolated prior to decommissioning of the L&ILW and the small facilities. Since both the stations and the used fuel facility will be dismantled concurrently, it is not anticipated that there will be any interferences.

The impact of decommissioning the BNGSs on the other OPG-owned facilities on the Bruce Nuclear Site will be further assessed in the BNGSs DDP that will be prepared prior to SWS.

The impact of BNGSs' shutdown on the interfacing systems and services with WWMF and the small facilities, as described in Section 2.2.8.1 and 2.2.8.2 respectively, will be further assessed in the SSP or the DDP (see Section 1.1) that will be prepared prior to SWS (see Section 1.1). Overall, these systems and services will either be maintained or reconfigured to allow the WWMF and the small facilities to continue operating safely after the BNGSs have been shutdown and are decommissioned.



Note 1: Green border text box indicates the possability of site restoration being postponed by the Contractor for overall optimization
Note 2: BNGS facilities are planned to be turned over to OPG in 2065

Figure 4-3: BNGSs Decommissioning Interferences with Other Nuclear Facilities on the Bruce Nuclear Site

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4.1 Preparation for Safe Storage (Stabilization)

It is expected that OPG will utilize a similar approach to that being planned for PNGS Preparation for Safe Storage for BNGSs' Preparation for Safe Storage stage, while accommodating BNGSs' site specific SSCs, and lessons learned will be incorporated, as appropriate.

4.1.1 Preparation for Safe Storage Project Scope

The Preparation for Safe Storage Project (also refers to as Safe Storage Project) will plan and execute the safe transition of BNGSs from its current (electricity generating) state to its predetermined SSS. The SSS refers to the physical, operational and administrative state in which the BNGSs 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 ALARA.

4.1.2 SWS Planning Activities

Work to define the SSS will start prior to 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 and for SWS, taking into account OPEX from Pickering Safe Storage, refurbishment projects, as well as international guidance referenced in Section 1.2.4.

- Confirming the regulatory and system drivers that will determine the operational demands during the SWS period.
- Completing a Predictive Effects Assessment to proactively assess the potential environmental impacts resulting from proposed SWS activities or physical/operational changes to the station. The results of the assessment will identify environmental monitoring studies and/or mitigation measures required to manage the predicted effects.
- Reviewing and revising programs that are in place during operations 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. The plans and protocols, developed during the detailed planning stage, for monitoring the following would be submitted to the CNSC for acceptance and implemented during the SWS period:
  - 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 or service water to the station in the SSS.
- Conducting a system by system review of the plant through end state determination reports to determine which modifications are required to transition the plant to a SSS.
- Developing a safety assessment framework to manage the nuclear and reactor safety aspects of Stabilization activities.
- Engaging stakeholders, including the public, in SWS planning activities.

In support of the Safe Storage Project, a safety assessment will also be completed, including controls and approvals, to facilitate the shutdown and Stabilization of the station. The objectives for the safety assessment will [R-5]:

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, 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

Similar to PNGS, a SOP and SAP will be prepared and submitted to the CNSC prior to entering into the SWS period – see also Section 1.1. In addition, a DDP[3] will be prepared and submitted to the CNSC with the application for a licence to perform decommissioning activities.

The SOP will describe the arrangements and activities that ensure safe and reliable operation of the BNGSs to the end of commercial operation. The SOP will cover the period starting 5 years prior to the final shutdown of the first BNGS operating unit and ending with the final shutdown of the last operating unit. The SOP provides confidence that as the BNGSs 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 the BNGSs 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. 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 phase.

This DDP will be prepared to meet the applicable requirements of CSA N294:19 [R-5] and it will be organized to address the various stages of the decommissioning (Section 3.4.2). For the SWS period (i.e., 3.4.2 (b)), the DDP will address the following in detail:

- SSS (pools), i.e., when the fuel is still in the IFBs;
- SSS (dry), i.e., when the fuel has been transferred to dry storage.

Future stages of decommissioning (i.e., 3.4.2 (c) and (d)) will also be addressed conceptually. The DDP will later be revised to provide additional details in preparation for, and execution of, Dismantling and Demolition and Site Restoration (see Section 4.2.4).

4.1.4 Stabilization

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

The Stabilization activities that will be undertaken as part of the Safe Storage Project will be carried out under the existing Power Reactor Operating Licence and can be performed with currently available technology, while utilizing similar approach and OPEX gained from Stabilization of PNGS. It is estimated that the transition of the stations will take approximately 1-2 years to complete following shutdown of the last unit.

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 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. This will be completed as efficiently as possible to achieve a guaranteed defueled state using conventional defueling practices (utilizing existing fuelling machines) and is expected to take a minimum of 6 months per unit to complete. All fuel removed from the units will be transferred to their respective IFBs for storage and monitoring.

4.1.4.2 Dewatering

Following the completion of defueling activities, each unit will be dewatered and the heavy water will be transferred to a suitable storage facility.

The moderator system will be drained, followed by a light water flush of the moderator heat exchangers and air drying of the calandria to reduce residual contamination. The heat transport system will be drained to Very Low Level Drain State (VLLDS) and then bulk vacuum dried.

4.1.4.3 End State of Stabilization Activities

As Stabilization activities progress, systems that are no longer required to support the operation of the stations 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.

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 documented in the Safe Storage End State Determination Reports (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 will 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 BNGS achieve the conditions prescribed in the End State Declaration reports for Stabilization.

4.1.4.4 Radiation Surveys and Decontamination

Detailed post-operational/scoping surveys will be conducted after BNGS 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 [R-76]. 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 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.
- Removing from the site hazardous chemicals or compressed chemical gases, which are no longer required.

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

4.1.4.6 Site Characterization

OPG will perform characterization surveys during the Preparation for Safe Storage or during the SWS stage to investigate the amount (if any) of contamination present on the BNGS site and to identify the decontamination necessary to reduce occupational exposure for facility maintenance during the SWS period. Characterization of the radioactive contamination remaining in the stations 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 3.5). 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 stations 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 Pickering Preparation for Safe Storage Project, systems required to satisfy operational and regulatory requirements in the SWS stage include:

- IFBs (including sufficient cooling, purification, monitoring equipment, Emergency Mitigating Equipment[11] and the means to continue transferring spent fuel to dry fuel storage containers);
- The WWMF, including the ability to continue to receive, package, process and store DSCs containing spent fuel (Note: The WWMF is included here for completeness, however it is not included in the scope of the BNGS PDP – See Section 2.2.8.1);
- Select heavy water storage tanks located at various locations across the facility for interim storage of the tritiated heavy water (if required);
- Spent resin storage and handling systems;
- Environmental monitoring equipment for intermittent (or continuous) monitoring of selected atmospheric emission 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;
- Low and intermediate level waste management systems, including the means to collect, store, package, and ship low and intermediate level waste generated on site;
- An (alternative) central monitoring and control station; and

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

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

Administratively, programs that will continue to support station operations, organized by Safety and Control Areas 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 [R-77] will continue to be addressed during the SWS:

- Reporting that meets the requirements of CNSC REGDOC-3.1.1 [R-78];
- Public and Indigenous engagement that meets the requirements of CNSC REGDOC-3.2.1 [R-7] and CNSC REGDOC-3.2.2 [R-8], respectively; and
- Financial guarantee that meets the requirements of CNSC REGDOC-3.3.1 [R-79] (which supersedes G-206 the CNSC Regulatory Guide [R-6]).

In all cases, the programs and procedures will be adapted to meet regulatory requirements, while remaining commensurate with the complexity and risks of 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 SWS. Waste from BNGSs during SWS will be processed at the WWMF until it is shutdown. OPG will also maintain the IFBs and associated systems while the fuel remains in the bays, up until the fuel is transferred to the used fuel disposal facility.

During the SWS phase, OPG will perform continuous monitoring and surveillance of the facility to ensure that worker, public and environmental safety is maintained.

The SSP (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, that may result from any animals, plants, fungi or their detritus in the building or from the growth of molds 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 [R-80], 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 [R-81], will be maintained.

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.

Adequate level of security will be provided during SWS. Security during the SWS period will be conducted primarily to prevent unauthorized entry due to the presence of spent fuel on the site. Once all the spent fuel has been shipped off-site to the used fuel disposal facility, 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., that will be maintained in good condition for the duration of this period. Fire and radiation alarms will also be monitored and maintained. A small group of plant staff will be maintained 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.

Fuel will be transferred to dry fuel storage at the end of the cooling period. Consequently, the IFBs will remain in operation through the first part of the SWS period. In order to comply with CNSC and IAEA requirements, safeguards arrangements will be maintained until all of the used fuel has been removed from the IFBs. The defected fuel is planned to be removed last from the fuel bays.

Used fuel will be transferred from the IFBs to the used fuel disposal facility (i.e., APM), which will be available no earlier than 2043. Once all waste has been removed from the IFBs, the following will be carried out:

- Conduct surveys to confirm that no fuel particles remain in the IFBs. 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 IFBs 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 IFBs;
- 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 IFBs for the remainder of the SWS period; and
- With the approval of the CNSC, shut down and remove the safeguards 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 stage, OPG will make detailed preparations for the dismantling of the remaining systems and structures and the disposal of the waste. 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 [R-5]. 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 Decommissioning Contractor(s) will be hired to manage and perform the Dismantling & Demolition and Site Restoration. The activities performed by the Decommissioning Contractor(s) will include, but not be limited to, updating procedures for the characterization surveys, dismantling work, waste packaging, 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 the 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 procedures and sequences for the removal of SSCs;
- Perform a safety assessment to evaluate the processes for decontamination and dismantling the stations, including waste handling, conditioning and on-site processing;
- 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 (fork lifts 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 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, which typically includes but is not limited to:
  - 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;
  - Determine the transport and disposal container requirements for radioactive materials and hazardous wastes including the requirements for shielding and stabilization of the waste;
  - 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; and
  - Assess/investigate decontamination methods such as chemical cleaning, electro polishing, mechanical abrasion or melting. These decontamination methods may be used to decontaminate scrap metal if the reduction in 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 metals that are decontaminated to levels below the clearance levels will be released for recycling in the open market;
- 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.

An Impact Assessments (IA) and safety assessment 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 and 13.0 for additional details on the safety assessment and IA, respectively.

Acceptable site radiological release criteria and clearance levels for decommissioning waste will be developed prior to Dismantling & Demolition. The guidance provided in CSA N292.5 [R-17] will be followed for the application of exemption quantity and 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 [R-17].

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 Buildings and Site Preparation

Building and site preparation work will include activities to prepare the site 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 to determine the extent of site contamination (see also Section 4.1.4.6);
- Clean all plant areas of loose contamination and process all liquid and solid wastes;
- 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 waste including resins, filter media, metallic and non-metallic components generated in dismantling, site security and emergency programs and industrial safety; 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 Section 1.1, a DDP will be prepared and submitted approximately two to five years for CNSC acceptance 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 phase. The DDP will be prepared to meet the requirements of CSA N294:19 [R-5].

The DDP will establish the criteria (clearance levels) that will be used to determine if 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 was 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 done efficiently with safety being the top priority. The Decommissioning Planning Envelopes may include the:

- Reactor Vault;
- Reactor Building;
- Vacuum Building and Pressure Relief Ducts;
- Reactor Auxiliary Bay;
- Turbine Hall;
- Turbine Auxiliary Bay;
- Central Service Area;
- Pump House and Water Treatment Building; and
- Standby Generator Buildings, fuel storage tanks and other small buildings (machine shops, garages, etc.) in the fenced area.

Additional details of the site restoration work will also be included in the DDP.

However, a decision may be taken to dismantle some of the conventional plant in the above list during the SWS period to reduce the 'footprint' of the site and in the interest of maintaining a safe shutdown state.

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. The decommissioning safety assessment will address potential radiological hazards to workers, the public, and the environment, from both routine decommissioning activities and credible accidents during decommissioning. The decommissioning safety assessment will also identify the mitigating methods to address the risks associated with these hazards and any residual risks to the public once decommissioning is complete [R-5].

4.2.5 End State of SWS Stage

By the end of the SWS period, all used fuel, including all defected fuel and all waste in the IFBs, is planned to have been removed from the stations. Radioactive decay will have substantially reduced the residual contamination levels throughout the stations 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 stations 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 regulatory body.

4.3 Dismantling & Demolition and Site Restoration Period

Dismantling work will 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. Remedial action support surveys for radioactive and other hazardous materials will be performed throughout the dismantling work, up to the final survey.

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. Specify 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 are surveyed as they are removed and disposed of in accordance with radiological clearance levels that have been developed (see Section 4.2.2).

(e) Remove the steam generators and pressurizer 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 generators through the steam generator compartment roof slab and the reactor auxiliary bay roof deck. Assuming this method is used, 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. The generators will be disconnected from the surrounding piping and supports, and prepared for removal. The exterior surfaces of the steam generators will be decontaminated as required, interior volume will be filled with low-density cellular concrete for stabilization of the internal contamination and openings (nozzles, inspection hatches and other penetrations) will be welded shut. The steam generators will be segmented prior to disposal as they are considered as large objects, which could exceed the waste disposal facility size/weight guidelines. The segmented sections can then serve as their own disposal containers, provided that all penetrations are properly sealed and the internal contaminants are stabilized.

(f) Remove the pressurizer, 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 of these components will be completed similar to the work done on the steam generators.

(g) At each calandria face, remove the fuelling machine bridge structure and insulated feeder cabinet that enclose the PHT headers and feeder tubes.

(h) Remove the PHT and moderator piping and pumps. Any fuel cladding failure that has occurred or may occur during the lifetime of the plant is assumed to have released fission products at sufficiently low levels that the build-up of quantities of long-lived isotopes (e.g., Cs-137, Sr-90, or transuranics) has been prevented from reaching levels exceeding those that permit the major PHT and moderator system components to be shipped as Surface Contaminated Object or Low Specific Activity waste and to be emplaced within the requirements of the long-term disposal facilities for respective LLW and ILW (see Section 4.4.1.3).

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

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

(k) Segment the calandria/shield tank structure in-situ with a remote cutter and remove the ILW first. Work is directed from a shielded work platform installed overhead in the reactor vault. Parts of the calandria and internal components are expected to be classified as decommissioning LLW, and will be packaged in B-25 waste containers. The 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 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.

- In parallel with the pressure tube and calandria tube removal, begin removal of the steel shot in the calandria faces. Shot removal may have to be coordinated with pressure tube and calandria tube removal to minimize area doses to segmentation crew.

- Transport all waste in suitable containers to the transportation staging area.

- Segment the balance of the calandria structure.

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

(m) 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.).

(n) Remove activated concrete biological shield and accessible contaminated concrete. Remove those portions of the associated enclosures necessary for access and component extraction.

(o) Remove contaminated equipment and material from the Central Service Area, Fuelling Facilities Auxiliary Areas, D_2O facilities, and Vacuum Structure. Remediate contaminated surfaces until radiation surveys indicate that the structure can be released for unrestricted access.

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

(q) 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 4.4.1.3).

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

(s) 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 [R-76]. 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/activation. 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 descaling, 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 planing, scarifying or drilling and spalling).

Large structures will be removed and segmented into smaller pieces at the stations 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 might be used to decontaminate scrap metal if the reduction in 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 “internally clean” but located within potentially contaminated areas are treated as though they are contaminated and disposed of as LLW.

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 levels 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, surveyed and released for uncontrolled disposal. Material deemed to be free from contamination (i.e., below the established clearance levels) 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:

- Remove the equipment from the Pump House;
- WTP;
- 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 4.3.7) 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. The reactor auxiliary bays, reactor vaults, fuelling facilities auxiliary areas, and central service area will be demolished. Any remaining buildings (including buildings that were not contaminated and temporary structures) will be removed using conventional demolition techniques.

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. Internal floors and walls will be removed from the lower levels upward, using controlled blasting techniques. 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 stations.

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 backfill on site if needed.

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

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, which will characterize and prepare the material for release or shipment to an appropriate waste disposal, storage or recycling facility. The estimated maximum size criteria 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 [R-82]). Radioactive, hazardous and conventional wastes will be managed as described in Section 4.4.

4.3.6 Restore the Site

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

- Removing or remediating contaminated soil to meet the regulations for clearing the site as ‘brownfield’ [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;
- Restoring the lake front property (including the water inlets and outlets) 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 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 utility's electrical transmission and distribution system [R-15] and [R-16].

Soil and structural surfaces that are within authorized limits may remain at site following Dismantling & Demolition activities. The Bruce Nuclear site will be shown to meet the final clearance levels in support of release from further regulatory control.

4.3.7 Surveys

A series of surveys for radioactive and other hazardous materials will be performed throughout the course of the Dismantling & Demolition work. MARSSIM-like survey, surveys such as those based on Annex G of CSA N294:19 and any other surveys based on guidelines available at the time of decommissioning will be performed [R-5], [R-54], [R-83]. Several different types of surveys should be performed at different stages of the decommissioning:

- A scoping survey – to determine facility status;
- A characterization survey – to evaluate remediation options and perform risk assessments;
- Operational surveys during the various decommissioning phases, pre- and post-Storage With Surveillance, and Remedial Action Support Surveys during Dismantling & Demolition operations – to control the spread of contamination, assess wastes for category and determine levels of site remediation achieved;
- Final survey (also referred to as the abandonment survey, as shown in Figure 4-1 and Figure 4-2 [R-15], [R-16]) during Site Restoration – to provide evidence that a declared end state has been achieved; and
- A verification survey by an independent party, as may be requested by the regulator – to provide compliance monitoring and to ensure that agreed site remediation levels have been achieved, that will then be used as the basis for release from CNSC 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, impacted and non-impacted areas and provide an estimate of the variability of the contamination (Annex G, [R-5]). 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, [R-5]). Both of the surveys mentioned above will assist with the planning of the decontamination work.

Operational surveys and remedial action support surveys will be performed throughout the dismantling and decontamination process in order to guide and monitor the decontamination work. They are also used to help control the exposure of decontamination workers to radiation and hazardous materials. Operational 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 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 now 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 will describe the survey work that will be performed, the schedule for that work, the methods that will be used to collect and analyze the data and the structure of the final report that will be produced. This plan will also set out the performance criteria for the measurements and analyses that will be performed and the acceptance criteria for data from other sources, such as previous survey work, that will be incorporated into the final survey. The end state criteria set out in the DDP 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 4-1 and Figure 4-2) 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 [R-5]:

- 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 remedial action 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 for in the DDP.

All of these surveys will be performed according to approved procedures that will be based on the recognized standards and guidelines applicable at the time [R-5], [R-54] and [R-83]. 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.

4.3.8 Final End State

By the end of the Dismantling & Demolition and Site Restoration period, the site will be free of industrial and radiological hazards. All of the station SSCs will have been dismantled and all non-essential buildings demolished and site facilities, including the WWMF and the small facilities (CMLF, RWOS1 and CSF), will have been demolished to a depth of one meter below grade. The switchyard will remain for continued use.

All radioactive contamination in excess of 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. All of the station systems will have been dismantled and all of the buildings demolished. 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 use. 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.

4.3.9 Release from Regulatory Control

Upon completion of decommissioning, the Bruce Nuclear Site will be in a condition that will support its removal from regulatory control. A 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 DDP). Any other information required by the applicable regulations will also be included in the report. The final report will be submitted to the CNSC as part of an application for release from regulatory control. Institution controls are not expected to be required.

4.4 Waste Management

Waste management is governed by OPG's Management of Waste and Other Environmentally Regulated Materials standard [R-84], which includes the instruction that all waste generators follow the concept of reduce, reuse and recycle in the waste management activities. All radioactive waste generated during decommissioning will be characterized as per CSA N292 series of Standards, consistent with OPG's Nuclear Waste Management program [R-85]. Transportation of decommissioning waste will be carried out per OPG's Radioactive Materials Transportation program [R-86], which includes the Radioactive Shipments procedure [R-87] that addresses consultation with the waste receiver per the transportation regulations. Non-radioactive waste packaging and transportation will be carried out according to OPG's Management of Waste and Other Environmentally Regulated Materials standard [R-84].

4.4.1 Radioactive Waste Management

4.4.1.1 Radioactive Waste Inventory

The radioactive material inventory of a reactor at the time of shut down 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 that is performed and the natural decay of the radioactive material. Estimates of the activity that will remain at BNGS A and B at the end of the SWS period are shown in Table 4-1. These estimates are based on Bruce A and B in-service date and their subsequent operating history following refurbishment, after which the radioactivity will be allowed to decay for 30 years post shutdown [R-88].

However, it is important to note that the current estimates of radioactivity may need to be updated post targeted site characterization activities of the BNGSs.

Table 4-1: Summary of Radionuclide Inventory at BNGS A and B after 30 Years of Decay

Radionuclide	Residual Activity			Half-life	Percentage
	Type	BNGS A (Bq)	BNGS B (Bq)	(years)	(%)
C-14	β	5.1×10^{13}	4.1×10^{13}	5,730	0.22
Fe-55	γ	1.4×10^{14}	1.4×10^{14}	2.73	0.58
Ni-59	γ	2.0×10^{14}	1.6×10^{14}	76,000	0.66
Co-60	β-γ	1.8×10^{15}	1.8×10^{15}	5.27	7.6
Ni-63	β	2.6×10^{16}	2.2×10^{16}	100	89.6
Zr-93	β-γ	1.3×10^{13}	1.0×10^{13}	1,530,000	0.06
Nb-94	β-γ	2.5×10^{14}	2.0×10^{14}	20,300	1.2
TOTAL		2.9×10^{16}	2.4×10^{16}		

Estimates of the volume of L&ILW that will be generated during the decommissioning have been prepared and are shown in Table 4-2 [R-15] and Table 4-3 [R-16].

Table 4-2: Estimated Volumes of L&ILW Generated During the Decommissioning of BNGS A

BNGS A Unit	Low-Level Radioactive Waste (m^3)	Intermediate-Level Radioactive Waste (m^3)
Unit 1	5,527	813
Unit 2	5,525	813
Unit 3	5,444	813
Unit 4	5,443	813
Unit 0 (common services)	5,518	205
TOTAL*	**27,457**	**3,456**

* May not add due to rounding

Table 4-3: Estimated Volumes of L&ILW Generated During the Decommissioning of BNGS B

BNGS B Unit	Low-Level Radioactive Waste (m^3)	Intermediate-Level Radioactive Waste (m^3)
Unit 5	5,592	835
Unit 6	5,608	835
Unit 7	5,586	835
Unit 8	5,589	835
Unit 0 (common services)	6,437	205
TOTAL*	**28,812**	**3,543**

* May not add due to rounding

The radioactive wastes generated during the 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 the Dismantling & Demolition and Site Restoration period 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 machine; and
- Other components of active systems.

Demolition will generate large amounts of concrete wastes.

Single unit inventory of plant system equipment and components of BNGS A and B was taken as base inventory for all four 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.

4.4.1.2 Management of High-Level Waste

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

When the stations are shut down, all the used fuel (resident in the eight 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 fuel is on the BNGS nuclear site. It is anticipated that all the used fuel remaining in the IFBs will be transferred directly to the used fuel disposal facility. The transfers will continue for 10 to 15 years after station shutdown. Once all of the used fuel has been removed, the IFBs will be decontaminated and secured for the remainder of the SWS period. It is not anticipated that any activity will remain in the IFBs after the decontamination is complete. Used fuel stored in DSCs at the WWMF will also be transferred to the used fuel disposal facility during the same time frame. Although decommissioning of IFBs is addressed by this PDP, the used fuel transfer activities from the IFBs or operations of the WWMF are not part of BNGS decommissioning scope. Although the life cycle plans of the BNGSs and the WWMF are separate from each other and, interdependencies were considered (see Section 2.2.8 and Figure 4-3), while decommissioning planning for the WWMF has been documented in a separate PDP [R-1].

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 [R-89]. 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 [R-90]. APM involves the containment and isolation of used nuclear fuel in a deep geological repository in a suitable rock formation. By the end of the SWS period and before dismantling begins, all used fuel is assumed to have been removed from the site to the used fuel disposal facility (i.e., APM).

4.4.1.3 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, to meet the regulatory requirements for waste transport and disposal and minimize waste. 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 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 the BNGSs 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 (e.g., steam generators, as described in Section 4.3.1) will be segmented and packaged as such. 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 placed in standard waste containers. Contaminated concrete (e.g., surface contaminated concrete from the IFBs) will be broken up, loaded into disposal containers and shipped to a licensed long-term waste management facility. The remaining concrete that meets the clearance criteria will be crushed, 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.

Although OPG owns and operates the WWMF on the Bruce Nuclear site for interim storage of radioactive waste generated during the operating phase of OPG-owned NGSs, there are no plans to store or dispose decommissioning waste from any of OPG's nuclear facilities at the WWMF. Any loose contamination removed by Operations prior to stations entering into SWS will continue to be sent to the WWMF and waste from BNGSs during SWS will be processed at the WWMF until it is shutdown.

OPG had planned to dispose of L&ILW from its owned generating stations in a DGR at the Bruce Nuclear Site. Early in 2020, the L&ILW DGR Project was cancelled. OPG is exploring options and remains committed to the permanent and safe disposal of its operational waste as well as future decommissioning waste.

OPG is also participating in Natural Resources Canada (NRCan)'s work in public engagement on the existing Radioactive Waste Policy to ensure OPG is meeting international best practices. The NWMO was asked to lead a dialogue to develop an integrated strategy for Canada's radioactive waste through close collaboration among waste owners and producers (including OPG), indigenous people and other interested Canadians. Any progress in regard to the Policy and Integrated Strategy will be taken into consideration in OPG's decommissioning waste disposal strategy.

Note: For financial planning purposes, the L&ILW generated during decommissioning is assumed to be transferred to long-term disposal facilities for respective LLW and ILW [R-15], [R-16].

4.4.2 Hazardous Waste Management

4.4.2.1 Hazardous Waste Inventory During Operation

Designated Substances are defined in the Regulations made pursuant to the Ontario OH&S Act [R-91]. An assessment of the Designated Substances used at both BNGSs has been previously completed as required. The results of the assessments indicate that three designated substances are likely to be found in the stations at the time of shutdown:

(a) Asbestos – As per the site asbestos designated substance assessment, B-REP-08965.211, asbestos is present in various older buildings across the Bruce site. Asbestos can be present in many building materials including:

- Cement insulation
- Gaskets
- Vinyl floor tiles
- Transite cement pipes & casings
- Insulating cloth
- Firestop coatings
- Roofing materials
- Caulking, grout & mastic

The most common type of asbestos present is chrysotile. To a far lesser extent, amosite can sometimes be found. This is largely due to the fact that chrysotile asbestos had replaced crocidolite asbestos by the time BNGS A was built in the 1970s. Due to its later construction BNGS B has much less asbestos than its Bruce A counterpart however asbestos has been found in some Bruce B pipe insulation as well as other materials such as vinyl floor tiles and gaskets.

Asbestos insulation is being removed on an 'as needed' basis. There is also an ongoing program to inspect and repair the asbestos insulation used in the stations. Damaged insulation is removed if it cannot be repaired. It is likely that some of these items will be replaced with non-asbestos-containing materials before the decommissioning begins, however much will remain.

An asbestos sample results inventory is maintained which houses asbestos bulk sampling data for the site. This resource will be available to decommissioning planners however it does not replace the more specific designated substance survey (required by O. Reg. 278/05 [R-92] and Section 30 of the OH&S Act [R-91]) that will be required immediately prior to decommissioning which will detail the location of designated substances, including asbestos, on the construction project.

(b) Lead – Lead blocks, shot, plates and blankets are used for radiation shielding around both stations. The melting and pouring of lead for shielding was carried out on the Bruce Nuclear Site, but not at either BNGS A or BNGS B.

Lead paints are not currently used at either station. However, lead paints were used in the past and it is estimated that about 17 percent of the surfaces in the stations are covered with paint or primer that may contain lead-based pigments.

Lead solders are also used on electrical equipment throughout the stations.

(c) Mercury – Mercury was not used as a construction material. However, it is used in some equipment and instruments such as thermometers, manometers, hygrometers, mercury-wetted relays, magnetol, 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 either station.

Small quantities of some other designated substances, such as benzene and isocyanates, are occasionally used during projects, but they are not routinely stored at either station. Silica-containing materials are used as decontamination (sandblasting) agents within the protected area of both Bruce A and B.

Most of the hazardous materials stored on the site (flammable, cryogenic gases, 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 or disposed of via a licensed waste oil/diesel carrier and receiver.

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 that only small quantities should remain at the start of the decommissioning. These hazardous materials include:

(a) Compressed gases including acetylene, argon, oxygen, carbon dioxide, hydrogen;

(b) Cryogenic gases such as liquid nitrogen;

(c) Flammable and combustible liquids including fuel oil, lubricating oil and material oil;

(d) Corrosives such as sulphuric acid, sodium hydroxide, hydrazine and sodium hypochlorite;

(e) Toxic materials such as boric acid;

(f) Miscellaneous hazardous materials (inventory varies on a daily basis); and

(g) Pesticides and herbicides – biocides are added to the water treatment cooling towers; other 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. A map showing the most significant stores of hazardous materials at BNGS A is shown in Appendix A, Figure A-1. A map showing the locations of the most significant stores of hazardous materials at BNGS B is shown in Appendix A, Figure A-2.

4.4.2.2 Hazardous Waste Inventory During Decommissioning

Hazardous waste that does not form part of the stations' SSCs is not included as part of decommissioning activities. All operational waste will be removed prior to decommissioning.

Hazardous wastes removed during the Preparation for Safe Storage period will include oils, lubricants, electrohydraulic fluid (i.e., Fire Resistant Fluid) 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 IFBs 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.

4.4.2.3 Management of Hazardous Waste

The BNGSs are already registered with the MECP[12] 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 are 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 federal (i.e., Transportation of Dangerous Goods (TDG) Act and Regulations [R-82]) and provincial regulations. All hazardous wastes, including non-radioactive hazardous waste, will be transferred to an appropriate, licensed waste management facility for storage or disposal at approved disposal facilities. Bill of Ladings and waste manifests will be prepared and submitted as required by the federal (TDG) and provincial regulations, respectively. Mixed waste (i.e., radioactive waste mixed with clean waste that is also hazardous) will be transferred to an appropriate long-term disposal facility.

4.4.3 Other Wastes

The bulk of the non-hazardous waste materials generated during the decommissioning will be produced during the Dismantling & Demolition and Site Restoration period of the decommissioning, 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.

If the volume or value of the contaminated scrap metal generated during the decommissioning is sufficient to justify further processing, chemical cleaning, electro polishing, mechanical abrasion or melting might 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.

[12] In 2022, the MECP is poised to hand over oversight over the Provincial hazardous waste program to Resource Productivity and Recovery Authority.

5.0 DECOMMISSIONING COST ESTIMATES AND FINANCIAL GUARANTEE

This section deals with the costs associated with decommissioning the BNGSs and the provision of a financial guarantee for the accumulated liability.

5.1 Cost Estimates

The decommissioning cost estimate update was prepared by the TLG Services LLC. (TLG), on behalf of OPG.

The costs associated with decommissioning the BNGS A and BNGS B are estimated at $3.479 billion and $3.423 billion (2022 Dollars), respectively, for this financial guarantee period (2023-2027) and covers the activities as detailed in Section 3 of [R-15] and [R-16]. The aforementioned decommissioning costs are accurate as of the time of PDP approval. As OPG is currently in the process of finalizing its 2022 Ontario Nuclear Funds Agreement Reference Plan, these decommissioning costs may change pending further reviews by the Province.

A summary of the cost estimates for decommissioning the BNGSs can be found in Appendix B. The cost estimates will be updated when changes to the BNGSs planning assumptions occur. These changes may include the addition of or removal of facilities, systems and equipment or other changes to planning assumptions such as shutdown dates.

The costs associated with the management of used fuel including interim storage, transportation and disposal from the BNGSs 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 status report to the CNSC staff detailing amounts accumulated in applicable segregated funds for decommissioning and management of used fuel. The report will also identify any material changes in decommissioning plans or cost estimates, which may affect the financial liability incurred.

Only facilities and land within the licensed/protected area are covered by the decommissioning segregated funds.

5.2 Financial Guarantee

For the 2023 – 2027 Financial Guarantee liabilities calculations, the TLG cost estimates will be adjusted to incorporate costs from the Financial Guarantee year onwards and will include oversight costs specific to the OPG decommissioning program. The OPG Financial Guarantee liabilities calculations process allows for managing/evaluating changes that may be required if the shutdown dates are affected.

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 is 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 the decommissioning phase 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 the BNGSs can be split into the following three categories [R-93]:

(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 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.

Prior to decommissioning, OPG will establish a Human Factors Engineering Program Plan (HFEPP) for the decommissioning of the BNGSs according to the recommendations of CNSC REGDOC-2.5.1, 'General Design Considerations: Human Factors' [R-94] and REGDOC-2.2.1 'Human Factors' [R-95] and also lessons learned from decommissioning of PNGS. The details of the Plan will be included in the DDP. The following items should be included in the HFEPP:

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

Decommissioning work will also comply with requirements of HF 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 [R-96].

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. Human and Organizational Factors issues that arise during transition to decommissioning may include [R-97]:

- Loss of personnel expertise during the transition from operations to decommissioning;
- Loss of knowledge/station experience due to transition from Bruce Power to OPG;
- 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, will 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 station and the duration of the SWS period, e.g., reduction in staff numbers.

The Human and Organizational Factors issues listed above will have a major impact on the course of the 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 shutdown will be implemented.

As mentioned in Section 3.6, the risks associated with the 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 stations throughout the course of the Preparation for Safe Storage period of the project. OPG staff will perform the work in this period although contractors may be retained to provide specialized services under the supervision of OPG staff.

OPG will also retain responsibility for the stations 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 the organization required to oversee the decommissioning program will be assembled from available OPG station staff and outside resources as needed. The Decommissioning Contractor(s) will be retained to perform the Dismantling & Demolition and Site Restoration work. OPG will provide the necessary oversight during this 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 the BNGSs 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 period of the decommissioning. 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.

6.3 Staffing

The staffing numbers for each phase of decommissioning can be found in [R-15], [R-16] 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). Business plan staffing numbers have not yet been established and will be determined at a later date.

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 [R-98]. 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.

Details of the training program for SWS will be provided in the DDP (or a separate SSP).

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

7.0 POTENTIAL ENVIRONMENTAL AND SOCIO-ECONOMIC EFFECTS

An IA is not required for the transition period. In consultation with the CNSC and to comply with all applicable laws and regulations, OPG will determine the requirements for performing an IA, if required prior to Dismantling & Demolition. Section 13.0 provides further information on the IA process. This section is only intended to highlight some of the major effects on the natural and socio-economic environment that might occur over the course of the decommissioning work. This listing is not intended to be exhaustive.

7.1 Natural Environment

7.1.1 Air Quality

The decontamination and dismantling of nuclear systems could release airborne radioactivity. The impact of these releases will be minimized through the use of temporary containment structures and local filtered ventilation.

The heavy construction equipment and the vehicles used for transport of waste and other materials will release particulates (dust) and exhaust gases into the atmosphere. These vehicles may also result in traffic and noise pollution. The nature and extent of these releases will depend on the type of equipment in use at the time of the decommissioning. Dusts, fumes and other emissions from cutting or blasting operations, particularly during the dismantling operations, may have some impact on air quality.

Traffic resulting from the movement of heavy vehicles to and from the Bruce Nuclear Site during decommissioning may have an impact on the surrounding community but the additional impact on the environment should not be significant. Shipment of radioactive waste and used fuel from the site is governed by the Radioactive Materials Transportation program [R-86] and will be subject to strict application of the following transportation regulations [R-82], [R-99] and [R-100].

As described in Section 7.2.2, there may be noise pollution resulting from use of heavy equipment but this should be limited to a small number of distinct events during the Dismantling & Demolition work.

7.1.2 Surface Waters, Groundwater and Soil Quality

Some increase in turbidity of the water along the lakeshore may result from filling and sealing the stations' water inlets and outlets as well as from runoff during the Dismantling & Demolition and Site Restoration work.

The wetlands on the Bruce Nuclear Site are well removed from both BNGS A and BNGS B. Runoff from the decommissioning work can be controlled by standard construction techniques.

As indicated in Section 2.3.2.3, tritium in ground water does not appear to be extensive or at significantly high levels throughout the Bruce Nuclear Site. High tritium levels were found in the foundation drain effluents, but historical data indicate that concentrations are decreasing and should significantly decrease further due to dispersion and radioactive decay from now through the end of SWS period.

Since discharge canals could also be contaminated by waterborne effluents containing radionuclides, additional sampling during future environmental monitoring campaigns and/or pre-planning characterization after station shutdown is required to verify the condition of discharge canals.

Environmental monitoring data also indicate that fission products, activation products and fuel related radionuclides have been detected in various effluents around BNGS B, but as mentioned in Section 2.3.2.3 the latest environmental protection report [R-18], did not show elevated levels of radionuclides. Approximately 1,000 m^3 has been accounted for in the BNGS B Decommissioning Cost Estimate [R-16]. Any existing contamination in soil at BNGS A are assumed to decay to below site release limits by the time of dismantling/site remediation and, as such, no contaminated soil has been accounted for in the BNGS A Decommissioning Cost Estimate [R-15]. The foundation drainage system should be characterized after station shutdown to further determine its radiological condition and potential need for remediation [R-25].

Annual reports on the monitoring and remedial work are being submitted to the CNSC [R-18].

Decommissioning is a potential source of soil and groundwater contamination, through spills of heavy water, oils and chemicals. The impact of possible releases will be minimized through the reduction of inventories immediately following the end of operations or during Preparation for Safe Storage and through the use of good practices as well as appropriate mitigating actions. More details regarding mitigating actions, such as runoff control measures, will be provided in the DDP.

7.1.3 Vegetation

It is not anticipated that the work performed during Preparation for Safe Storage period would have any impact on the vegetation in the immediate vicinity of the Bruce Nuclear Site beyond that caused by normal station operations.

The reduced level of activity on site during the SWS period might permit increased growth of the vegetation on the site. However, it is anticipated that the growth of vegetation inside the security fence would be controlled.

The Bruce Nuclear Site is located within the Huron-Ontario section of the Great Lakes - St. Lawrence Forest Region. This region is characterized by the presence of sugar maple and beech trees associated with red and white ash, yellow birch and red, white and bur oaks. Hemlock, white pine and balsam fir occur with the tolerant hardwood types and eastern cedar is present in swampy areas. The areas closest to the stations are covered by grass or scrub vegetation.

The most heavily vegetated areas of the site are not likely to be impacted during the course of the decommissioning work but the dust produced during the Dismantling & Demolition and Site Restoration period may have a temporary impact on some of the vegetation in the immediate vicinity of the site.

The Douglas Point swamp has been designated as an environmentally sensitive area. Part of the swamp is located within the eastern boundary of the Bruce Nuclear Site. It extends east of the site to the former lake shoreline.

7.1.4 Wildlife

Some parts of the Bruce Nuclear site that are not routinely used have become a habitat for wildlife. A variety of species of mammals, birds, reptiles and amphibians have been observed in these areas. Some of them are considered rare, threatened or endangered, as documented in [R-20]. These populations may increase during the SWS period since there will be less activity on the site. The increased level of activity during the Dismantling & Demolition and Site Restoration period along with the noise and dust has potential to affect species inhabiting the Bruce Nuclear Site. Increased vehicular traffic during some phases of the decommissioning may have potential to impact wildlife.

The warm water of the condenser cooling water outlets have created feeding grounds and resting places for double-crested cormorant, black-crowned night heron and a variety of other water birds including ducks, geese and gulls. Shutting down the stations will change the habitat of these birds. Removing the warm water source during decommissioning will change the water environment which may impact fish and water fowl species.

7.1.5 Aquatic Life

The operation of the stations has created an artificial habitat for some fish species, particularly in the warm water released from the condenser cooling water outlets. Shutting down the stations and eventual decommissioning and removal of the structures associated with the cooling water system will change this habitat. This may also have an impact on sport fishing in the area.

Lake Huron is used locally for both sport and indigenous commercial fishing. The Baie du Doré wetland adjacent to the Bruce Nuclear Site is a habitat for fish spawning and rearing. A drainage ditch downstream of the wetlands on the eastern part of the site has been declared as a fish habitat by the Department of Fisheries and Oceans.

Changes in run-off from the site during Dismantling & Demolition and Site Restoration period may impact some species found on the site and this will require discussion and consultation with the Department of Fisheries and Oceans. It should be possible to control these impacts by controlling run-off from the work areas. Some increase in turbidity of the water along the lakeshore may result from filling and sealing the stations' water inlets and outlets as well as from run-off during the Dismantling & Demolition and Site Restoration work. This may have a temporary impact on some aquatic life forms.

If part of the decommissioning plan requires in-filling of the intake channels, then mitigation and off-set commitments may be required under the Fisheries Act [R-101].

7.2 Land Use and Noise

7.2.1 Land Use

It is expected that the site itself will continue to be utilized for other OPG uses. Decommissioning itself is anticipated to have minimal impact on the use of the surrounding lands.

7.2.2 Noise

Several station systems are known to be noise sources. These include the station stacks, the standby generators and the paging system. Shutdown of the station will reduce and eventually eliminate these noise sources.

Heavy construction equipment and blasting may be used during the Dismantling & Demolition work towards the end of the decommissioning project. This work may produce localized elevated noise levels during the dismantling work. Site workers and wildlife may be temporarily impacted by the increased noise. The potential impacts of demolition noise will be assessed prior to Dismantling & Demolition and appropriate mitigation strategies will be put in place, such as not using certain demolition methods.

7.3 Human and Socio-Economic Environment

7.3.1 Purpose

The Regulatory Guide G-219 specifies that a PDP should include the "identification of any features of the surrounding… social environment that could be significantly affected by the decommissioning process" [R-3]. This section will focus on the potential for socio-economic impacts at the local community and regional level associated with the decommissioning of the stations.

This section does not attempt to assess or evaluate what impacts may actually result at the time when decommissioning actually occurs. The impacts resulting from the decommissioning process will be assessed in a future IA, if required, to comply with all applicable laws and regulations prior to Dismantling & Demolition, and their significance will be determined at that time.

7.3.2 Scope

If an IA is required per the IAA [R-10] which came in force in 2019, the scope of the socio-economic assessment considerations would include the other planned activities occurring in the same time period, such as decommissioning of the WWMF, which when taken together with the planned decommissioning of the BNGSs may have the potential for cumulative impact on the local communities. For more details on the IA, refer to Section 13.0.

Aspects to be considered include:

- Direct economic impacts – employment (local/non-local), skill groups required, labour supply, etc.;
- Indirect economic impacts – employee expenditure, suppliers, labour markets, etc.;
- Demographics – changes in population size and characteristics (long and short term);
- Housing; and
- Other local services – police, health, social, education, etc.

7.3.3 Definitions

Socio-economic impacts are defined as changes in people's well-being and/or changes in significant aspects of their communities as a result of a development or project.

Socio-Economic Impact Assessment (SEIA) is a process designed to identify and evaluate the potential social, cultural and economic effects of a proposed project, policy, program or plan on people, organizations, institutions, communities and social systems. The purpose of SEIA is to recommend impact management measures that would improve a project by reducing negative community effects and enhancing community benefit.

Impact management involves the coordinated application of measures designed to mitigate, enhance, compensate, plan for contingencies, monitor and ensure continuing liaison. Measures could also include formal impact agreements.

SEIA and impact management improve projects by identifying and managing the costs and benefits and by facilitating decision-making. A SEIA would be undertaken as part of the EA of decommissioning, if required.

7.3.4 Temporal Considerations

Shutting down the stations and the four phases associated with decommissioning, (i.e., Planning, Preparation, Execution and Completion Phases) will each have discrete activities that will result in effects on local communities. Socio-economic effects will begin with the commencement of planning activities that engage the local communities. For planning purposes, it is assumed that these effects will commence for BNGS A in 2044 and for BNGS B in 2059 and extend until decommissioning is complete for the site in 2095 and 2099 respectively (see Table 7-1).

Table 7-1: Planning Schedules Affecting Socio-Economic Conditions for the Decommissioning the Bruce Nuclear Site

Stage	BNGS A Dates	Bruce A Time Required	BNGS B Dates	Bruce B Time Required	WWMF Dates	WWMF Time Required
Preparation for Safe Storage including shutdown Notes 1&2	2044 – 2045	1 year	2059 – 2060	1 year	–	–
SWS Notes 1&2	2045 – 2085	40 years	2060 – 2090	30 years	–	–
Preparation for & activities associated with Dismantling & Demolition and Site Restoration and release from regulatory control Notes 1&2	2085 – 2095	10 years	2090 – 2099	9 years	2064-2069 (L&ILW) 2089-2095 (Used fuel)	5 years 6 years
Total Decommissioning Duration at Site	**2044 – 2095**	**51 years**	**2059 – 2099**	**40 years**	**As above**	**As above**

Note 1: These dates are for the first unit decommissioned (Unit 1 at BNGS A and Unit 6 at BNGS B).
Note 2: All dates are nominal.
Note 3: The small facilities are excluded from this table due to its size and estimated socio-economic impact.

The scheduled phases of decommissioning are almost continuous and overlapping, extending for a total period of 51 and 40 years, for BNGS A and BNGS B respectively. Actual activities associated with these planned phases will be intermittent; however, it is important to understand the overall flow of activities, as these will be the major source of potential socio-economic impacts.

7.3.5 Preparation for Decommissioning/Shutdown/Preparation for Safe Storage

The most significant source of community effect will be changes in the size of the workforce when the stations are shut down. Prior to shutdown, there would be approximately 4,000 workers at the stations. About 1 year will be needed to complete the transition activities from operation to SWS for each station. After each station is shut down, most of the established workforce will no longer be required. The reduction of staff would probably be staggered, as the units are shut down. See Section 6.3 for further details on the staffing needs during this decommissioning phase. 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 will 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. Approximately 2,000 light vehicles per day now access the Bruce Nuclear Site and this number would decrease incrementally. 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 the long-term disposal facilities for respective LLW and ILW as described in 4.4.1.3.

The closure of the BNGSs 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 shutdown activities. It is possible that indirect economic effects would occur. Under current assessment legislation, 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.

7.3.6 Storage With Surveillance

The SWS period will last for nominally 30 years for each unit. Over that period, a small workforce will be required at each station, which may represent opportunities for local employment and consumer spending. Towards the end of the SWS period, the staff complement will increase at each station to accommodate the planning activities and mobilizing for Dismantling & Demolition and Site Restoration. See Section 6.3 for further details on staffing needs during this decommissioning phase.

7.3.7 Dismantling & Demolition and Site Restoration

When Dismantling & Demolition begins, the workforce will increase at each of BNGS A and BNGS B. See Section 6.3 for further details on the staffing needs during this decommissioning phase. The Dismantling & Demolition activities at each station will extend over approximately 10 years. 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. L&ILW generated during decommissioning will be transported by truck to the long-term disposal facilities for respective LLW and ILW as described in 4.4.1.3. The volume of these wastes is substantial (~64,000 m^3, per Table 4-2 and Table 4-3), so the number of truck trips would be considerable, probably more than the present transportation trips for operational waste to the WWMF at the Bruce Nuclear Site.

At the conclusion of the Dismantling & Demolition period, the site will be restored for other OPG use(s). During Site Restoration, the workforce will decrease significantly at each of BNGS A and BNGS B. All of the visual effects of a large industrial plant in the midst of a generally rural area will be eliminated. 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. Under current assessment legislation, taxes 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 AND 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 BNGSs 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 they will be addressed as appropriate.

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

Hazard	Most Likely Source(s) of Hazard	Description/Comments
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.	
	Storage With Surveillance • Storage of used fuel in the facility. • Radiation fields will exist in other parts of the facility throughout SWS period.	Used fuel will continue to be stored in the facility for an initial cooling period after shutdown and the work required to transfer this fuel to a used fuel disposal facility 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.

Hazard	Most Likely Source(s) of Hazard	Description/Comments
	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 the Dismantling & Demolition and Site Restoration period.
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.	
	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).
	Dismantling & Demolition and Site Restoration • Handling the cleaning agents used during decontamination work. • Transporting bulk/waste chemicals. • Concrete dust generated during the dismantling work.	
Industrial and Construction Hazards	**Preparation for Safe Storage** • Similar hazards to those encountered in an operating station during a routine maintenance outage. • Airborne hazards necessitating the use of breathing air or Powered Air Purifying Respirator (PAPR).	

Hazard	Most Likely Source(s) of Hazard	Description/Comments
	Storage With Surveillance • Similar hazards to those encountered in an operating station during a routine maintenance outage. • Airborne hazards necessitating the use of breathing air or PAPR.	
	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.	
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.	
Motor Vehicle Accidents	• Highway travel/shipments. • Vehicle/pedestrian collisions. • Vehicle/wildlife collisions.	
Inclement Weather	• Temperature extremes (hot/cold). • Lightning. • High winds.	Workers at the above-grade structures face the greatest risk of lightning strike.
Work around Open Water	• Work around the Pump Houses.	

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

8.1.1 Occupational Dose Estimate

A preliminary assessment of the occupational dose estimate for the decommissioning of BNGS A was conducted in 1986 [R-102].

According to this analysis, the total estimated dose for the decommissioning of BNGS A is 5.15 person-sieverts (515 person-rem). This estimate was based on 40 years of continuous operation of the BNGS A units followed by 30 years of decay. All four BNGS A units were laid-up in the late 1990s. Unit 4 was restarted in 2003 and Unit 3 was restarted in 2004. Bruce Power refurbished Units 1 and 2 and these units were restarted in 2012. Refurbishment for Units 3 and 4 is also planned.

As a result of the lay-up and refurbishment, the dose estimate is likely conservative for BNGS A but is considered adequate for preliminary planning purposes. For preliminary planning purposes, it is assumed that the occupational dose estimate for BNGS A will also be applicable to the BNGS B. The occupational dose estimate will have to be re-assessed in the light of refurbishing BNGS B (Units 5 - 8).

An Occupational Dose Estimate for the decommissioning of the BNGSs will be prepared prior to Dismantling & Demolition. 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 the used fuel from the IFBs. 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 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 [R-76]. 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 during the different phases of the decommissioning program 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.

Throughout the decommissioning phases, qualified staffs will be used 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 Period

Station staff and/or contractors will perform the defueling and dewatering activities with contractor(s) performing decontamination activities during the Preparation for Safe Storage period. The decontamination work that will be performed at this time should further reduce the radiation dose rates in the stations. When these activities are complete, the portions of the stations 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 be continued 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 phase will be used to more accurately predict the radiation levels that are likely to exist during later phases of the work.

8.2.2 Storage with Surveillance Period

Used fuel transfers will continue during the SWS period for up to 10 years after station shutdown. Used fuel stored in DSCs at the WWMF will also be transferred to the used fuel disposal facility during the same timeframe. OPG staff will perform this work.

Radiation fields will exist in parts of the facility throughout the SWS period. At the beginning of the phase, 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 phase of the decommissioning, 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. 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 period.

8.2.3 Dismantling & Demolition and Site Restoration Period

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, work breaks 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.

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 [R-91]. 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 Section 6.2, Decommissioning Contractor(s) will be retained to perform the decommissioning work on behalf of the owner during the Dismantling & Demolition and Site Restoration period of the decommissioning project. The Decommissioning 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 licence to perform decommissioning activities, OPG policies and the contract.

8.4 Emergency Response Planning

During the preparation of the DDP, 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 emergency situations that might occur will be similar to those that might occur in an operating station during a routine maintenance outage. 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 an outage, 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 used fuel stored in IFBs. For example, distribution of KI pills to residents in the vicinity of the Bruce Nuclear site will no longer be required.

As the project progresses (particularly after all of the radioactive materials have been removed from the site), the potential emergency situations will come to more closely resemble those that might occur during the course of a major construction project.

At all stages of the project, 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 co-ordinate 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. Even though the BNGSs and the WWMF are different facilities that are under separate licences, the same security staff will be responsible for all three 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 the agreement with the CNSC.

10.0 QUALITY ASSURANCE

OPG has QA programs for its operations, which is detailed in the Nuclear Management System [R-11] 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

The IAEA Technical Report [R-103] states that operational records should be retained in order to meet the needs of future decommissioning. It is recognized that there is a potential for information about the BNGSs to be lost as work transition through the stages of decommissioning, and staff numbers decrease. It is therefore necessary that measures be taken early on to preserve and improve the existing records database, capturing all potentially relevant information. The records maintained by each station will conform to Bruce Power Record Management requirements. In addition, records filing and retention are governed by OPG's Information Management program [R-104], which identifies records relevant to decommissioning as permanent records. Decommissioning-related documentation will also be managed and maintained in accordance with CSA N294:19 [R-5]. The IAEA documents on record keeping (e.g., Technical Reports Series No. 411 [R-103]) will also be consulted to provide additional guidance. At end of the lease and when the facilities and the site are returned to OPG, all Bruce Power records will be assumed by OPG. These records will contain historical information that may be required in the future in order to update this PDP, prepare the DDP and ultimately facilitate successful decommissioning. They will include, but are not limited to:

(a) The DDPs and Storage with Surveillance Plans;

(b) Interim end-state reports;

(c) Design of facilities and buildings included in the decommissioning plan;

(d) Licences and permits required for the decommissioning work;

(e) Details of the operating history of the reactors;

(f) Details of the initial design and configuration of station systems and the maintenance and modifications made to that configuration over the course of the stations' operating lifetime including records of:

- Updated drawings and photographs taken from inspections, modifications, and repairs to SSCs;
- Details of materials used;

- Special repair or maintenance activities and techniques; and
- Details of the design, material composition and the history and location of all temporary modifications and devices;

(g) Records of routine and extraordinary radiation dose rate and contamination surveys that are performed throughout the station (these records are stored in an electronic database called the Visual Survey Data System);

(h) Records of worker and contractor doses received during the course of the stations' operating lifetime;

(i) Descriptions of the nature and location of any hazardous materials in the stations and the disposition of any hazardous materials that have been removed;

(j) Reports and other documents that describe the criteria used to define radioactive and hazardous materials and to distinguish contaminated from uncontaminated materials;

i) the criteria used to define the final contamination status of the facility;

ii) the principles and models used in deriving the criteria in Items a) and b);

iii) the residual radionuclide inventory after decontamination;

iv) the amounts of radioactive and hazardous materials removed and the disposition method;

v) waste management and transfer records;

vi) 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;

vii) the survey methods and the types of instruments used;

(k) The equipment, nuclear and non-nuclear materials, and structures remaining at the end of decommissioning;

(l) Details of any spills or releases of radioactive materials or environmentally hazardous substances that may have occurred over the course of the stations' operational lifetime;

(m) Records of any unplanned events or unusual occurrences;

(n) Site characterization and environmental review or IA; and

(o) Public and Indigenous engagement/communications records.

Records pertinent to the shutdown of the stations will also be maintained. The progressive shutdown of the operational units is very similar to the commissioning of a station. Record keeping during shutdown will be similar to record keeping during commissioning. Records from Stabilization such as the system end-stating activities, scoping and characterization surveys, etc. (see Section 4.1.4) will be well documented and be properly archived so that they can be readily available at the time of Preparation for Dismantling and Demolition. OPG will document the progress of decommissioning in a traceable manner.

Furthermore, during the course of the decommissioning, OPG will retain records of:

- The plans and procedures used in decommissioning;
- The progress achieved in meeting the schedule for the decommissioning;
- The implementation and results of the decommissioning, including the residual radionuclide inventory after decontamination;
- The results and interpretations of environmental monitoring programs;
- The manner in which and the location where any nuclear or hazardous waste is managed, stored, disposed of or transferred (i.e., waste management and transfer records);
- The name and quantity of any radioactive nuclear substances, hazardous substances and radiation that remain at the nuclear facility after completion of the decommissioning;
- The amount of radionuclides discharged via airborne and liquid pathways;
- Occupational dose records, i.e., records of worker and contractor doses received during the decommissioning phases;
- The status of each worker's qualifications, re-qualification and training, including the results of all tests and examinations completed in accordance with the licence;
- Any deviations from plans and procedures;
- The quality assurance records;
- The final radiological and hazardous materials surveys;
- Final end-state reports; and
- The land remediation undertaken, including the results of verification analyses as compared to criteria used or derived for soil and water quality (defined in the DDP), and the disposition of any affected media.

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

12.0 PUBLIC AND STAKEHOLDER ENGAGEMENT PROGRAM

A public and stakeholder engagement program along with an Indigenous relations program will support the development of the DDP and IA (if one is required – see also Section 13.0) and to support consultation for future uses of the site. The program will include both information and consultation opportunities. It will be designed to involve a broad cross-section of stakeholders employing a variety of methods that will meet the needs of the participants and the objectives of the business.

The program will identify issues and concerns; ensure opportunities for involvement; ensure all input was considered in decommissioning planning and/or in the environmental risk assessment, and include the documentation of the process and results. The program will also support the development of an integrated community impact management plan.

The public and stakeholder engagement programs will comply with the applicable requirements of REGDOC-3.2.1 [R-7], Public Information and Disclosure, and REGDOC-3.2.2, Indigenous Engagement [R-8].

13.0 IMPACT ASSESSMENT

The IAA came into force in 2019 and is the legal basis for the federal EA process in Canada, now known as IA [R-10]. In consultation with the CNSC and to comply with all applicable laws and regulations, OPG will determine the requirements for performing an IA, if required, prior to Dismantling & Demolition to ensure that adequate provisions for the protection of the environment and the health and safety of persons are made during decommissioning. Some of the effects on the natural and socio-economic environment that might occur over the course of the decommissioning work are described in Section 7.0.

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Appendix A Types, Quantities and Locations of Hazardous Materials Stored at BNGSs

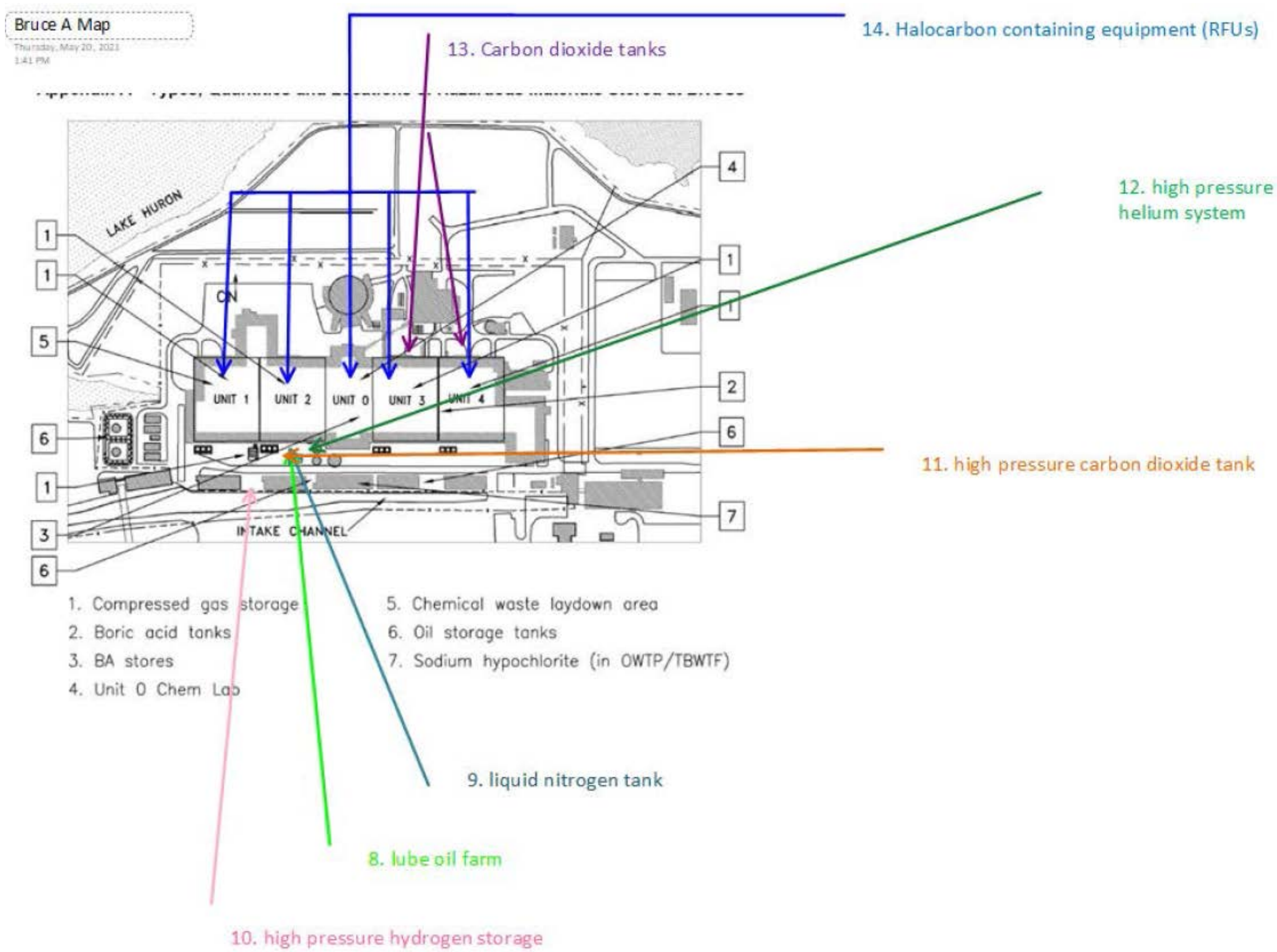

Figure A-1: Location of the Principal Stores of Hazardous Materials at BNGS A

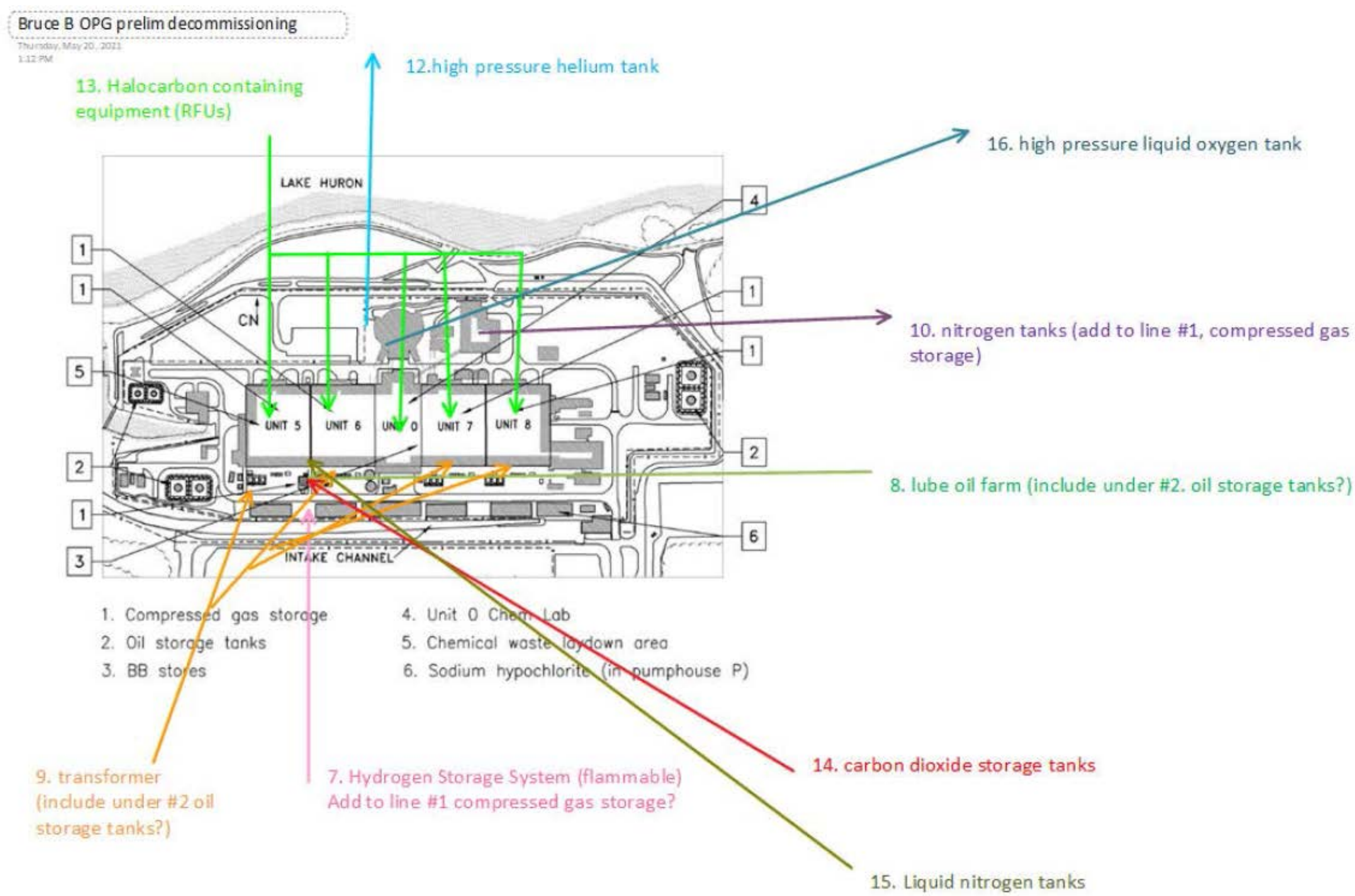

Figure A-2: Location of the Principal Stores of Hazardous Materials at BNGS B

Table A-1: Typical Types, Quantities and Locations of Hazardous Materials Stored at BNGS A and B

Material/Type	Estimated Quantity	Location on Station Site
Boric Acid (3 percent)	2 tanks per unit at Bruce A Unit 3 & Unit 4 only. Tank: 6500 L each	Bruce A: Units 3 & 4 only Bruce B: None
Carbon Dioxide (Bulk)	Bruce A & Bruce B: One bulk tank supplies all 4 units at both stations. The tanks have a capacity of 12,700 kg each.	Bruce A: Outside powerhouse South side of Unit 1 Bruce B: Outside powerhouse South side of Unit 6
Compressed Gases (including acetylene, argon, carbon dioxide, and oxygen)	Typically, 425-475 cylinders (unverified) Acetylene & argon are used in welding projects and cylinders are brought in on an as need basis. There is some in the welding shop at all times. Breathing Air, Service Air & Instrument Air are all made using compressors not found in cylinders.	Bruce A: Compressed Gas Cylinder Storage Area and various places throughout the station Bruce B: Compressed Gas Cylinder Storage Area and various places throughout the station
Fuel Oil	Bruce A: 2 SG fuel oil storage tanks with maximum capacity of 1,101,381 L each. 2 fuel oil storage tanks with maximum capacity; Tank 1: 45,000 L Tank 2: 22,750 L	Bruce A: Outside the powerhouse and inside the security fence in various places.
	Bruce B: 4 SGs fuel oil storage tanks with maximum capacity of 1,135,500 L each. 2 EPG fuel oil storage tanks with maximum capacity 363,360 L each.	Bruce B: Outside the powerhouse and inside the security fence in various places.
Hydrazine (35 percent)	One Unit 0 tote is located at each station with a maximum capacity of 1,136 L each. Each unit 1-8 has a hydrazine addition tank with a maximum capacity of 1400 L.	Bruce A: Unit 0, 1, 2, 3 & 4 Bruce B: Unit 0, 5, 6, 7 & 8
Hydrogen (Bulk)	Each Station has one storage trailer, Generator Hydrogen Cooling system and a Generator per unit (8 units): Trailer: bank of 30 cylinders (Size: 9-5/8" X 20' X 6-1/4" Long)	Bruce A: 3 trailers Trailer: Unit 0 Hydrogen Cooling System: powerhouse Generator: Unit 1, 2, 3 & 4

Material/Type	Estimated Quantity	Location on Station Site
	Hydrogen Cooling System volume: 4,900 cu. ft. Generator: 24,500-29,400 cu. ft depending on unit	Bruce B: Trailer: Unit 0 Hydrogen Cooling System: powerhouse Generator: Unit 5, 6, 7 & 8
Lubricating Oil	Bruce A & Bruce B: Have three tanks each with a total capacity of 182,000 L at BA and 182,000 L at BB. Tank 1: 73,000 L Tank 2: 73,000 L Tank 3: 36,000 L	Bruce A & Bruce B: Outdoor lube Oil Tank Area (Outside Unit 1 and Unit 5 construction south)
Mineral Oil	Bruce A: Main Output Transformers: One per unit (1-4) each containing 73,700 L. Bruce B: Main Output Transformers: One per unit (5-8) each containing 80,000 L.	All transformer are located outside between the powerhouse and the Pumphouse at each unit (1-8)
	Bruce A: Unit Service Transformers: One per unit (1-4) each containing 35,000 L Bruce B: Unit Service Transformers: One per unit (5-8) each containing 48,000 L	
	Bruce A: System Service Transformers: One per unit (1-4) containing 67,800 L. Bruce B: System Service Transformers: One per unit (5-8) containing 105,000 L.	
Liquid Nitrogen Bulk Storage	One bulk tank at each station with a maximum capacity of 5,700 L.	Outside the powerhouse
Sodium Hydroxide (Caustic Soda)	Bruce A: Storage Tank (Tank 901) Maximum of 35,000 L Two Day Tanks (Tank 903 & Tank 904) Maximum of 1,500 L)	Bruce A: Water Demin Plant Note: The equipment is currently not in use.
	Bruce B: Day Tank Maximum 1,700 L	Bruce B: New Water Treatment Plant (Demin)
Sodium Hypochlorite (12 percent)	Bruce A: 12% Sodium Hypochlorite - Stationary Tote Maximum 1,500 L (tank 20) currently not in use. 1,500 L in Old Water Treatment Plant (OWTP) for Waste Treatment Facility system (stationary tote), plus 250 L total of jugs to top up the tank. Transit Tote Maximum 1,000 L	Bruce A: WTP (Demin)

Material/Type	Estimated Quantity	Location on Station Site
	Bruce B: Day Tank (Tank 14) Maximum 1,000 L and another 2000 L in the Bruce B OWTP storage area.	Bruce B: New WTP (Demin)
Sulphuric Acid	Bruce A: Storage Tank (Tank 902) Maximum 29,000 L (0-71630-Tank 902) Two Day Tanks (Tank 905 & Tank 906) Maximum of 950 L each Stationary Tote (Tank 21) Maximum 1,500 L Transit Tote Maximum 1,000 L	Bruce A: WTP (Demin)
	Bruce B: Maximum 36,000 L	Bruce B: New WTP (Demin)
Miscellaneous Hazardous Materials	Not Verified	Chemical Waste Facility
		The inventory in these areas varies on a daily basis.

Appendix B Executive Summary of Decommissioning Cost Study for the Bruce Nuclear Generating Stations A and B

This study, prepared for OPG by TLG, estimates the decommissioning costs of BNGS A and BNGS B at $3.479 billion and $3.423 billion (2022 Dollars) respectively. The major contributors to the overall decommissioning cost are labor and radioactive waste management. The cost is based on several key assumptions regarding regulatory requirements, estimating methodology, allowance requirements, low and intermediate-level radioactive waste, disposal site availability for radioactive waste management and site restoration requirements. A complete discussion of the assumptions used in this estimate is presented in Section 3 of [R-15] and [R-16].

NOTE: for the 2023-2027 Financial Guarantee liabilities calculations, the TLG cost estimates will be adjusted to incorporate costs from the Financial Guarantee year onwards and include oversight costs specific to the OPG decommissioning program.

The estimate includes a SWS period prior to the initiation of dismantling operations. Decontamination and dismantling activities are coordinated at each of the four units at BNGS A and BNGS B to optimize the project schedule and maintain continuity in the overall process.

Regulations

Guidance on nuclear station decommissioning in Canada is found in Regulatory Guide G-219, “Decommissioning Planning for Licensed Activities” [R-3] promulgated by the CNSC. This document provides guidance regarding the preparation of decommissioning plans for activities licensed by the CNSC.

The CNSC summarized the statement on decommissioning in G-219 as follows: ‘The CNSC requires that an acceptable preliminary decommissioning plan be filed as early as possible in the life cycle of a licensed activity...The main roles of the preliminary decommissioning planning process and plan are to:…2) document a preferred decommissioning strategy which, in light of current knowledge, represents a technically feasible, safe and environmentally acceptable approach; and 3) provide a structured and dynamic outline for establishing and maintaining an acceptable financial guarantee program and preparing a detailed decommissioning plan.’

This statement is similar in philosophy to the U.S. Nuclear Regulatory Commission’s position on decommissioning: that adequate funds will be collected over the operating life of a nuclear facility, such that, at the end of its useful life, the facility may be removed from service safely, without endangering the health and welfare of the public. The basic intent of this requirement is the same for both Canada and the U.S.: that the estimates for performing this future work be reviewed and updated periodically to capture economic trends, and technical advances in the performance of any field-related activities that would affect final decontamination and dismantling of a facility and changes in facility configuration or conditions.

This study addresses all activities necessary to comply with the applicable CNSC requirements and includes those decommissioning activities and work stages defined by the CSA's N294:19 'Decommissioning of Facilities Containing Nuclear Substances' [R-4].

Methodology

The methodology used to develop the decommissioning cost estimates for OPG follows the basic approach originally presented in the cost estimating guidelines[13] developed by the Atomic Industrial Forum (now Nuclear Energy Institute). This reference describes a unit cost factor method for estimating decommissioning activity costs. The unit cost factors used in this study reflect site-specific costs and the latest available information about worker productivity in decommissioning. The experience gained in the Shippingport Station Decommissioning Project, completed in 1989, as well as from TLG's involvement in the decommissioning planning and engineering for the Vermont Yankee, Chrystal River, Gentilly-2, Shoreham, Yankee Rowe, Trojan, Rancho Seco, Pathfinder and Cintichem reactor facilities, is reflected within this estimate.

An activity duration critical path is used to determine the total decommissioning program schedule required for calculating the carrying costs, which include program management, administration, field engineering, equipment rental, QA and security. This systematic approach for assembling decommissioning estimates has ensured a high degree of confidence in the reliability of the resulting costs in line with CSA N294:19 requirements.

Allowance

Consistent with accepted cost estimating practice, allowances are applied to the decontamination and dismantling costs developed as "specific provision for unforeseeable elements of cost within the defined project scope, particularly important where previous experience relating estimates and actual costs has shown that unforeseeable events which will increase costs are likely to occur."[14] The cost elements in the estimate are based on ideal conditions; therefore, the types of unforeseeable events that are almost certain to occur in decommissioning, based on industry experience, are addressed through a percentage allowance applied on a line-item basis. This allowance factor is a nearly universal element in all large-scale construction and demolition projects. It should be noted that allowances, as used in this estimate, does not account for price escalation and inflation in the cost of decommissioning over the remaining operating life of the station and subsequent storage period.

The use and role of allowances within decommissioning estimates is not a safety factor issue. Safety factors provide additional security and address situations that may never occur. Allowance funds, by contrast, are expected to be fully expended throughout the program. Inclusion of allowance is necessary to provide assurance that sufficient funding will be available to accomplish the intended tasks.

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13 T.S. LaGuardia et al., 'Guidelines for Producing Commercial Nuclear Power Plant Decommissioning Cost Estimates,' AIF/NESP-036, May 1986.

14 Project and Cost Engineers' Handbook, Second Edition, American Association of Cost Engineers, Marcel Dekker, Inc., New York, New York, p. 239.

Low- and Intermediate-Level Radioactive Waste Disposal

The contaminated and activated material generated in the decontamination and dismantling of a commercial nuclear reactor is classified as LLW and ILW. OPG has developed both 'fixed' and 'schedule-sensitive variable unit' disposal charges for both classifications of waste based on disposing of these products at the long-term disposal facility for L&ILW. Refer to Section 3.4.5 of the BNGS A and B Decommissioning Costing Studies [R-13] and [R-14] for a description of the applicable Bruce A and B waste management disposal rates, respectively. Note: disposal fees include transportation to the waste facility, the applicable tariffs, fees and mileage-related expenses.

High-Level Radioactive Waste

The disposition of high-level radioactive waste is limited to the used fuel generated from operations. This study includes the direct cost of removing fuel from the calandria to the fuel bays as a decommissioning expense after permanent cessation of operations. Other used fuel management costs are not considered and are accounted for separately by OPG.

Site Restoration

Site restoration, which includes the demolition of "clean" structures, will occur promptly after radioactive material has been removed from the station (site meets radiological release criteria).

Consequently, this study assumes that site structures within the restricted access area are removed to a nominal depth of one meter below the local grade level wherever possible. Foundation grade slabs greater than one meter in thickness will be abandoned in place and covered over with a layer of backfill. The site is then graded and stabilized.

Summary

This study provides an estimate for the decommissioning BNGS A and BNGS B under current requirements and is based on present-day costs and available technology. Tables are provided at the end of this section that summarizes the decommissioning costs by category and the costs organized by Work Breakdown Structure (WBS) element. The categories as used in the summary table include:

- Decontamination – The cost of decontaminating systems and structures.
- Removal – The cost of removing systems and structures.
- Packaging – The cost of packaging contaminated material for disposal.
- LLW and ILW Transportation and Disposal – The cost of transporting and disposing of contaminated material.
- Project Management – The cost associated with managing and supporting the decommissioning work activities.

- LLW and ILW disposal facilities – Incremental decommissioning-related costs associated with excavation and decommissioning (allocated among nuclear generating stations).

- Management of Heavy Water – The costs associated with the long term management of heavy water.

- Other – Those costs not directly associated with the cost categories described above, including – defueling, dewatering, EAs, energy, taxes, fees, insurance, overheads, etc.

- Allowance – The cost allocated to project allowance. This cost is applied to each WBS element and varies by element.

- Risk Contingency – The costs associated with decommissioning circumstances not included within specific WBS elements of the estimate. The risk contingency is included to address problems that are likely to occur beyond the project scope (i.e. unknown unknowns).

This information is extracted from the detailed work breakdown structure for each reactor unit and common systems/structures provided in Appendix C of the cost estimates. The schedule and sequence of decommissioning activities are identified in Section 4.0 of the cost estimates [R-15] and [R-16]. A detailed breakdown of the major cost contributors to the decommissioning cost estimate is reported in Section 6 of the cost estimates [R-15] and [R-16].

This cost analysis is designed to provide OPG with sufficient information to assess its financial obligations, as they pertain to the eventual decommissioning of BNGS A and BNGS B. It is a cost estimate prepared in advance of the detailed engineering preparations required to carry out the decommissioning and is based upon current industry experience.

Table B-1: Summary of Decommissioning Cost Estimate for BNGS A

Work Category	Costs Estimate 2022$ CDN[2] (thousands) [R-15]
Decontamination	36,361
Removal	455,786
Packaging	140,730
LLW and ILW Transportation and Disposal	128,439
Project Management (Utility & DOC)	803,692
LLW & ILW Waste Disposal Facilities	114,726
Management of Heavy Water	108,046
Other[1]	968,970
Sub-Total Direct Cost	**2,756,750**
Allowance[3]	495,081
Sub-Total Direct Cost with Allowance	**3,251,831**
Risk Contingency[4]	227,628
Total	**3,479,459**

Table B-2: Summary of Decommissioning Cost Estimate for BNGS B

Work Category	Costs Estimate 2022$ CDN[2] (thousands) [R-16]
Decontamination	35,917
Removal	453,640
Packaging	141,717
LLW and ILW Transportation and Disposal	113,958
Project Management (Utility & DOC)	795,638
LLW & ILW Waste Disposal Facilities	119,188
Management of Heavy Water	108,046
Other[1]	951,765
Sub-Total Direct Cost	**2,719,869**
Allowance[3]	479,457
Sub-Total Direct Cost with Allowance	**3,199,326**
Risk Contingency[4]	223,953
Total	**3,423,279**

Note:

(1) Other includes: Engineering and preparations, insurance, taxes, energy and facility maintenance, defueling, dewatering costs, etc.

(2) Columns may not add due to rounding.

(3) Allowance as a Percent of Direct Costs.

(4) Risk Contingency as a Percent of Direct Costs with Allowance.

Appendix C Compliance Matrix with CSA N294:19

Table C-1: 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.	1.3 5.2
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.	1.2, 1.4 1.3, 6.1, 6.2 11.0 1.3, 5.2
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 & 13.0 1.4 8.2 4.3.5, 4.4 9.1 9.2
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.	1.3 5.2
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).	4.3.8
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) 4.3.8, 4.3.9

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.	3.5 4.1.4.6, 4.3.7
5.4.3	All radioactive waste generated shall be characterized as per the CSA N292 series of Standards.	4.4

Section in CSA N294:19	Requirement in CSA N294:19	Section in This PDP
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. The strategy should be based on good management practices including the waste hierarchy.	4.4
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	A decommissioning strategy should be developed early in the life cycle of a facility (normally during the siting phase) and should be reviewed and updated as new information is obtained. The strategy should contain a high-level approach and rationale for decommissioning the facility, which will be further developed in decommissioning plans. The owner shall demonstrate that, under the strategy selected, the facility will be maintained in a safe configuration at all times.	1.3 3.4.1
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. In-situ decommissioning is an acceptable practice for uranium mines and mills. Additionally, in-situ decommissioning may be considered a viable solution under exceptional circumstances (e.g., following a severe accident) or for legacy sites for which decommissioning was not planned as part of the design, and which will remain under institutional control for the foreseeable future. In order to align with international best practice, in-situ decommissioning should not be considered a reasonable decommissioning option for situations where removal is possible and practicable. Note: Legacy sites (in the Canadian context) specifically refer to research and demonstration facilities dating back to the birth of nuclear technologies in Canada for which decommissioning was not planned as part of the design.	N/A
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.	2.2.8.1, 2.2.8.2 3.1 4.0

Section in CSA N294:19	Requirement in CSA N294:19	Section in This PDP
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 Appendix B
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.	4.1, 3.5 11.0 13.0 3.6, 4.1.2, 4.2.4, 8.1 4.1.3, 6.4 1.1, 3.3 4.1 (4.1.1 - 4.1.4) 1.2.1, 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, surveillance and maintenance shall be conducted to ensure the health and safety of persons and the protection of the environment.	4.1.1, 4.1.2, and 4.1.4

Section in CSA N294:19	Requirement in CSA N294:19	Section in This PDP
7.5.1	An assessment of the state of the facility shall be performed to provide baseline information for evaluating the hazards to be controlled during decommissioning. A thorough field survey shall be performed and supplemented by a review of existing records, as required.	3.6, 4.1.2, 4.1.4.3, 4.3.7, 8.1 3.5, 4.1.4.4, 4.1.4.6, 4.3.7, 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
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.	3.6, 4.2.4, 4.4.1.2, 8.0, Table 8-1 N/A

Section in CSA N294:19	Requirement in CSA N294:19	Section in This PDP
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 4.4
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.	4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 4.3.6

Section in CSA N294:19	Requirement in CSA N294:19	Section in This PDP
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
8.1.9.1	Surveys during decommissioning shall be performed to comply with (a) worker occupational safety and radiation protection programs; (b) environmental monitoring criteria; and (c) processes to release materials and equipment from the site.	4.3.7
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.	4.3.7, 4.3.9
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

Section in CSA N294:19	Requirement in CSA N294:19	Section in This PDP
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, 4.3.8
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.	4.3.7
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, 4.2.5, 4.3.4, 4.3.9

Table C-2: Compliance Matrix between CSA N294:19 Annex A and this Plan

Section in CSA N294:19 Annex A	Requirement in CSA N294:19	Section in This PDP
A.2 (a)	A PDP may include the following: a description of the location of the facility, including (i) a map of the facility and its specifications; (ii) geographic information; (iii) details regarding the surrounding environment; (iv) land uses; and (v) illustrations and maps of the facility in relation to the municipality;	Figure 2-1, Figure 2-2, 2.1 2.3 2.1, 2.3.4 7.2
A.2 (b)	purpose and description of the facility, including (i) primary components and systems; (ii) building type and construction, including location of any hazardous building materials (e.g., asbestos, PCBs); (iii) building services (e.g., power, heating, ventilation, sewer, water, fire protection); (iv) laboratories and other hazardous handling areas; (v) type, quantity, and form of radioactive and hazardous materials stored, produced, or used during operation; and (vi) design features used to reduce the spread of contamination and facilitate decontamination and dismantling;	2.2 Figure 2-2, Figure 2-4 2.2 4.4.2.1, Table A-1 2.2.4 2.2 Table A-1 Appendix A, 2.2.5
A.2 (c)	post-operational conditions, including (i) a summary of the shutdown process, including planned removal of stored inventories of hazardous materials or radioactive materials; (ii) the predicted nature and extent of contamination remaining in the primary systems and components (in list or table format with reference to applicable illustrations); (iii) the predicted nature and extent of contamination on floors, walls, work surfaces, ventilation systems, etc.; and (iv) the identification of any separate planning envelopes; and (v) an overview of the principal hazardous conditions anticipated to exist	4.1, 4.1.4, 4.1.4.5 3.5, Table 4-1 Appendix A, 3.5, 4.1.4.6 3.4.2, 4.2.4 8.0

Section in CSA N294:19 Annex A	Requirement in CSA N294:19	Section in This PDP
A.2 (d)	the decommissioning strategy, including (i) the final end-state objective; (ii) rationale for (1) the decommissioning strategy selected; (2) interim end states; (3) periods of storage with surveillance; and (4) in-situ decommissioning concepts; (iii) the requirements for long-term institutional controls; and (iv) 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, 4.3.8 3.4.1 N/A: No long-term institutional controls will be established. 3.4.1, 3.4.3
A.2 (e)	a plan of the decommissioning work, including i) a work breakdown structure; ii) a summary of the main steps for decontamination/disassembly/removal of each of the systems (preferably grouped into work packages); iii) for each work package, identification of those types of activities that could pose a significant hazard to workers, the public, or the environment; iv) the role of existing operational standard procedures for radiation protection, hazardous materials handling, industrial safety, and environmental protection in managing hazards; v) specific activities for which additional protection/mitigation procedures will be required at the detailed planning stage; vi) a summary of the final dismantlement of the structures; and vii) 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;	Appendix B 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 4.3.8, 4.3.9 4.0, Figure 4-1, Figure 4-2
A.2 (f)	radiological monitoring and survey commitments, including (i) a program for conducting periodic contamination surveys and the recording of contamination events during facility operation; (ii) a commitment to conduct detailed post-operation surveys in support of DDP development; (iii) a commitment to develop plans and protocols acceptable to the AHJ at the detailed planning stage for monitoring (1) work hazards during decommissioning; (2) personnel dosimetry; (3) environmental emissions and effluents; and (4) materials, sites, and structures to be cleared from regulatory control;	4.2.3, 4.3.7 4.1.4.4, 4.1.4.6, 4.3.7 4.1.1, 4.2, 8.0, 8.1.1, 8.2.1 - 8.2.3, 8.2 4.3.5, 4.3.6

Section in CSA N294:19 Annex A	Requirement in CSA N294:19	Section in This PDP
A.2 (g)	a waste management strategy specifying (i) the approximate quantities and characteristics of radioactive and chemically hazardous wastes expected to arise from the decommissioning (tied to specific work packages, if possible); (ii) the anticipated final disposition of radioactive and chemically hazardous materials; and (iii) a commitment to segregate as much material as possible for reuse and recycling;	4.4, 4.4.1, 4.4.2, Table 4-2, Table 4-3 1.5, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 4.4.3, 4.3
A.2 (h)	a commitment to prepare a DDP for regulatory approval prior to dismantling and demolition;	4.2.4
A.2 (i)	a commitment to periodically review and update the PDP until a DDP is prepared, in accordance with Clause 6.2.2;	1.1
A.2 (j)	the physical state of the facility at (i) the end of operations; and (ii) the start of decommissioning;	3.5 4.0, 4.1
A.2 (k)	the records required for decommissioning, including a description of the facility operational records that will be maintained to periodically update the PDP and prepare the DDP(s); and	11.0
A.2 (l)	a public consultation plan, including a public information program and avenues for public participation.	12.0
A.2 (m)	an indigenous engagement plan as per the requirements and guidance of CNSC REGDOC-3.2.2; and	12.0
A.2 (n)	the cost and a financial guarantee, specifying i) an estimate of the total present-value cost of the decommissioning; ii) a reasonable basis for how cost estimates were derived; and iii) a description of how the required funds will be provided;	5.1, 5.2 Appendix B

Table C-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 Appendix B
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.	2.1, 2.2, 2.2.8 2.2.2, 2.2.3 2.2.4, 2.2.5, 2.2.6, 2.2.7 1.5 4.3.8 3.6 3.4 4.0 4.4.1.1, 4.4.2, 4.4.3
I.5.1.1.1	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)

Item	CSA N294:19 Annex I	Section in this Plan
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
I.5.1.2.1	SWS (sometimes referred to as “storage with surveillance”) 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, 4.4.1.1, 4.4.1.2, 4.4.1.3
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.	4.4.2.3 4.3.6 4.3.8

Appendix D OPG and Bruce Power Interface Documents and Services

Table D-1: OPG and Bruce Power Services Interface Documents

Document Number	Document Title	Ownership
BP-PROC-00029	Active Liquid Effluent Waste Acceptance Criteria	Bruce Power
BP-PROC-00095	Site Traffic Management	Bruce Power
BP-PROC-00180	Security Clearances	Bruce Power
B-PROC-RA-00097	Vehicle Monitor Procedure	Bruce Power
BP-RPP-00018	Facility Access and Working Rights	Bruce Power
W-PROC-WM-0027	Landfill Waste Acceptance Criteria	OPG
W-PROC-WM-0048	Tritiated Deuterium Oxide Transportation Package Receiving, Handling, and Shipping	OPG
W-PROC-WM-0065	Lifting ISO-20 & ISO-40 Containers	OPG
W-PROC-WM-0032	Trillium Transportation Package Receiving, Handling and Shipping-Slurrying Resin Through Secondary Lid	OPG
W-PROC-WM-0033	Radioactive Shipments	OPG
W-PROC-WM-0035	Trillium Transportation Package Receipt/Handling, Loading Through the Primary/Secondary Lid	OPG
W-PROC-WM-0041	ISO 20/40 Package Receiving, Handling, and Preparation for Shipping	OPG
W-PROC-WM-0049	Roadrunner Transportation Package Receiving, Handling, and Shipping	OPG
W-PROC-WM-0040	Type A and Less Package Receiving, Handling and Shipping	OPG
W-PROG-WM-0002	Radioactive Material Transportation	OPG
W-PROC-WM-0078	Inrradiated Material Transportation (IMT) Package	OPG
W-PROC-WM-0081	Multipurpose Transportation Package (MPTP)	OPG

Table D-2: OPG and Bruce Power Interface Services

Service	Ownership
Scaffolding	Bruce Power
Maintenance Support	Bruce Power
Emergency Response	Bruce Power
Domestic and Fire Water	Bruce Power
Sewage and Storm Sewer	Bruce Power
Active Liquid Waste Disposal	Bruce Power
Electrical Power	Bruce Power
Dosimetry	Bruce Power
Effluent Monitoring, between OPG's NWMD and Bruce Power's Health Physics Laboratory	Bruce Power
Security	Bruce Power
Snow Removal	Bruce Power
Bus and Winter Storm Transportation	Bruce Power
Vehicle Radiation Detection	Bruce Power
Site Environmental Monitoring	Bruce Power
Chemical Analysis Laboratory Services for Heavy Water	Bruce Power
Centre of Site Laboratory Support – Certified Heavy Water Standards Preparation	Bruce Power
Centre of Site Laboratory Support – Support Services for NWMD	Bruce Power
Access to Space in the Leased Premises and the Retained Facilities	Bruce Power
Heavy Water Plant Monitoring and Demolition	Bruce Power
Bruce Power General Services	Bruce Power
Maintenance of OPG Transport and Work Equipment	Bruce Power
Landfill Services	OPG
OPG General Services	OPG
Transportation of Non-Waste Radioactive Material	OPG
Southern Ontario Seismic Network Program	OPG
Access to Spare Revenue Meter Instrument Transformers	OPG
Storage of Pressure Tube "Off Cuts"	OPG
Freon Storage	OPG