Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

Gentilly-1 Waste Facility Detailed Decommissioning Plan Volume 1 - Program Overview

61-508310-DDP-001817

Revision 1

Information Use

Approved by:	Julie Therrien	2024/05/30
	Manager, G-1 & DP Operations	Date

Effective Date: 2024/08/16

Expiry Date: 2029/08/14

Refer to ATOM for current version. Printed copies should not be considered current without first consulting ATOM.

Revision History

Rev. No.	Date	Details of Rev.	Prepared By	Reviewed By	Approved By
1	*2024/05/28*	*Issued as "Approved for Use".* *Major changes:* *Revised to* *i. Address the CNSC comments:* *- K. Campbell, Letter to J. Therrien, CNSC Staff response to CNL's Gentilly-1 Waste Facility Detailed Decommissioning Plan Volume 1 – Program Overview, Revision 0, 61-NOCN-23-0007-L, 2023 September 18.* *- W. Islam, Email to J. Therrien, G1 DDP Comments Review, 2024 January 11.* *ii. Align the schedule with current CNL Decommissioning timelines.*	*S. Bukhari*	*D. Couture*	*J. Therrien*
1D1	*2024/05/14*	*Issued for "Review and Comment".*	*S. Bukhari*	*D. Couture*	
0	*2023/03/23*	*Issued for "CNSC Acceptance".* *This document supersedes Gentilly-1 Waste Facility Preliminary Decommissioning Plan, 61-508310-PDP-001, Revision 3.*	*S. Bukhari*	*D. Couture*	*J. Therrien*
D1	*2023/01/26*	*Issued for "Review and Comment".*	*S. Bukhari*	*H. Athauda-Arachchige* *A. Bilton* *S. Brown* *R. Corcoran* *D. Couture* *F. Liu* *D. Morris* *A. Riopelle* *S. Scott* *M. Stever* *C. Stirling* *A. Taylor* *J. Therrien* *F. Trzebiatowski*	

Rev. No.	Date	Details of Rev.	Prepared By	Reviewed By	Approved By
				A. Postlethwaite	

Table of Contents

Section **Page**

Figures

Tables

1. Purpose and Scope

1.1 Introduction

The Gentilly Nuclear Generating Station (NGS) is a former nuclear power station located on the south shore of the St. Lawrence River in Bécancour, about 15 km east of Trois-Rivières and 100 km northeast of Montreal in the province of Québec. The Gentilly NGS site hosts two (2) shutdown nuclear reactors. The nuclear power plant includes the Gentilly-1 Nuclear Generating Station (G-1 NGS) (250 MWe), and the Gentilly-2 Nuclear Generating Station (G-2 NGS) (685 MWe). The G-1 NGS, now Gentilly-1 Waste Facility (G1WF), is owned by the Atomic Energy of Canada Limited (AECL) while G-2 NGS is owned by Hydro-Québec (HQ).

The G1WF consists of a permanently shut down and partially decommissioned prototype Canada Deuterium Uranium (CANDU) Boiling Light Water (BLW) reactor (CANDU-BLW-250) and its associated structures. Currently, the G1WF is maintained under Phase 2 Decommissioning (i.e., Storage with Surveillance (SWS) phase).

Atomic Energy of Canada Limited maintains ownership of the G1WF and leases the land from HQ, and Canadian Nuclear Laboratories (CNL[1]) operate the G1WF under the authority of a Waste Facility Decommissioning Licence (WFDL) [1] issued by the Canadian Nuclear Safety Commission (CNSC), pursuant to the *Class 1 Nuclear Facilities Regulations* [2].

1.2 Purpose

Canadian Nuclear Laboratories is currently planning for Phase 3 Decommissioning (i.e., Decommissioning & Demolition (D&D)) at the G1WF while continuing with the Phase 2 Decommissioning (i.e., SWS phase). This document, Detailed Decommissioning Plan (DDP) Volume 1: Program Overview, will replace the Preliminary Decommissioning Plan (PDP) [3] upon its acceptance by CNSC staff.

1.3 Scope

This document, DDP Volume 1: Program Overview, is intended to provide an overview of various decommissioning strategies and alternatives considered to achieve the final decommissioning end-state for the G1WF and describes how the G1WF site will be maintained in a safe, secure state during the ongoing SWS phase and future decommissioning activities. This document also describes individual facilities/buildings and their decommissioning approach, schedules, costs, funding, proposed monitoring, and surveillance throughout the decommissioning phases. This document also identifies the management system and work

[1] CNL was incorporated as a wholly-owned subsidiary of AECL on 2014 May 30 and officially launched on 2014 November 3. CNL later became a Government-owned, Contractor-operated (GoCo) private-sector company as of 2015 September 13.

program requirements that are to be followed for the Phase 3 Decommissioning (i.e., D&D) activities at the G1WF site.

The G1WF Phase 3 Decommissioning (i.e., D&D) in its entirety is planned under two (2) separate planning envelopes with each planning envelope being the subject of an individual DDP. Table 1 shows planning envelopes of G1WF along with their description (See Section 12 for details).

This document, *DDP Volume 1: Program Overview*, serves as a licensing-basis document, and does not seek regulatory permission to decommission and/or remove any of the buildings or structures at the G1WF site. Based on the overall G1WF site decommissioning priority, individual DDPs for the different planning envelopes will be developed and submitted to the CNSC for their review and acceptance.

Table 1: Decommissioning Planning Envelopes for G1WF

Planning Envelope	Description	Non-Nuclear/Nuclear
Planning Envelope A (PE-A)	• Southern Portion of Turbine Building including Tunnel to Reactor Building and Spent Fuel Canister Area • Basement Portion of Service Building including Spent Resin Storage Area	Nuclear
Planning Envelope B (PE-B)	Reactor Building: • Clear-Out including Calandria and Bioshield • Dome and Containment Structure	Nuclear

1.4 Out of Scope/Exemptions

This overview decommissioning plan does not consider the decommissioning of buildings or portions of the buildings that are owned by HQ, the land which is owned by HQ and where the entire G1WF is located on, buried services or process systems that are 1 m away from the building footprint perimeter, or buildings associated with the operation of G-2 NGS. Since the above-grade section of the Service Building belongs to HQ, the decommissioning scope for this building covered under this DDP is limited to the internal decommissioning and decontamination of AECL-owned portion of the building, (i.e., the Service Building basement and the below-grade spent resin storage tank and vaults). Also excluded from the scope is the north volume of the Turbine Building that was transferred to HQ after being cleaned to meet the Radiological Safety Zone (RSZ) 1 criteria.

Remediation/restoration of G1WF site for the next land use (i.e., end-state land use) is not within the AECL's jurisdiction and hence not considered in this document.

1.5 Regulatory Requirement

This DDP Volume 1: Program Overview document has been prepared to comply with the G1WF Licence Conditions 1.1 (Licensing Basis) and 2.1 (Decommissioning Plans) [4]. It is consistent with the requirements of CNL Cleanup Program [5] and meets the requirements of the Canadian Standard Association (CSA) N294:19 [6] and the CNSC REGDOCs including REGDOC-3.3.1 *Financial Guarantees for Decommissioning of Nuclear Facilities and Termination of Licensed Activities* [7] and REGDOC-2.11.2 *Waste Management: Decommissioning* [8].

2. Definitions and Acronyms

2.1 Definitions

The definitions listed in this section are taken from the CNSC REGDOC 3.6 *Glossary of CNSC Terminology* [9].

Preliminary Decommissioning Plan	An overview of a proposed decommissioning approach that is sufficiently detailed to assure that the proposed approach is, in the light of existing knowledge, technically and financially feasible and appropriate in the interests of health, safety, security and protection of the environment. **Note:** The decommissioning plan defines areas to be decommissioned and the general structure and sequence of the principal decommissioning work packages envisioned. As such, the plan forms the strategic basis for establishing financial guarantees and provides the structural outline of the subsequent Detailed Decommissioning Plan(s).
Detailed Decommissioning Plan	A plan setting out the detailed work program, safety and environmental protection procedures, and management systems that will be followed in the decommissioning of a licensed activity/facility. Note: Detailed Decommissioning Plans should evolve from the Preliminary Decommissioning Plan.
Storage with Surveillance	A planned stage during a decommissioning program during which the remaining nuclear substances, equipment, and site(s) are placed and maintained in a safe condition until decontamination and dismantling actions are performed. This state might also be referred to as Care and Maintenance.

2.2 Abbreviations and Acronyms

This document relies primarily on word meaning as found in common dictionaries. The current *Glossary of Controlled Terms and Acronyms* [10] contains specific meanings for those words that require further clarification.

AACE	The Association for the Advancement of Cost Engineering
ACM	Asbestos Containing Material
ACMR	Annual Compliance Monitoring Report

asl	above sea level
AECB	Atomic Energy Control Board
AECL	Atomic Energy of Canada Limited
ALARA	As Low As Reasonably Achievable, social and economic factors being taken into account
BLW	Boiling Light Water
CANDU	Canada Deuterium Uranium
CNL	Canadian Nuclear Laboratories
CNSC	Canadian Nuclear Safety Commission
COG	CANDU Owners Group
CAP	Corrective Action Plan
CSA	Canadian Standards Association
DCE	Decommissioning Cost Estimate
DCPs	Dose Control Points
DCGLs	Derived Concentration Guideline Levels
D&D	Decommissioning & Demolition
DDP	Detailed Decommissioning Plan
D&ER	Decommissioning and Environmental Remediation
DPWF	Douglas Point Waste Facility
DROL	Designated Representative of the Licensee
DRLs	Derived Release Limits
DWP	Detailed Work Plan
ECC	Engineering Change Control

EDDWP	Engineering Dismantling and Demolition Work Plan
EDRMS	Electronic Document and Records Management System
EmP	Emergency Preparedness
EnvP	Environmental Protection
EPC	Engineering, Procurement, and Construction
ERM	Environmental Remediation Management
FA	Facility Authority
FHA	Fire Hazard Assessment
FM	Facility Manager
FSS	Final Status Survey
G-1	Gentilly-1
G-1 NGS	Gentilly-1 Nuclear Generating Station
GoC	Government of Canada
GoCo	Government owned Contractor operated
G1WF	Gentilly-1 Waste Facility
G-2	Gentilly-2
G-2 NGS	Gentilly-2 Nuclear Generating Station
GM	General Manager
GHGRP	Greenhouse Gas Reporting Program
HF	Human Factors
HFEPP	Human Factors Engineering Program Plan
HWP	Historic Waste Programme

HQ	Hydro-Québec
HSSE	Health, Safety, Security and Environment
HSSE&Q	Health, Safety, Security, Environment, and Quality
HTPS	Heat Transport Purification System
HU	Human Performance
IAA	Impact Assessment Act
IAEA	International Atomic Energy Agency
IES	Interim End State
IIS	Items Important to Safety
ILW	Intermediate Level Waste
ISDC	International Structure for Decommissioning Costing
ISDCEX	International Structure for Decommissioning Costing Excel
ISO	International Organization for Standardization
IWC	Integrated Work Control
JHA	Job Hazard Analysis
LCH	Licence Conditions Handbook
LLW	Low Level Waste
LMP	Life Management Program
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MPS	Moderator Purification System
MSDS	Material Safety Data Sheet
MWe	Megawatt Electrical

MWh	Megawatt Hour
MoU	Memorandum of Understanding
NEWs	Nuclear Energy Workers
NGS	Nuclear Generating Station
NM&SM	Nuclear Materials and Safeguards Management
NPRI	National Pollutant Release Inventory
NSCA	Nuclear Safety Control Act
NPDWF	Nuclear Power Demonstration Waste Facility
NSDF	Near Surface Disposal Facility
OSH	Occupational Safety & Health
OPEX	Operating Experience
PCB	Polychlorinated Biphenyl
PDP	Preliminary Decommissioning Plan
PE	Planning Envelope
PIP	Public Information Program
PPE&C	Personal Protective Equipment and Clothing
QA	Quality Assurance
REGDOC	Regulatory Document
RP	Radiation Protection
RSZ	Radiological Safety Zone
RWA	Radiological Work Assessment
RWP	Radiological Work Permit

SAR	Safety Analysis Report
SFCA	Spent Fuel Canister Area
SMEs	Subject Matter Experts
SRC	Safety Review Committee
SRG	Stewardship and Renewal Group
SSCs	Structures, Systems, and Components
SWS	Storage with Surveillance
TDG	Transportation of Dangerous Goods
UHF	Ultra-High Frequency
WAC	Waste Acceptance Criteria
WANO	World Association of Nuclear Operators
WCAF	Work Control Authorization Form
WCP	Work Control Package
WEF	Waste Enquiry Form
WFDL	Waste Facility Decommissioning Licence
WL	Whiteshell Laboratories
WM	Waste Management
WMA	Waste Management Area
WMF	Waste Management Facility

3. Description of Site/Building/Facility

3.1 Introduction

The G1WF consists of a permanently shut down and partially decommissioned prototype reactor (CANDU-BLW-250) and its associated structures. After its complete shutdown in 1982 and attaining Phase 1 Decommissioning (i.e., Safe Shutdown State) in 1986, it has been maintained under Phase 2 Decommissioning (i.e., SWS phase).

3.2 Site Description

The Gentilly Nuclear Generating Complex consists of 240 hectares of land owned by HQ and provides an exclusion zone having a radius of 914 m on land from the units [11]. The exclusion of all unauthorized persons from this site limits exposure of the surrounding population and prevents any habitation, in accordance with the requirements and regulations of the CNSC. Figure 1 depicts the location and Figure 2 shows the site layout of Gentilly Nuclear Generating Complex including G-1 NGS (now G1WF) and G-2 NGS.

The G1WF is located close to the Bécancour Waterfront Industrial Park [12], which is situated on 7,000 hectares of land (Figure 3). The Gentilly NGS site is connected to Highway 30 and to Route 132. The bridge on Highway 55 allows access across the St. Lawrence River and connects the Bécancour Waterfront Industrial Park to the city of Trois-Rivières. The Bécancour Waterfront Industrial Park is served daily by the Canadian National Railway, and the Gentilly NGS site has its own rail head. Trois-Rivières airport and Montreal airport are located at 20 minutes from Gentilly NGS site and less than two (2) hours from Bécancour Waterfront Industrial Park.

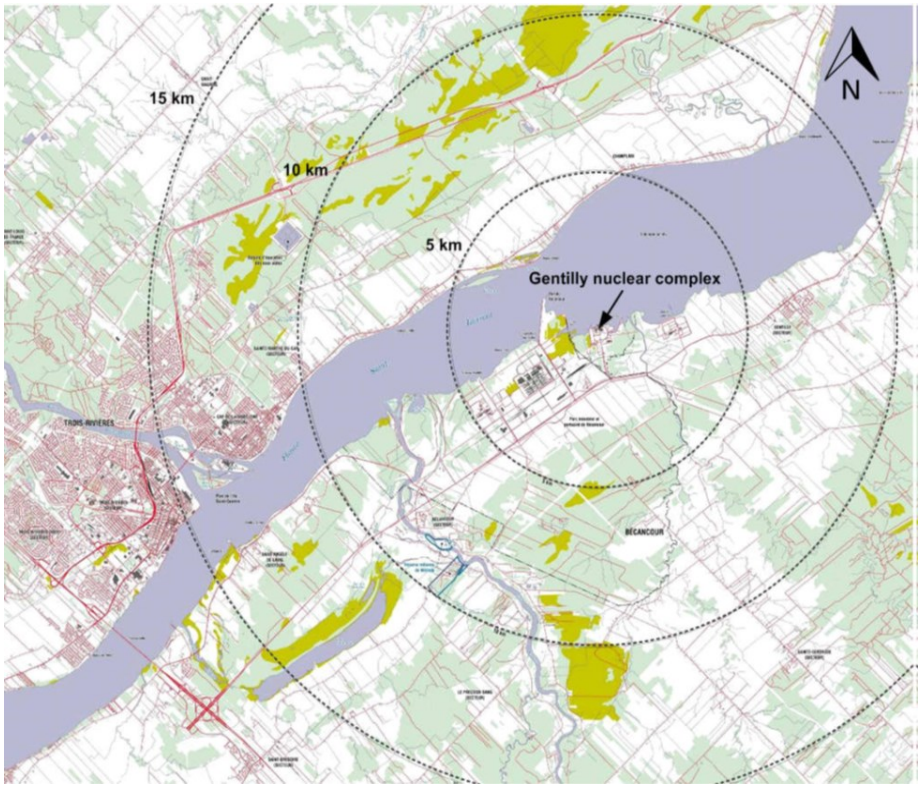

Figure 1: Location of the Gentilly Nuclear Complex

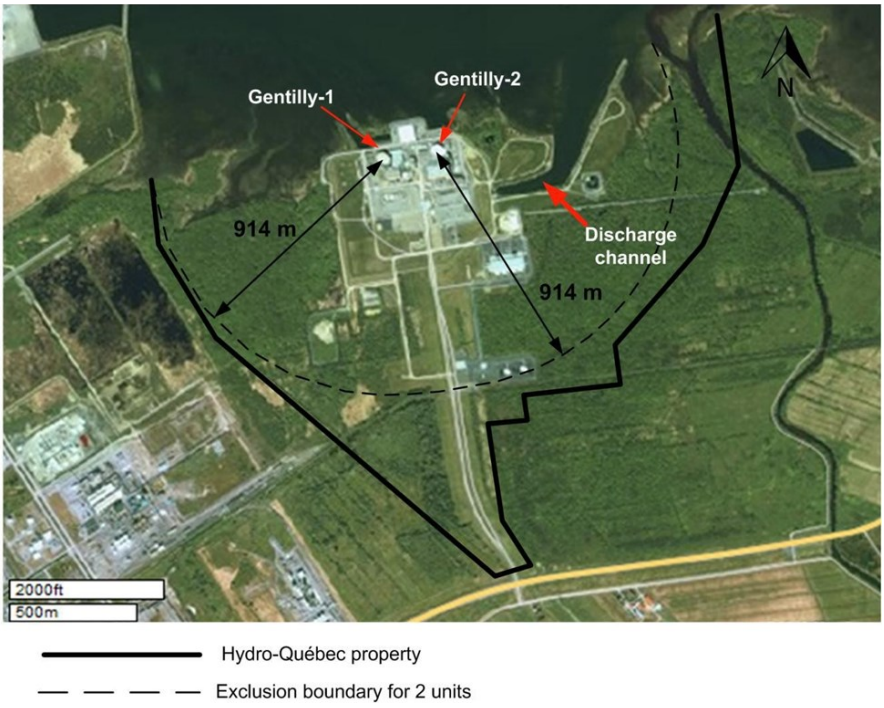

Figure 2: Gentilly Nuclear Complex Site Layout

Figure 3: Surrounding Region of the Bécancour Waterfront Industrial Park

3.3 Construction and Layout

The G1WF layout is shown in Figure 4. The G1WF includes following:

- Reactor Building
- Service Building
- Turbine Building
- Spent Resin Storage Area

Figure 5 shows the underground layout revealing connections of the Reactor Building with the Service Building Basement and the Spent Resin Storage Area.

The details of the G1WF buildings and structures are described in the following subsections.

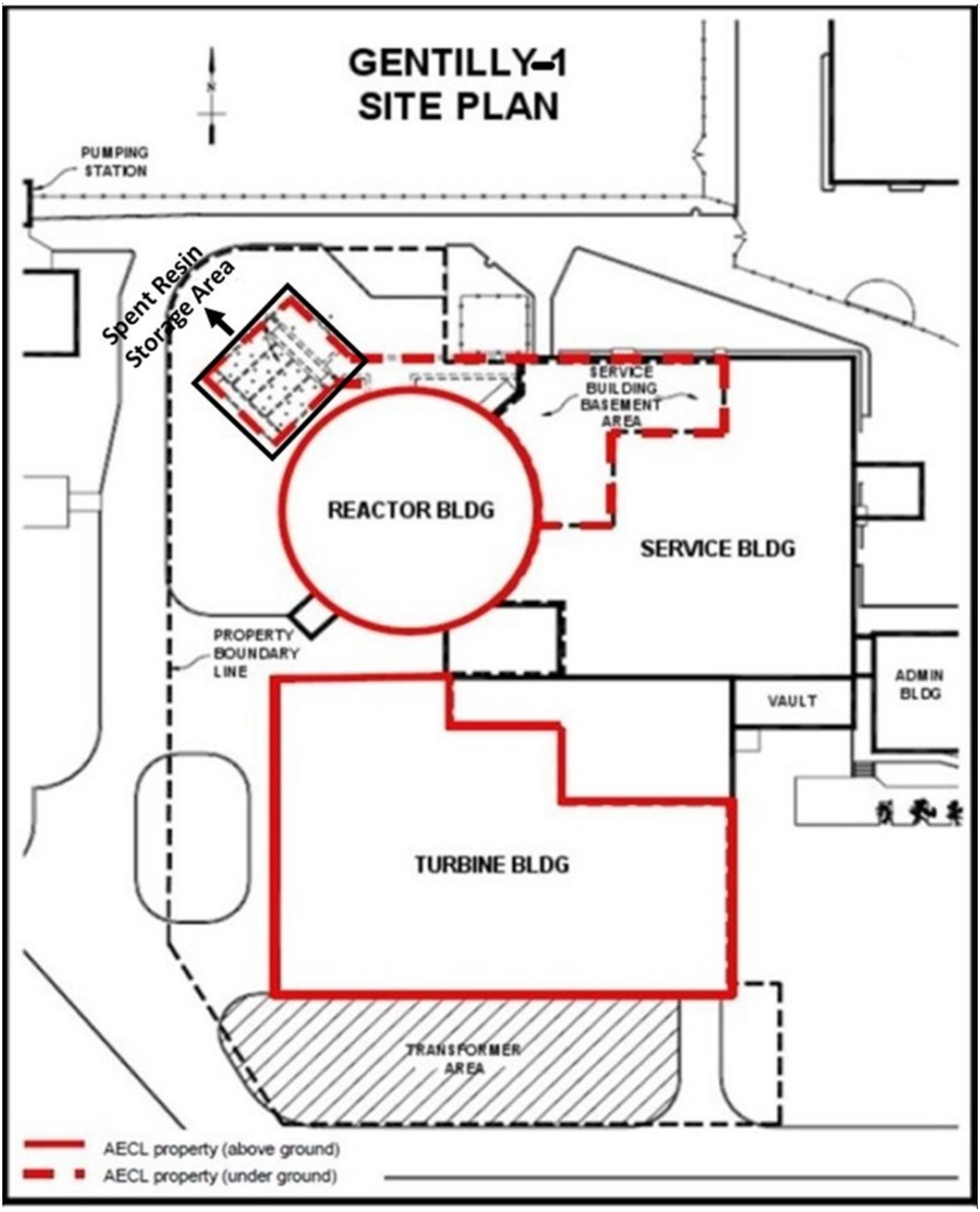

Figure 4: Gentilly-1 Waste Facility Layout

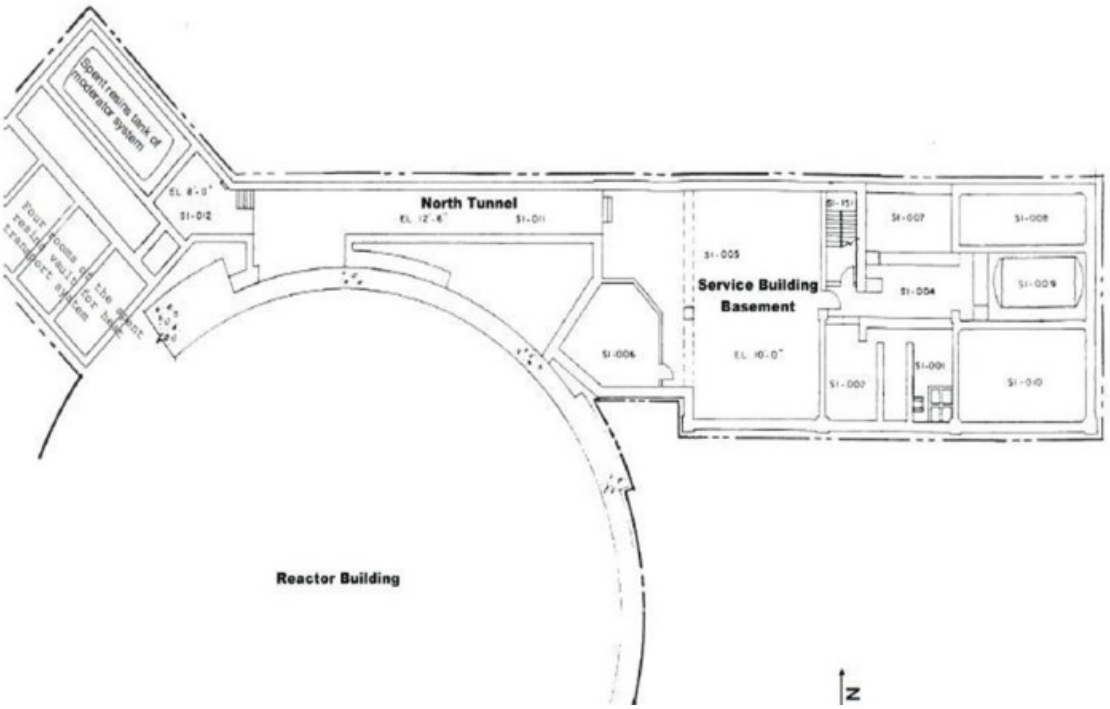

Figure 5: Gentilly-1 Waste Facility Underground Layout

3.3.1 Reactor Building

The main purpose of the Reactor Building was to house the reactor and its associated equipment and to provide containment. The Reactor Building was designed with an exterior containment structure and a separate internal structure that supports the reactor and its associated systems [11]. The Reactor Building exterior view, general layout, interior top view, and polar crane and dousing tank are shown in Figure 6, Figure 7, Figure 8 and Figure 9 respectively. Table 2 lists the approximate area of rooms in the Reactor Building.

Figure 6: G1WF Reactor Building – Exterior View

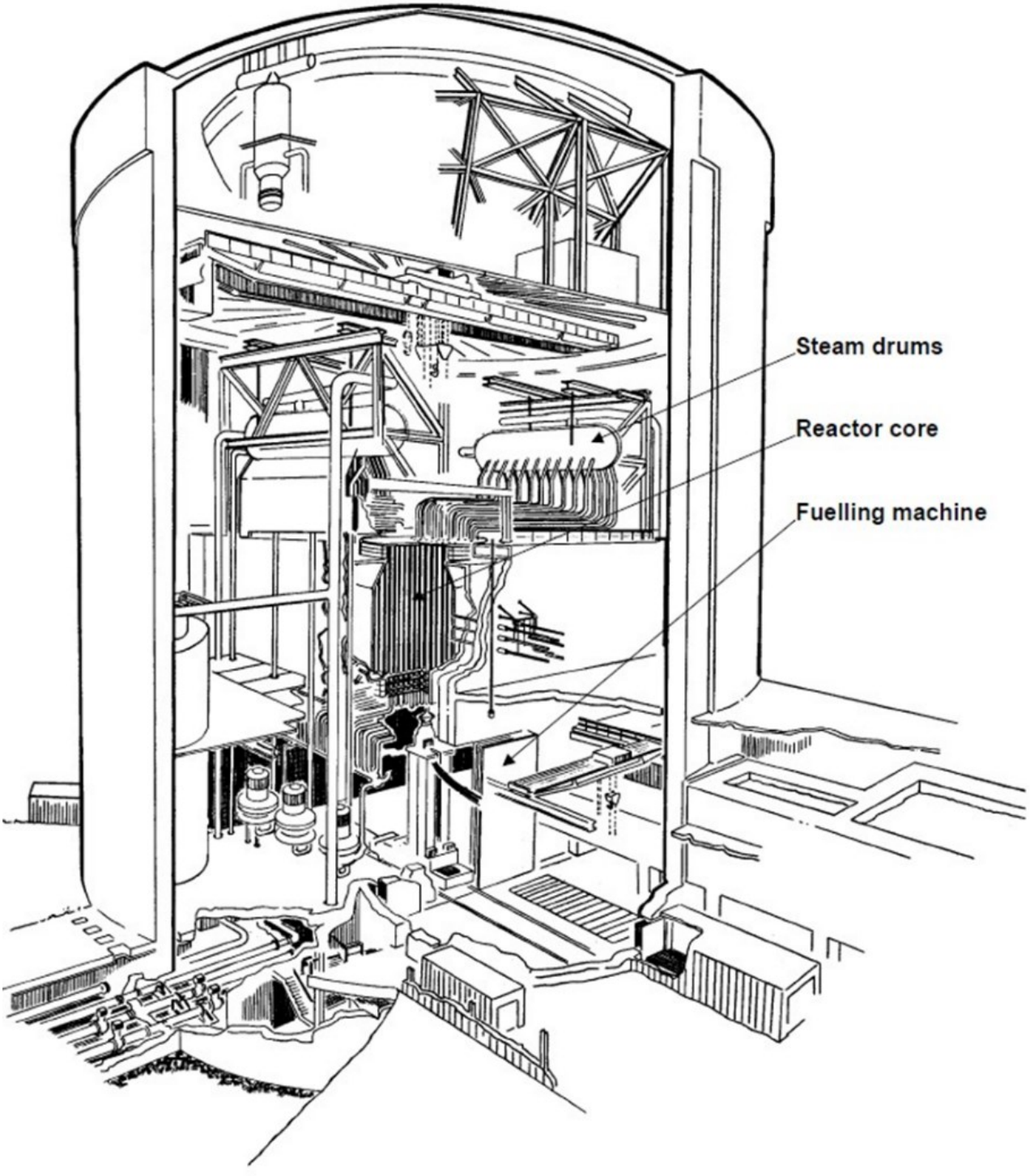

Figure 7: G1WF Reactor Building - General Layout

Figure 8: G1WF Reactor Building Interior Top View Showing Different Levels and Equipment

Figure 9: G1WF Reactor Building - Polar Crane and Dousing Tank (above the white structure)

Table 2: Approximate Area of Rooms in the Reactor Building

Room number	Approximate area (m^2)	Room number	Approximate area (m^2)	Room number	Approximate area (m^2)
R-001	13	R-105	133	R-204	51
R-002	13	R-106	133	R-301	13
R-003	52	R-107	196	R-302	13
R-005	43	R-108	80	R-303	44
R-006	28	R-109	53	R-304	51
R-007	133	R-110	7	R-401	79
R-008	133	R-111	4	R-402	95
R-009	36	R-112	5	R-403	130
R-010	142	R-113	42	R-404	237
R-011	196	R-114	28	R-405	134
R-101	13	R-201	13	R-406	134
R-102	13	R-202	13	R-501	965
R-104	142	R-203	68	R-601	318

The Reactor Building contained the CANDU-BLW-250 prototype reactor, which was fuelled with natural uranium in the form of zircaloy-cladded UO_2 pellets and moderated by deuterium oxide (i.e., heavy water). The reactor vessel (i.e., Calandria) is a vertical cylindrical vessel that contained the heavy water moderator and was traversed by 308 pressure tubes. The heat produced by the reactor fuel was removed by the light water coolant. The steam drum separated the steam produced by the core from the liquid coolant and delivered the steam to the turbine in order to generate 250 MWe of electrical output.

The external containment structure of the Reactor Building has a double functionality: to prevent the escape of radioactive particles; and to prevent the ingress of water (rain or flood) from the outside of the building. The containment structure of the Reactor Building is comprised of three (3) structural components: a concrete base slab (1.372 m thick) founded on rock, a cylindrical concrete outer wall (1.22 m thick), and a concrete dome (0.61 m thick). The containment structure of the Reactor Building encloses a total volume of 52,000 m^3. The original design required that the containment structure of Reactor Building prevent the escape of steam or radioactive gases in case of a severe nuclear accident.

The internal space in the Reactor Building is divided into six (6) levels including the basement. The internal structures serve to support the reactor core, heat transport systems, shielding, and safety systems, as well as associated equipment. As the fuel was removed and the process systems are out of operation, many of the functions and loads for which the structure was originally designed are now absent.

At the time of construction, the building was seismically classified as Zone 2, which was the seismic zone for the region at the time. This classification was based on the system of four (4)

seismic zones (0, 1, 2, and 3) with boundaries based on PGA at 0.01 annual probability of exceedance. For the Gentilly NGS site, this corresponded to a probability of 1 in 100 years for a seismic event with a PGA of 0.04 g. The design basis earthquake at the time was a PGA of 0.15 g [13].

An underground, non-radioactive drainage system (i.e., groundwater) remains operative in order to maintain the structural integrity of the Reactor Building. A dehumidifier is operated in the summer months to reduce humidity in the Reactor Building in order to prevent corrosion of the metal components and to prevent condensation on the walls and other surfaces.

During the initial decommissioning, the fuel was removed from the reactor core and was stored in the Spent Fuel Canister Area (SFCA), which is a dry storage facility located in Room T-110 of the Turbine Building. Furthermore, the heat transport systems and moderator systems were drained and dried.

During the static state of the G-1 NGS (now G1WF), the facility's equipment, operations tools, and supplies were disconnected, dismantled, and removed. The resulting waste materials were stored within the Reactor Building on different floors and in the Turbine Building. These legacy waste materials, totalling approximately 423,000 kg, were removed from the Reactor Building between 2017 and 2022.

No other activities, other than the regular SWS activities including hazard reduction campaigns, have been performed inside the Reactor Building since the completion of the initial decommissioning (1986). The details of SWS activities are described in the *Gentilly-1 Waste Decommissioning Storage with Surveillance Plan* [14].

3.3.2 Service Building

The original purpose of the Service Building was to provide storage, maintenance, overhaul, repair, and decontamination of equipment for the efficient operation of the nuclear generating station [11]. This building housed the Spent Fuel Bay, control room, helium storage tank, aqua-ammonia storage tank, radiation waste management facilities, laboratories, personnel change rooms, and station ventilation equipment. Figure 10 shows a southward exterior view of the Service Building, while Figure 11 shows the layout of the Service Building basement.

Figure 10: Service Building Exterior View (Southward)

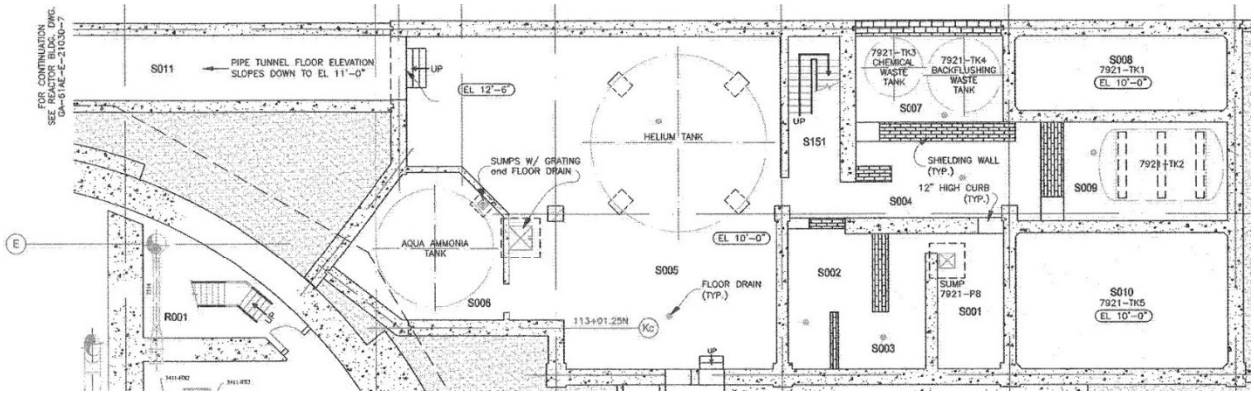

Figure 11: Service Building Basement Layout

The dimension of the Service Building is 49.7 m by 44.2 m [11]. The structure of the Service Building consists of a conventional steel frame with a reinforced concrete basement and floors. It is anchored to the bedrock by a concrete foundation. The outer walls are constructed of concrete blocks covered with external metal cladding.

The Service Building is divided into two (2) sections (i.e., north and south). The north section is two (2) storeys high with a basement below, while the south section is four-storeys high (without a basement).

As part of the initial decommissioning activities at G-1 NGS during 1984 to 1986, the Service Building was isolated from other structures and all process systems were removed.

In 1993, AECL and HQ agreed that only the basement of the Service Building remained as AECL property as part of the G1WF [15]. All of the remaining areas transferred to HQ were cleaned to meet HQ Zone 1 (uncontaminated area) criteria. All process systems which traversed the boundaries were severed on CNL's side and capped if contaminated.

In the AECL portion of the Service Building, only the sump systems are operative. The sumps have been decontaminated and are manually pumped when high levels are detected during visual inspection. No other activities, other than regular SWS activities including hazard reduction campaigns and characterization, have been performed inside the Service Building since the completion of the initial decommissioning (1984-1986). The details of regular SWS activities are described in the *Gentilly-1 Waste Decommissioning Storage with Surveillance Plan* [14].

In 2020, a characterization survey of the materials and equipment present in the Service Building basement was conducted to identify both radiological and non-radiological/chemical contaminants and the findings are summarised in *Characterization Report for Material and Equipment in the G-1 Service Building Basement* [16] (see Section 6.1.1.4.3 for details).

3.3.3 Turbine Building

The exterior view of the Turbine Building is shown in Figure 12 and Figure 13 while ground floor layout of the Turbine Building is presented in Figure 14. The Turbine Building is a rectangular structure 68.6 m by 48.2 m with a partial basement [11]. The concrete foundations are built on solid bedrock and the super structure has following six (6) levels:

- Level 000 (Elevation 0.9 m to 5.9 m above sea level (asl))
- Level 100 (Elevation 7.2 m asl)
- Level 200 (Elevation 11.4 m to 12.1 m asl)
- Level 300 (Elevation 13.7 m to 14.8 m asl)
- Level 400 (Elevation 19.36 m asl)
- Level 600 (Elevation 27.5 m to 28.5 m asl)

No modification to the Turbine Building structure has been made since the commissioning of the concrete canisters and the completion of the spent fuel transfer.

The Turbine Building (Figure 13 & Figure 14) is divided into following three (3) independent entities:

- Spent Fuel Canister Area
- South Volume
- North Volume

The Turbine Building was designed for a combination of dead load, live load, wind, and the earthquake loading conditions. After the reactor shutdown in 1984, a safety assessment was conducted to store the spent fuel at the G-1 NGS site and the Turbine Building was chosen to host the SFCA [11] [17] because following reasons:

- The Turbine Building was AECL property.
- The Turbine Building was qualified in term of the seismicity and the flooding.
- The Transportation distance between the spent fuel bay and the SFCA was minimum.
- The indoor handling and transportation were possible.
- It enabled easy monitoring, control, and supervision of the area by the site personnel.

Since 1986, the AECL portion of the Turbine Building is under regular SWS activities which are described in *Gentilly-1 Waste Facility Decommissioning Storage with Surveillance Plan* [14]. During the 2014-2015 period, approximately 293,500kg of legacy waste was removed from Turbine Building. Some asbestos repairs were also conducted to ensure the safe storage of building during the ongoing SWS phase.

In 2017, a detailed characterization survey of the Turbine Building was conducted to appraise the non-radiological (i.e., chemical and hazardous substances) and radiological contaminations on equipment, systems, and components including process piping [18].

Figure 12: Turbine Building Exterior View (Eastward)

Figure 13: Turbine Building Sections (Top View)

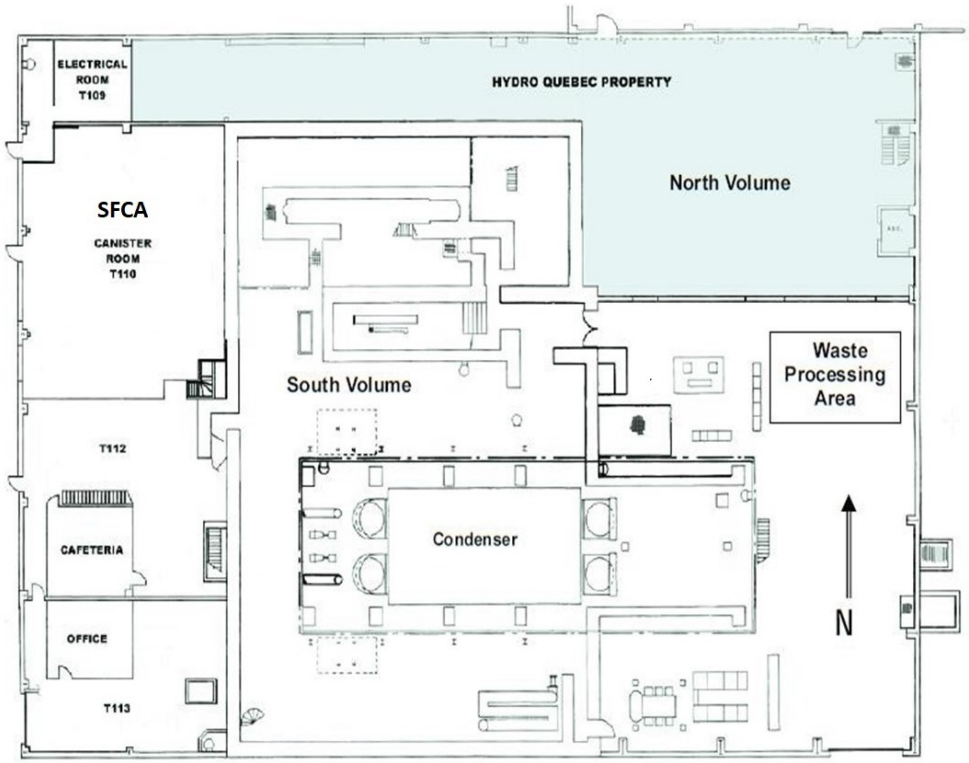

Figure 14: Turbine Building Layout (Ground Floor)

3.3.3.1 Spent Fuel Canister Area

The SFCA of the Turbine Building is AECL property.

3.3.3.1.1 Layout

The SFCA is described in detail in *Gentilly-1 Spent Fuel Dry Storage Canisters Turbine Building Room T-110 Layout General Arrangement* [19]. The SFCA is a dry storage facility with 11 concrete canisters and is located in the Turbine Building Room T-110. During the initial decommissioning (1984-1986), the spent fuel was removed from the reactor core and packaged in the fuel baskets which were stored in the concrete canisters.

The SFCA is enclosed by following four walls:

- Block wall on north.
- Block wall on south.
- Shielding wall on east.
- Block wall on west.

To support the future spent fuel basket retrieval activities, the SFCA has been modified [20]. The current layout of the SFCA is shown in Figure 15.

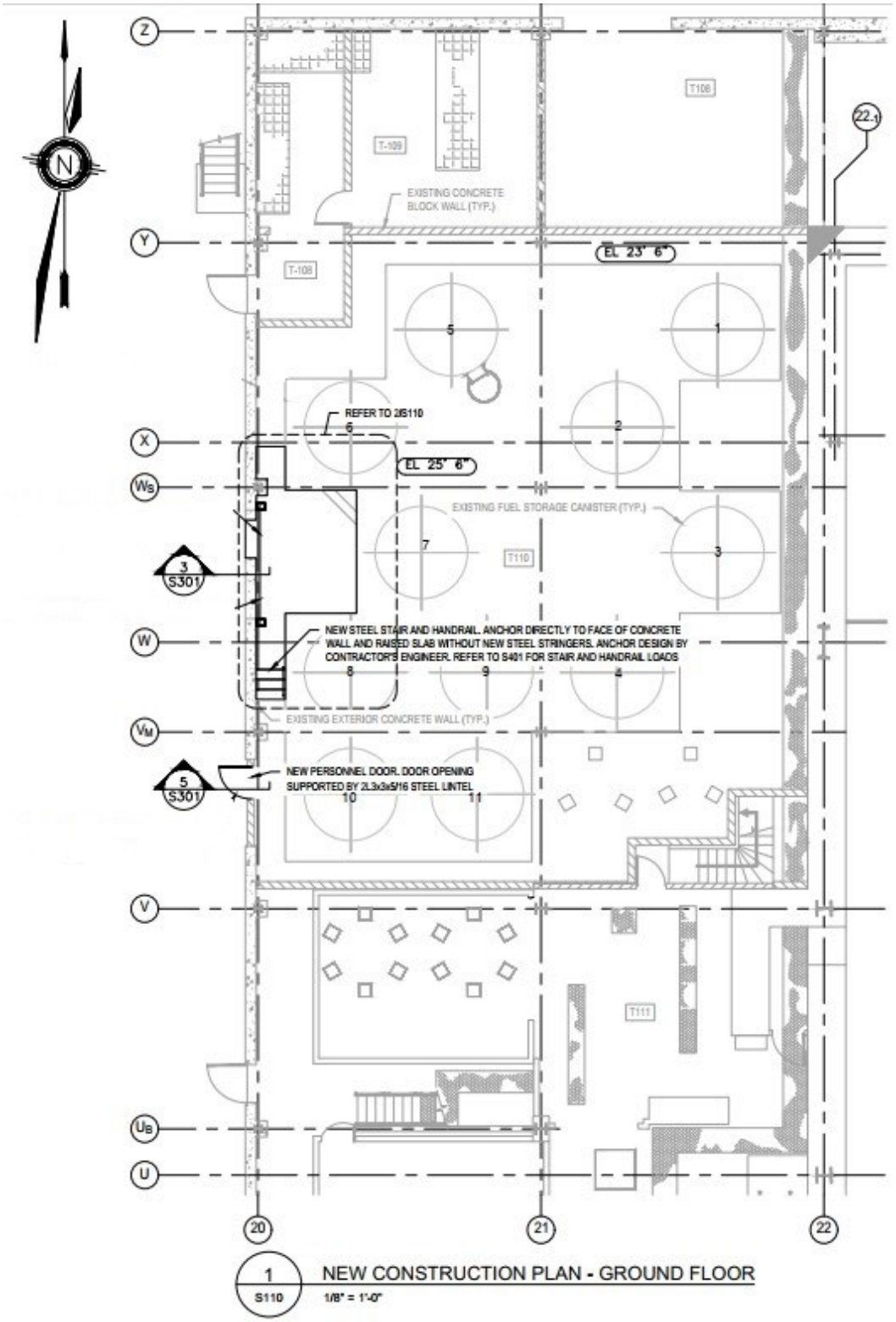

Figure 15: Spent Fuel Canister Area Building Layout

3.3.3.1.2 Concrete Canisters

There are 11 concrete canisters housing spent fuel baskets in the SFCA Room T-110. Each concrete canister is a cylindrical reinforced concrete shell with an internal liner of standard weight carbon steel pipe liner. Each concrete canister has an outside diameter of 2.59 m (8.50 ft), is 6.0 m (19.7 ft) high, and has an inner cavity with a diameter of 0.845 m (33.3 in). The internal surface of the steel liner of each concrete canister has an epoxy paint coating to prevent corrosion and to facilitate decontamination should it be required. Each concrete canister provides a combined shielding of 86 cm (33.6 in) of concrete and 0.95 cm (0.374 in) of steel.

The concrete canisters are designed for dead weight, wind, thermal, and seismic loads to meet the following conditions during or after a Design Basis Accident [17]:

- No release of radioactive material from the concrete canisters above site release limits.
- No loss of effective shielding from the concrete canisters above the design limits.
- No significant tilt of the concrete canisters.

3.3.3.2 South Volume

The South Volume of the Turbine Building is owned by AECL. The South Volume of the Turbine Building hosts the turbine generators (i.e., turbine systems and their associated equipment). The turbine systems are made up of metals and concrete. The south volume of the Turbine Building also includes the tunnel which leads to the Reactor Building. This tunnel is a confined space and is not easily accessible.

Figure 16 shows the high-pressure turbine located in the South Volume of the Turbine Building.

Figure 16: Turbine Building - High Pressure Turbine System

3.3.3.3 North Volume

The North Volume of the Turbine Building was previously within the AECL property boundary but has since transferred to the HQ after being decontaminated to meet the HQ's RSZ 1 criterion [15]. The North Volume of the Turbine Building is excluded from the scope of this DDP.

3.3.4 Spent Resin Storage Area

The Spent Resin Storage Area (Figure 17) is located adjacent to the basements of the Service Building and the Reactor Building and consists of two (2) reinforced concrete vaults and one (1) stainless steel tank [21].

The south part of the Spent Resin Storage Area is the Heat Transport Purification System (HTPS) resin storage tank (7921-TK8) which is a reinforced concrete vault and is divided into four (4) sections (i.e., A, B, C, and D). The floors and walls of the HTPS resin storage tank are covered with fibre glass reinforced epoxy lining consisting of a primer coat and several body coats with two (2) layers of cloth and two (2) finishing coats of white gloss epoxy seal.

Across the north and south ends and spanning the four (4) sections of the HTPS resin storage tank are pipe galleries. Access to the south gallery is by a manhole at the southwest corner. The access was necessary to operate the valves to direct the spent resin to the desired direction. The north gallery spans the ends of the four (4) sections of the HTPS resin storage tank and contains valves and piping to drain excess water, following a resin transfer, to the resin tank sump. Access to the north gallery is by a manhole at the northwest corner.

At the northeast of the north gallery is the HTPS resin storage tank sump. The access to the HTPS resin storage tank sump is by a manhole. Attached to the north side of the north gallery is the Moderator Purification System (MPS) resin storage vault which contains a stainless steel tank (3451-TK1).

The HTPS and MPS resin storage tanks (i.e., reinforced concrete tank and stainless steel tank) contained spent ion exchange resins used in the deionization of the HTPS cooling water and the MPS water [22].

The HTPS spent resins were originally stored under water. The water was then drained during the initial decommissioning, eliminating any possibility of water leaking to the surrounding soil. The MPS and auxiliary systems resins were stored under a water cover in the original stainless steel tank during operation.

Since the end of the initial decommissioning, only minor changes have been made to the Spent Resin Storage Area structure to complete the safe removal of the stored resins.

The spent resins were removed in 2018, as part of a hazard reduction campaign [23]. The HTPS spent resin was packaged and sent to CRL's Waste Management Area (WMA) for storage. While MPS spent resin recovered from MPS was sent off-site for processing and volume reduction. The processed and volume-reduced MPS spent resin was packaged and sent to CRL WMA for interim storage. In 2019, characterization of the emptied tanks and vaults was

completed, and the results have been summarized in *Gentilly-1 Spent Resin Storage Structure Characterization Report* [24].

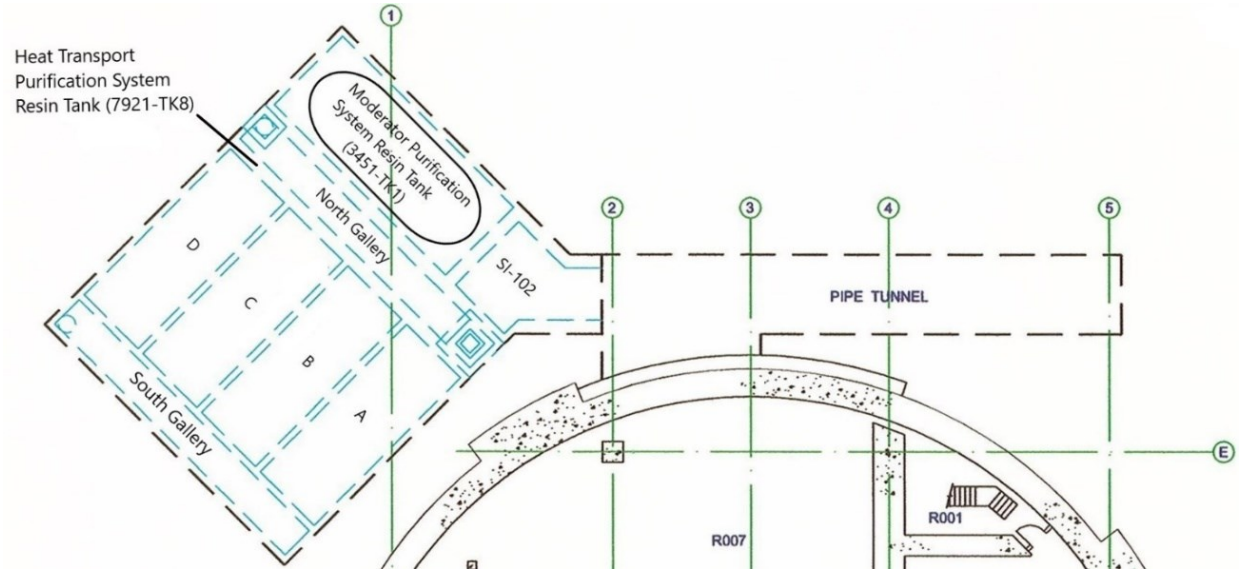

Figure 17: G1WF Underground Spent Resin Storage Area

3.4 Major Building Services and Process Systems

The building services and process systems at G1WF have been classified into Items Important to Safety (IIS) and Items not Important to Safety. The IIS consists of Spent Fuel Canisters, Reactor Building Containment, and Fire Alarm System. While Items not Important to Safety include Turbine Building Containment, Alarms, Radiation and Contamination Monitoring Equipment, Fire Protection System, Drainage System, Water and Sewer, Heating, Class IV Electrical Power Supply, Security, and Lighting.

3.4.1 Items Important to Safety

3.4.1.1 Spent Fuel Canisters

The Spent Fuel Canisters are used to store the dry spent fuel that resulted from G-1 NGS operations. To ensure the integrity of the canisters, each canister is provided with a closed-circuit air-circulating sampling system to allow monitoring of the internal space between the canister liner and the sealed fuel baskets [25]. The objective is to assess the presence of fission products and/or moisture. The system consists of a disc glass filter, a charcoal cartridge, and a moisture trap placed in series with the intake of a Gast pump. The exhaust is returned to the canister.

3.4.1.2 Reactor Building Containment

The structure of the G1WF Reactor Building provides a barrier that prevents the escape of any potential loose contamination to the environment. Although slight degradation of the containment structures is possible, significant effects of degradation are prevented through building inspection and maintenance programs.

The external containment structure has the following functions:

- Prevention of escape of radioactive particles.
- Prevention of ingress of water (rain or flood) from outside of the building.

3.4.1.3 Fire Alarm System

A fire alarm system covers part of the Turbine Building (RSZ1 only) and the Reactor Building entrance. Fire alarms in temporary structures erected for decommissioning are installed and removed as required. The fire alarm panel is located in the TB electrical room.

The fire panel status and alarms are signalled locally and remotely on the annunciation system located at the La Prade site guard post.

The remote signalling of the fire panel status and alarms is assured by means of two (2) systems, (i.e., via internet and via a microwave (UHF) transmission system).

3.4.2 Items Not Important to Safety

3.4.2.1 Turbine Building Containment

The containment of the Turbine Building provides a barrier that prevents the escape of any potential loose contamination to the environment. Although slight degradation of the containment structures is possible, significant effects of degradation are prevented through the building inspection and maintenance programs.

The external containment structure has the following functions:

- Prevention of escape of radioactive particles.
- Prevention of ingress of water (rain or flood) from outside of the building.

3.4.2.2 Alarms Annunciation System

The G1WF is provided with a remote annunciation system located at the La Prade site guard post and is monitored at all the times.

The system consists of a computer that receives fire alarms via internet and the status of certain SSCs via the microwave transmission system.

The computer displays labeled fire alarm zones and the following alarms:

- Power failure
- Fire alarm
- Fire trouble
- Underground sump water high level
- Building access doors status

3.4.2.3 Radiation and Contamination Monitoring Equipment

The following radiation detection equipment is used at G1WF during routine inspections:

- FH-40G survey meter to measure contact gamma dose rates on the spent fuel canisters and gamma dose rates in Reactor Building.
- Ludlum 29-29 alpha/ beta sample counter to analyze swipes.
- Inspector 1000 detector to monitor low-level gamma radiation.
- Hand & Foot monitors to detect alpha/beta contaminations and gamma radiation fields.
- Whole-body monitors to detect alpha/beta contaminations, and gamma radiation fields.
- Waste bag monitor to detect gamma radiation field/contamination.

During the execution of SWS (routine, non-routine, and hazard reduction) and decommissioning (Phase 3 Decommissioning) activities following equipment will be used:

- iCAM which measures airborne alpha/beta contaminations.
- Hand & Foot Monitor which measures alpha/beta contaminations and gamma radiation fields.
- Whole body monitor which measures alpha/beta contaminations and gamma radiation fields.
- Scintrex which measures tritium in air.

3.4.2.4 Fire Protection System

The firefighting service is provided by the municipal fire departments of the town of Bécancour. The Fire Protection System at G1WF consists of portable fire extinguishers and on-site fire hydrants. The portable fire extinguishers are located inside all buildings, at specific locations. In the event of a fire at G1WF, the on-site fire hydrants would be used. HQ is responsible for the operation and maintenance of fire hydrants.

3.4.2.5 Drainage System

G1WF drainage system consists of the following:

- Building Drainage System
- Groundwater Drainage System

3.4.2.5.1 Building Drainage System

The building drainage system consists of sumps that are located indoors at a low elevation and as such, collect any water from within the buildings. These include:

- Two (2) sumps located in S/B (S-001, S-012).
- Four (4) sumps located in T/B (T-002, T-004, T-005, T-007).
- One (1) sump in the Spent Resin Vaults that discharge by gravity to the sump located in Room S-012.

Water accumulated in the building sumps is manually pumped into totes using portable pumps. The collected water is then sampled, analysed for tritium and beta/gamma-emitting radionuclides, and eventually transferred overland to HQ. If the analysed collected water meets the HQ's acceptance criterion (i.e., beta/gamma = 5.3E+13 Bq/a and Tritium 1.1E+19 Bq/a) then it is disposed of via HQ's Outfall Discharge Pipe. However, if the analysed collected water does not meet the HQ's acceptance criterion, then it is sent to Chalk River Laboratories (CRL) Waste Treatment Centre for processing and disposal.

3.4.2.5.2 Ground Water Drainage System

Two (2) underground drainage sumps located around the periphery of the Reactor Building with permanently installed pumps. The sumps collect any precipitation and groundwater from around and underneath the Reactor Building. A weeping tile system also directs groundwater from the Spent Resin Storage Vaults to the Reactor Building underground sumps.

These sumps are automatically drained upon high-level detection to the storm water system of HQ's G-2 NGS, which ultimately discharges to the St. Lawrence River.

3.4.2.6 Water and Sewer System

Domestic water and fire water are supplied from HQ to the G1WF. It is important to note that no fire water is supplied inside the AECL-owned buildings. The sewage water generated in the maintenance shop is directed to an underground septic tank, which is emptied by a local contractor when full.

3.4.2.7 Heating and Ventilation System

The maintenance area located in the Turbine Building comprises a workshop (T-113), an RP instruments room and a change room (T-112). The workshop and RP equipment room are provided with electrical heaters. The change room is equipped with an air exchanger and air conditioning unit.

There is no forced ventilation at the G1WF. However, there are three (3) louvres (one 2 ft x 2 ft louvre in the Reactor Building and two (2) 15 ft x 9 ft louvres in the southern part of the Turbine Building) at the facility, which can potentially contribute to fugitive airborne emissions. To determine whether or not effluent monitoring and environmental monitoring are required at G1WF, the *Gentilly-1 Waste Facility Effluent Monitoring Plan* [26] assessed relevant information and supporting data in the Safety Analysis Report (SAR) and other reports that contained radiological sampling campaigns for airborne releases and corresponding analytical results, and found that any adverse effects from these fugitive airborne emissions are insignificant as it would require an implausible combined passive exhaust flow rate of 3,500 m^3/s through these louvres in order to trigger a dose to the public of 0.0005 mSv/a. Therefore, there is minimal or no source for airborne radioactivity release from the routine operations of the G1WF.

3.4.2.8 Class IV Electrical Power Supply

G1WF electrical power (Class IV) is supplied by HQ via distribution panels located in the Turbine Building electrical room (T-109). The system includes the following equipment:

- Two (2) 347/600, 225A distribution panels DP-1 and DP-2
- One (1) 600/120-208V, 9kVA transformer
- One (1) 120/208V distribution panel DP-1E
- Two (2) 347/600V, 200A fused disconnect switches DS1 and DS2

The distribution panel DP-1 is normally kept powered on and supplies the lighting area in the canister area, the panel DP-1E 120/208 V, and the lighting and heating in the electrical room. All circuits supplied by DP-1E are kept powered on including the fire alarm system, drainage system, and microwave transmission control unit.

The distribution panel DP-2 has only two (2) circuit breakers kept powered on: the reactor building sump pumps and heating in the electrical room. The other circuit breakers of DP-2 are powered off. Local distribution panels are also located in different areas of the facility.

3.4.2.9 Security System

Security services are provided by HQ in accordance with the CNSC Nuclear Security Regulations. Road access to the G1WF requires that visitors pass the fence boundaries of the Gentilly complex via security gates staffed and controlled by HQ personnel. Visitors to the Gentilly complex and the G1WF require authorization in accordance with established HQ procedures.

3.4.2.10 Access Control

All external access doors to the Reactor Building, as well as the areas of the Service Building and the Turbine Building that are included in the G1WF (AECL property), are kept closed and locked outside of normal work hours.

An intrusion alarm system is also installed on some doors of the G1WF buildings, which annunciate at the La Prade Heavy Water Asset Facility guardhouse annunciator when a door is opened.

3.4.2.11 Lighting System

Lights within the Turbine Building, Service Building, and Reactor Building are normally left on with the exception of the lighting in the Hall area (T-102) and Lubrication Oil area (T-112 & T-302) of the Turbine Building.

4. Operating History

The G-1 NGS, a 250 MW CANDU-BLW prototype reactor (CANDU-BLW-250), was put into service in 1972. This reactor attained full power only twice and was operated intermittently for a total of 183 effective full-power days until 1978, when it was determined that certain modifications and considerable repairs would be required. The station was then put into a layup state in 1980, and it was decided not to rehabilitate the plant in 1982. The decision to decommission the reactor was made in 1983.

A two (2) years initial decommissioning program began in 1984 (Phase 1 Decommissioning (i.e., Safe Shutdown State)), to bring the G-1 NGS to an interim safe and sustainable shutdown state that is equivalent to SWS as defined by the CNSC [8]. Activities included defueling the reactor, draining the moderator, and removing all other combustible and flammable materials from the site. Additionally, the facility's equipment and operations tools and supplies were also disconnected, dismantled, and removed. The resulting waste materials were stored within the Reactor Building on different floors and in the Turbine Building in sealed crates or drums. These waste materials were collectively referred to as DAW (see Section 3.3.1 and Section 3.3.3 for details). After the completion of the two (2) years decommissioning program in 1986, the achieved state of the G-1 NGS was termed Phase 2 Decommissioning (i.e., SWS). Since 1986, the G-1 NGS (now G1WF) has been maintained in SWS phase.

The operating responsibility of the G-1 facility was transferred from HQ to AECL in 1985. The Service Building and the northern portion of the Turbine Building were turned over to Hydro-Québec in 1994, after it was verified that this area met Hydro-Québec's Zone 1 radiological criteria (as defined in their *Gentilly-1 Power Plant Health Guideline and Radiation Protection Standards* [27]).

In 1999, a Waste Management Facility Operating Licence was issued by the Atomic Energy Control Board (AECB) to G-1 Site. In 2014, a Waste Facility Decommissioning Licence was issued by the CNSC covering three (3) prototype waste facilities (i.e., G1WF, Douglas Point Waste Facility (DPWF), and Nuclear Power Demonstration Waste Facility (NPDWF)) [28]. In 2014 July, the CNSC issued a new WFDL [29] which covered all three (3) Prototype Waste Facilities (G1WF, DPWF, and NPDWF). The basis of that licence approval was for the continued SWS phase and did not consider decommissioning of the facilities. In 2018 July, CNL requested CNSC approval that the existing combined WFDL be divided into three (3) separate licences, one for each prototype reactor facility (i.e., G1WF, DPWF, and NPDWF) [30]. Decommissioning strategies may vary from one prototype reactor site to another depending on the reactor characteristics, site characteristics, and the surrounding environment. Further, the final decommissioning of these sites will be carried out under different timelines. As such, decommissioning of nuclear facilities at any of these reactor sites will require a licence amendment specific to that site, and invokes various stakeholder participation and dialogue during the preliminary planning phase. This includes engaging the local communities, the elected municipal and provincial officials, Indigenous peoples, special interest groups, etc., and addressing their concerns/feedback.

Therefore, a stand-alone, site-specific decommissioning licence would make the licence amendment process less cumbersome from a regulatory perspective. To this effect and based on CNL's request [30], the CNSC issued a separate, new licence to G1WF in 2019 February [1].

In 2014 November, AECL officially launched a wholly owned subsidiary, the CNL which is now responsible for the operation of all CNL facilities including the G1WF.

4.1 Operating History: Operational Incidents and Accidents

Table 3 lists the unplanned events/accidents that originated either within the nuclear area buildings and structures of the G-1 NGS and contributed to contamination and/or radiation releases or elsewhere on the site.

Table 3: Gentilly-1 Nuclear Generating Station Operational Incidents and Accidents

Year	Unplanned Events
1970	• Oil leak was found in the reactor coolant pumps and motors. • Steam leakage occurred in the 12-inch coolant flow control valve. • Fuel channel end panel seal had a problem. • Liquid from sump was blown into the Reactor Building.
1971	• Non-planned transfer of D_2O green poison to the reservoir. • Heavy water was leaked on a half-inch line between orifice flange on inlet line to booster position 8 and valve 3211-V140. This caused tritium concentration in the reactor building to reach 16 CMA. • Heavy water was leaked due to failures of helium blower 3. • Leak occurred in the heat transport circuit. • Leak occurred from the heat transport pumps (331-P1, 3311-P3 and P5). • 3321 HX-1 Gasket was failed which resulted in a leak on the purification interchanger. • Crack on H-6 Outlet Feeder caused leakage. • Two (2) closures in T-9 and T-10 were leaking at fuel pressure. • Dump valves were leaking. • Gasket for heat transport purification system was failed which resulted in leak. • Main condenser-cracks were revealed on baffle plates attached to the steam dump line. • Cavitation was found on process water system 7131-P2. • Corrosion and crack were found on main condenser. • Standby condenser was leaked. • Tritium was leaked from valves, pipe joints, and moderator pump seals in the Reactor Building. • Surface contamination in R1-010 and R1-113 which was caused by leaks in

Year	Unplanned Events
	pressure tube end fittings and fuelling machine. • Contamination was released in Turbine Building due to opening of the "cases-vide" and starting of the pump without liquid. • Active liquid waste spill occurred in the Service Building active from the liquid waste system.
1972	• Fire was discovered in the terminal cabinet below the generator. • M-50 pressure regulator was malfunctioned. • Radiation fields from the Turbine steam lines were found to be higher than expected at 100% power. • Problems occurred due to malfunctioning of the drum pressure regulating system. The turbine governor was replaced, and an accumulator was installed on the oil system to the bypass control valves. • A stuck pushbutton led to an out-of-phase synchronization of the unit. • High vibrations on an alternator bearing were observed. The coupling between the turbine and the alternator was realigned, and the alternator end bearing was overhauled. • Continuing problems were observed with one of the reactor feed water pumps. The motor bearing was heated up. The problem was traced to improper adjustment of the pump thrust bearing. Then abnormally high vibrations were detected on the pump. Pump realignment, trimming of the pump stand to change the natural frequency of the unit, and the installation of an overhauled rotating element were tried in order to solve the problem. • During the run-up to 100% power, it was found that one (1) condensate extraction pump was insufficient to handle the flow. Therefore, two (2) 100% pumps were operated in parallel. • Low condenser vacuum was experienced. One time this problem was fixed by removing a large quantity of fish from the inlet water box. Other time this problem was fixed by correcting a low condenser vacuum by increasing the supply pressure to the steam ejectors. • A leak was discovered on the outlet feeder at N-19 and repaired. • South standby condenser was leaked. • The North standby condenser started up spuriously on one occasion. The problem was due to plugged instrument lines. Plugged instrument lines were a recurrent problem on the heat transport system. • Some of the liners on the butterfly valves were found damaged. Pieces of liners were discovered in the heat exchangers when the latter were opened up for repairs.

Year	Unplanned Events
	• Low absorber cooling flow observed which was corrected by cleaning the circuit inlet strainer. • Vibration problems on one of the feed-water pumps observed which limited reactor power to 55%. Repairs and cleaning the lubricating oil circuit were performed. • A disconnected instrument airline was found on the pressure control valve of the South standby condenser and the corresponding valve was found seized on the North standby condenser. • Isolating valves of the standby condensers found leaked which were repaired. • The anti-tilt protection ion chambers were causing spurious openings of protective channels. The problem was caused by high neutron flux at the inner end of the ion chambers, resulting in sudden discharges. This problem was fixed by adding cadmium shielding to the ion chamber plugs. • Failure of some brace welds developed cracks on the steam dump line. • Failure of one (1) of the heavy water pumps and required replacement of the shaft. • Tritium was found in the process water discharge of Moderator Heat Exchanger. • Five (5) tubes of Moderator Heat Exchanger were failed due to leakage. • Iodine was released from failed fuel. • Outlet feeder weld was leaked. • Radiation level was exceeded outside the Turbine Building.

Year	Unplanned Events
1973	• Two (2) instrument lines from the steam drum were found blocked. The material was analysed as ammonium carbonate and iron oxide. • Inspection of a moderator heat exchanger revealed accumulation of solid particles at an area of stagnant flow. • It was discovered that air lines on four (4) dousing system valve actuators were incorrectly connected to the actuators. The lines were changed to the proper connections. • Two (2) low-pressure process water pumps failed. The pump shaft support column had broken on both pumps, on one pump just below the packing gland and on the other at the centre shaft bearing. The pump impellers were also found to be badly eroded. • On pump 7131-P4 the inner column failed at the gland, on 7131-P2 the inner column failed at the middle bearing, and 7131-P1 was shut down due to high vibration caused by erosion of the impeller. All of the pumps were found to have badly damaged impellers due to cavitation. These low-pressure pumps were repaired. • Excessive vibrations were observed on circulating water pump 7121-P1. The pump thrust and guide bearing, and the upper motor bearing were found damaged. The pump thrust and guide bearings were repaired, and a new motor upper bearing was ordered. • A leakage occurred into the fuel channel gas annuli.
1974	• Inspection of the circulating water pump impellers revealed erosion damage similar to the damage suffered by the low-pressure process water pumps. • The cavitation damage was found at three (3) of the eight (8) holes that were drilled in the plug and also at the lower seat ring. • Main pumps 3311-P2 and P5 were found to have high vibration which was fixed by balancing their motors. • During the Reactor Building leak test, a leak was discovered in the main steam isolating valves. The defective valves were repaired. • Inspection of the heat exchanger 3314 TKl on the failed fuel detection system revealed that the coils were leaking badly due to stress corrosion cracking failure. • Site tests of the heat transport system main flow control valve actuators with the main pumps running indicated that the air supply to the air cylinders was inadequate. This meant that the valves could not be closed completely. The air pressure was increased from 55 to 65 psig and further commissioning showed that the higher pressure allowed full control of the valve over its entire range.

Year	Unplanned Events
	• 355 gallons of heavy water was spilled in fuelling machine close to channel Q15.
1975	• The shaft of a low-pressure process water pump was found broken and was repaired. • Three (3) poison injection shutdowns occurred as a result of process system mal-operations. • Pump P-4 had to be shut down because of the seal leakage. • Seals of Pump P-6 were failed. • The shaft of a low-pressure process water pump was found broken. • The flow control valve on the discharge of pump P-1 was stuck while being closed, then released suddenly. The transient resulted in a poison injection shutdown caused by the pressure change in the inlet header. • A poison injection shutdown resulted from a pressure transient following a turbine trip when the alternator was being synchronized. • Cavitation damage was found on low-pressure process water pump impeller. • A corrosion failure of the soldered joints of the cooling coils in the dousing tank. • The drainage of valve 4133-V32 caused discharge of 180 gallons oil in T115. • Steam was leaked in the Turbine Building resulting in atmospheric contamination. • The heat transport system was not pressurized because of high vibration problems on main pump 3311-P5. • Seals of heat transport system main pumps 3311-Pl, P3 and P4 were leaking.
1976	• Heavy water was leaked from the moderator heat exchanger (HX1 and HX2).

Year	Unplanned Events
1977	• A leak from moderator heat exchanger was found. • Leaks from tubes in heat exchanger (R14-S14 and R19-52 in HX2 and R3-S49 and R6-S47 in HX1). • Leaks were found from turbine bypass valve (4331-CV104) • Leak occurred from ammonia storage tank (3322-TK-1) to floor. • Water was found dripping from the insulation of one of the generator hydrogen coolers service water outlets pipes prompted site mechanics to remove the insulation and discover small hole in the pipe wall. • Leaks at spent fuel bays occurred due to temperature decrease. • Leaks were found from the south wall of the bay about eleven feet below the water surface. • Pitting occurred on the inside of condenser tubes. • Pressurization and Leak Test of Reactor Building revealed some issues with the airlock system.
1978	• Containment leakage occurred through the ventilation of Reactor Building. The areas included: - The space between inlet 7314-DM1 and DM2. - Exhaust duct DM3 and DM4. - DM1 and DM2.
1979	• Multiple boosters were leaked and led to tritium level rise in the Reactor Building. • Leakage found from main pump P-3. • Leakage discovered from standby condenser valves (P102-MV2, P152-MV2, T105-CV, T155-CV). • Main HTS pump leakage (Pump 2 and 6) was discovered. • River water was leaked into main condenser which increased level of sodium and calcium. • Water leakage occurred at pump house ground by the pipe supplying high pressure service water for cleaning of the travelling screens. • M-50 pressure controller steam was leaked. • Steam was leaked to standby condensers p102-CV.

4.2 Post-Operational Condition and Current Status

Since the start of Phase 2 decommissioning (i.e., SWS) activities in 1986, the G1WF has been maintained in a safe, sustainable, secure, and static state. The SWS activities have continued and included routine inspections and regular monitoring of the facility to ensure that the facility is kept in a safe static condition and that there is no hazard to the public at large or negative impact on the environment [14].

The stand-alone G1WF licence [1] allows the continued SWS activities which excludes Phase 3 Decommissioning (i.e., D&D) activities. Canadian Nuclear Laboratories maintains a systematic monitoring and inspection program and implements the surveillance and Life Management Program (LMP) activities according to the schedules listed in *Gentilly-1 Waste Facility Decommissioning Storage with Surveillance Plan* [14] to ensure that the G1WF remains in a safe, sustainable, and secure state until such time that the facility reaches the final decommissioning end-state (see Section 5 for details).

5. Storage with Surveillance

5.1 General

Currently, G1WF is under SWS phase and operating under a CNSC WFDL [1]. The G1WF SWS care and maintenance is being conducted in accordance to the *Gentilly-1 Waste Facility Decommissioning Storage with Surveillance Plan* [14]. The SWS phase will continue to be substantially applicable to the care and maintenance of the G1WF even during Phase 3 Decommissioning (i.e., D&D) activities to return the G1WF to a defined end state as agreed upon with the HQ and the regulator (i.e., CNSC). However, the surveillance activities and efforts will reduce as more buildings and/or Structures, Systems, and Components (SSCs) are removed from the G1WF or the hazards within the buildings and/or SSCs are reduced/eliminated. As such, the prescribed care and maintenance activities related to a building, areas or structure as noted in the *Gentilly-1 Waste Facility Decommissioning Storage with Surveillance Plan* [14] will cease once that building, area or structure or the related hazard has been removed. Following a building removal or facility change, the G1WF surveillance activities and their schedules will be reviewed for their continued applicability and safety relevance, and the *Gentilly-1 Waste Facility Decommissioning Storage with Surveillance Plan* [14] will be updated as needed. Planned reductions or the eliminated activities and any other changes made to the remaining SWS activities, or their schedules, will also be described in the individual DDPs covering those buildings/structures. The changes to SWS commitments, such as reducing the frequencies of surveillance activities and/or ageing-related structural evaluations or even abandoning a pre-scheduled activity altogether will be subject to Facility Authority (FA) approval.

5.2 Responsibilities

The current organizational structure for G1WF has been described in Section 17.

5.3 Functional Services and Systems

The existing functional services and systems at G1WF has been described in Section 3.4.

5.4 Monitoring, Surveillance, Testing, Evaluation, and Maintenance Activities

The majority of routine monitoring, surveillance, testing, and maintenance activities of G1WF buildings and SSCs, including IIS, are performed by the G1WF personnel on regular work days (between 7:00 a.m. and 5:30 p.m. Monday to Thursday, excluding holidays). Some other part of the CNL organisation or contractors may assist in completing these activities.

Radiological work at the G1WF, whether it is routine or non-routine follows the Radiation Protection (RP) requirements [31]. The routine monitoring requirements for radiation fields and contamination levels of workplace air and work areas are provided in *Radiation and Contamination Workplace Monitoring Routines* procedure [32]. Radiological monitoring at the

G1WF consists of direct and indirect contamination surveys for both alpha and beta/gamma and dose rate measurements of the building interior and exterior [33]. Based on the survey results, the building areas are assigned a RSZ rating in accordance with *Radiological Areas and Zones* procedure [34]. The G1WF zoning survey and the corresponding RSZ ratings are provided in *Radiological Safety Zone Plan for Gentilly-1 Waste Management Facility* [34] and Table 5 (Section 6.1.1.1).

Prior to assigning personnel for routine monitoring and surveillance activities, they are provided required trainings and pre-job briefs. All work at the G1WF will be performed or supervised by the designated trained personnel. The routine/periodic monitoring and surveillance activities at the G1WF include:

- Inspections or assessments of the buildings/structures in the interests of ensuring and maintaining effectiveness and/or safety over both the immediate and longer term.
- Surveillance to deter and/or detect undesirable activity (such as trespassing, damage to property, exposure to, or theft of nuclear substances in general and used nuclear fuel in particular).
- Environmental monitoring of radioactive releases (solid, liquid, or gaseous), from G1WF to the environment, including any significant adverse impacts on the environment and the public.
- Compliance monitoring and reporting to assess, demonstrate, and report the degree of compliance with applicable regulatory requirements and criteria.
- Periodic evaluation of structures as per the LMP and implementation of remedial actions as necessary.

5.5 Usage Boundaries during Storage with Surveillance

The main routine activities in the G1WF will be related to the surveillance, monitoring, and testing of the facility and maintenance of SSCs needed to maintain the Facility in its safe and permanent shutdown state.

CNL may perform some other non-routine activities to reduce risks at the G1WF during SWS which include following:

- Reduction or removal of radioactive legacy waste including combustibles and obsolete disconnected equipment.
- Reduction or isolation of Asbestos Containing Materials (ACM).
- Reduction or removal of loose hazardous wastes.

Other activities at G1WF may include following:

- Scoping and characterization work to support SWS maintenance activities and decommissioning planning.
- Activities to confirm the configuration and integrity of SSC.

- Work to install (and/or remove) support systems and equipment as needed to safely perform these activities.

Canadian Nuclear Laboratories may also use available area within the G1WF site for the following:

- Housekeeping activities.
- Assembling, commissioning, testing, handling, and storage of decommissioning equipment, tools, and supplies.
- Lay down area or workspace to perform maintenance work, fabrication, testing, and repair to G1WF components or decommissioning equipment.
- Segregation, packaging, interim storage, and shipping of waste material.
- Decontamination.

Any proposals for using the readily accessible areas of the buildings at the G1WF site during the SWS period for activities outside of those described above shall be subject to the Facility Manager's (FM) review and the FA approval.

Any work performed at G1WF shall:

- Remain within the scope of the G1WF licence [1],
- Conform to all applicable programs and standards identified in Section 8, and
- Obey existing radiological zoning and follow the RP programs process for any proposed modifications to not interfere with the future decommissioning scope or strategy of the facility.

Once the G1WF moves to Phase 3 Decommissioning (i.e., D&D), the usage boundaries will be adjusted to allow the decommissioning of the buildings/structures as defined in Section 3.3.

5.6 Facility Change or Modification Process

No change shall be made to the physical design or equipment at G1WF that would result in impact on health, safety, or the environment that is different in nature or greater in magnitude than those considered by the SAR [22], without the prior written approval of the Commission or a person authorized by the Commission (Licence Condition 7.1).

If improvement activities are required for attaining the safe sustainable storage state of any of the buildings, structures or areas, the following requirements will need to be followed:

- Assess whether the activity/change falls within or outside the scope of Licence Condition 7.1 and choose the path forward accordingly.
- Repairs and/or minor modifications to SSCs to maintain the Facility in a secured shutdown state do not require approval from the CNSC but shall be authorized by the FM and FA.
- All changes to physical design or equipment at G1WF will be subject to FM and FA approval and follow Decommissioning Process [35], Engineering Change Control (ECC)

procedure [36] and Independent Technical and Readiness Reviews [37] as applicable, and the requirements of CNL Programs identified in Section 8, as required.

6. Hazards Assessment

6.1 Hazards during SWS Phase

The hazards which may invariably exist at the G1WF during the current SWS phase (i.e., Phase 2 Decommissioning) include:

- Radiological Hazards
- Chemical Hazards
- Industrial Hazards
- Biological Hazards
- Environmental Hazards

The details of above listed hazards are provided in [15] and [22]. A brief description of these hazards is outlined in the following subsections.

6.1.1 Radiological Hazards

A radiological inventory at the completion of Phase 1 Decommissioning is provided in *Gentilly-1 Waste Storage Facility: Licensing Overview Document* [11]. Since then, the inventory has been kept updated annually and reported in the Annual Compliance Monitoring Report (ACMR). The inventory includes the radioactivity contained in the spent fuel; the radioactive contamination remaining on the structures, equipment, and components; and the radionuclides contained in stored wastes remaining at the facility. The majority of the radioactive materials at the G1WF is located in the Reactor Building, Turbine Building, and Resin Storage Tanks and Vault.

6.1.1.1 Radiological Safety Zone Designations

Radiological safety zoning is used to organize the facility areas in an effective way, to optimise the provision of RP measures and controls. The zoning reflects the type and level of radiological hazards in an area and the degree of RP measures required to control contamination and radiation exposure.

Canadian Nuclear Laboratories zoning system categorizes work areas into 1 of 5 radiological safety zones that reflect the external radiation and contamination hazards in a work area. The greater the level of the zone, greater the potential hazard and greater the operational measures needed to control radiation exposures and contaminations. Table 4 gives a general description of each of the zone levels.

Table 4: Radiological Safety Zone Description

Zone	Description
1	• Very low- level radiological hazard workplace and considered as a "Clean" zone. • Dose received by an individual from external sources of radiation during continuous occupancy in Zone 1 should not exceed 1 mSv (100 mrem) in one (1) year. • Considered suitable for unrestricted occupancy for all employees, and includes normal office areas, washrooms, normal access corridors, etc. • Zone 1 includes work areas where average body dose rates does not exceed 0.5 µSv/h (50 µrem/h).
2	• Low level radiological hazard workplace. • Normally free of radioactive contamination but may be subject to infrequent cross contamination from higher numbered zones. • A Zone 2 will normally be used as a buffer area between a higher numbered zone containing loose contamination and Zone 1. • Includes work areas where average whole body dose rates exceed 0.5 µSv/h (50 µrem/h) but are less than or equal to 10 µSv/h (1 mrem/hr). • Considered a zone of normal continuing occupancy for employees who are designated to be or are confirmed as Nuclear Energy Workers (NEWs) and have completed Group 4 training.
3	• Moderate level radiological hazard workplace. • Should normally be restricted to locations in a Controlled Area. • Considered to be a zone of medium occupancy, occupancy is subject to continuing review by line management and RP Staff. • Includes workplaces where average whole body dose rates exceed 10 µSv/h (1 mrem/hr) but are less than or equal to 1 mSv/h (100 mrem/hr) and/ or where low to moderate level contamination is allowed to exist.
4	• General dose rates and removable surface contamination levels may be high. • Restricted to areas in a Controlled Area, exceptions shall be approved by the responsible RP Program Manager. • Entry should be infrequent and accomplished according to established procedures aimed at controlling doses. • Includes work areas where average dose rates exceed 1 mSv/h (100 mrem/hr) but are less than or equal to 100 mSv/h (10 rem/hr).

Zone	Description
5	• General dose rates and contamination levels present in Zone 5 represent (potentially) a very high radiological hazard. • General dose rates in excess of Zone 4 levels shall only be tolerated within Zone 5. • All Zone 5's shall be reviewed and approved by the responsible RP Program Manager. • Shall, without exception, be located in a Controlled Area. • Includes work areas with average dose rates exceeding 100 mSv/h (10 rem/hr).

Areas within the G1WF have been zoned according to Radiological Areas and Zones procedure [38]. The G1WF radiological zones are summarized in [34]. The G1WF Radiological Safety Zones are given in Table 5 and the G1WF zoning map is shown in Figure 18.

Table 5: Radiological Safety Zones at G1WF

Room/Work Area	Radiation Zone	Contamination Zone	Overall Zone
Service Building	2	2	2
Turbine Building – North section excluding SFCA	2	2	2
Turbine Building – South Volume	1	2	2
Turbine Building – Change Room	1	1	1
Turbine Building – Main Access Area	1	1	1

Room/Work Area	Radiation Zone	Contamination Zone	Overall Zone
Spent Fuel Canister Foyer	1	1	1
Spent Fuel Canister Area	2	1	2
Tunnel between Reactor Building and Turbine Building	-*	-*	-*
Reactor Building	3	2	3
Reactor Building – Outer Airlock	1	1	1
Reactor Building – Undress/Monitoring Area	2	2	2
Spent Resin Storage Area – Upper Accessible Area	1	1	1
Spent Resin Storage Area – Lower Vaults	3	3	3

*Un-zoned due to the confined space hazard.

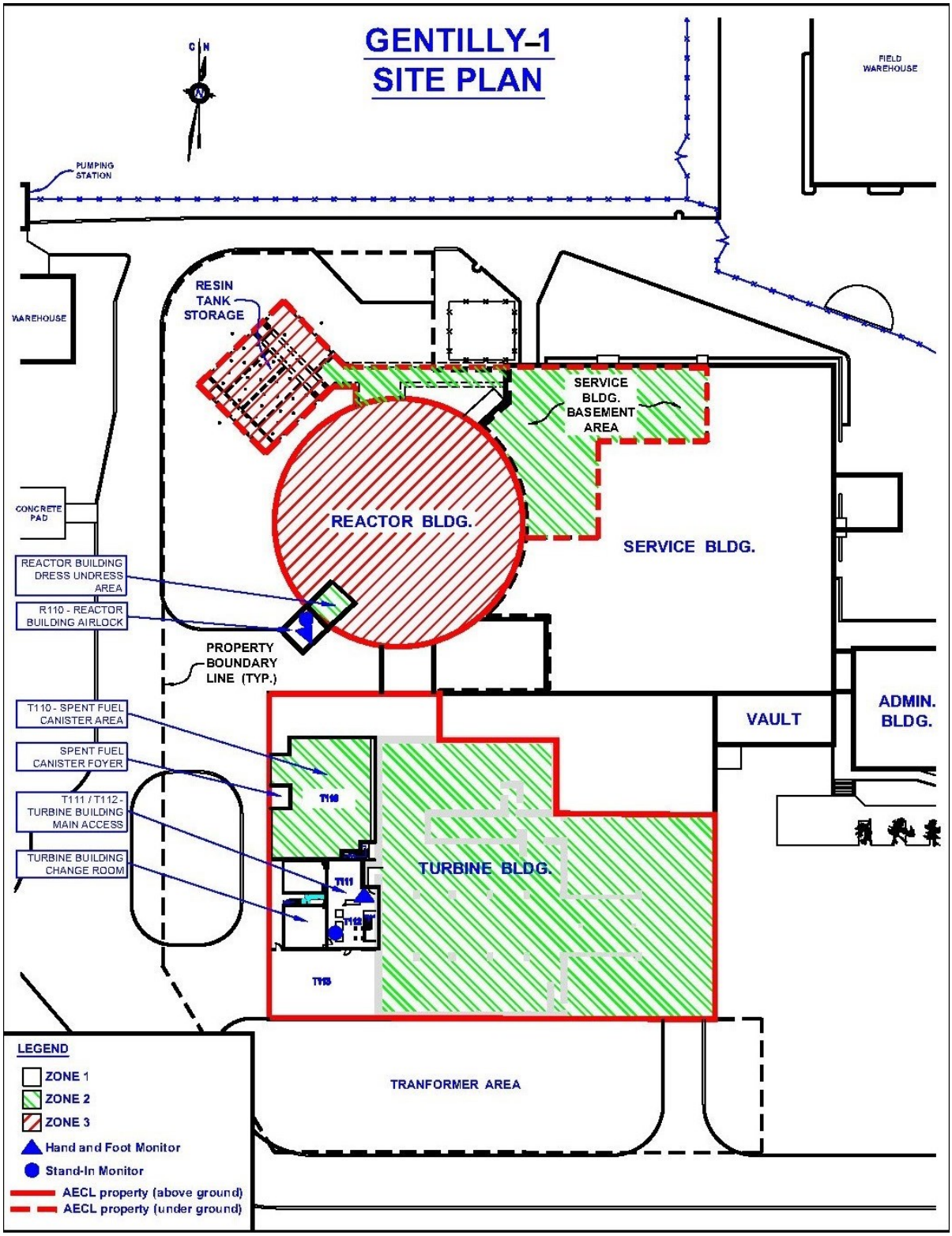

Figure 18: G1WF Zoning Map

6.1.1.2 Radiation Dose Rates

The G1WF ACMR for 2021 [39] presents the radiation measurements carried out and the results of the contact gamma dose rates on the SFCA concrete canisters and the gamma dose rates at the Reactor Building survey location.

Over the past five (5) years (i.e., 2017-2021) of SWS the measured contact dose rates (0.43-0.85 µSv/h) of the concrete canisters are well below the design dose rate limit of 10 µSv/h [39]. Similarly, the calculated equivalent dose rates from TLD readings at the SFCA (0.12-0.35 µSv/h) for the past five (5) years (i.e., 2017-2021) of SWS are also well below the design dose rate limit of 10 µSv/h [39].

The Reactor Building gamma radiation survey results of the past five (5) years (i.e., 2017-2021) also show a decreasing trend in the dose rates [39].

During the past five (5) years of SWS normal operations, the doses remained within the regulatory effective dose limits and CNL's action levels [19]. The reported maximum individual and maximum collective doses for five (5) year SWS period are 0.62 mSv and 2.56 person-mSv respectively [39]. All the listed SWS normal operational doses in Table 6 were within the applicable action levels (Appendix A).

Table 6: SWS Normal Operation Doses for G1WF

Dose Type	2017	2018	2019	2020	2021
Individual Dose (mSv)	0.18	0.62*	0.10	0.01	0.12
Collective Dose (person-mSv)	0.98	2.56*	0.28	0.01	0.20

* This dose was accrued mostly as a result of the Resin Retrieval Project [40].

6.1.1.3 Criticality Control

During initial decommissioning, the natural uranium fuel was removed from the reactor pool for storage in dry storage canisters [22]. The fuel bundles were loaded into several stainless steel containers (fuel baskets), dried and these baskets were then seal welded. Since irradiated fuel stored at G1WF SFCA contains only natural UO_2, it falls under the category of nuclear criticality safety exempted quantities of fissionable materials and are therefore exempted from the requirements in REGDOC-2.4.3 [41]. This is consistent with CNL Nuclear Criticality Safety Program requirements [42].

6.1.1.4 Radiological Hazards Location

6.1.1.4.1 Turbine Building

6.1.1.4.1.1 South Volume

The south volume of the Turbine Building hosts the turbine generators (i.e., turbine systems and their associated equipment), and also includes the tunnel which leads to the Reactor Building. A characterization survey was performed which indicated the presence of small amount and low contamination levels in south volume of the Turbine Building [18]. Based on the RSZ classification, the south volume of Turbine Building is RSZ 2 with Radiation Zone 1 and Contamination Zone 2.

The list of radionuclides along with their activities and decay times for turbine systems is provided in Table 7.

Table 7: Estimated Activities of Radionuclides for Turbine Systems

Radionuclide	Activity (Bq)			
	$t_{1/2}$ (years)	1986	2022	2029
^{60}Co	5.27	2.81E+09	2.46E+07	9.79E+06
^{137}Cs	30.17	2.21E+09	9.67E+08	8.23E+08

6.1.1.4.1.2 Spent Fuel Canister Area

The fuel from the operation of G-1 NGS that was originally stored in the Fuel Storage Bay, was transferred to the SFCA, inside the Turbine Building, in 1985-1986.

The main radiation hazard present in the SFCA, is due to the inventory of the radionuclides associated with the spent fuel bundles that were transferred from the Fuel Storage Bay in 1987 and stored in 11 canisters.

Based on the RSZ classification, the SFCA is RSZ 2 with Radiation Zone 2 and Contamination Zone 1.

6.1.1.4.2 Reactor Building

The main radiation hazard found in the Reactor Building is due to the inventory of radionuclides associated with the reactor core components, biological shield, heat transport system, and moderator system. The other systems that were activated and contaminated during the operation of the reactor include the fuelling machine, operational control systems, building services systems, and safety systems [22].

Activation products associated with the reactor core components are primarily ^{60}Co, ^{152}Eu, ^{55}Fe, ^{94}Nb, and ^{63}Ni [43]. The components associated with the reactor core include following:

- 308 pressure tubes
- 308 Calandria tubes
- Seven (7) control rods
- Two (2) Calandria-side tube sheets
- Two (2) sets of three (3) axial shield slabs
- Two (2) outer tube sheets
- Reflector baffle and Calandria
- Radial thermal shields (reactor vessel)
- Concrete biological shield

Analyses of the samples taken from the heat transport and moderator systems in 1984 indicated that the plated-out activities on the internal surfaces of the samples were predominantly ^{60}Co followed by ^{137}Cs.

The list of radionuclides along with their estimated activities and decay times for reactor core components and bioshield, heat transport system, and moderator system is provided in Table 8, Table 9, and Table 10 respectively.

Based on the RSZ classification, the Reactor Building is RSZ 3 with Radiation Zone 3 and Contamination Zone 2.

Table 8: Estimated Activities of Radionuclides for Reactor Core Components and Bioshield

Radionuclide	Activity (Bq)			
	$t_{1/2}$ (years)	1986	2022	2029
^{3}H	12.3	4.64E+06	6.09E+05	4.10E+05
^{14}C	5730	6.30E+11	6.27E+11	6.27E+11
^{55}Fe	2.73	6.76E+14	7.21E+10	1.22E+10
^{59}Ni	7.60E+04	1.60E+12	1.60E+12	1.60E+12
^{60}Co	5.27	5.72E+14	5.01E+12	1.99E+12
^{63}Ni	100	1.95E+14	1.52E+14	1.45E+14
^{94}Nb	2.00E+04	2.00E+12	2.00E+12	2.00E+12
^{95}Zr	0.175342	8.95E+02	1.27E-59	1.19E-71
^{113m}Cd	14.1	6.66E+07	1.13E+07	8.03E+06
^{121m}Sn	55	1.56E+11	9.91E+10	9.07E+10
^{125}Sb	2.76	3.29E+12	3.88E+08	6.67E+07
^{152}Eu	13.48	1.93E+14	3.02E+13	2.11E+13

Table 9: Estimated Activities of Radionuclides for Heat Transport System

Radionuclide	Activity (Bq)			
	$t_{1/2}$ (years)	1986	2022	2029
^{60}Co	5.27	4.76E+11	4.17E+09	1.66E+09
^{137}Cs	30.17	2.07E+11	9.06E+10	7.71E+10

Table 10: Estimated Activities of Radionuclides for Moderator System

Radionuclide	Activity (Bq)			
	$t_{1/2}$ (years)	1986	2022	2029
^{137}Cs	30.17	3.45E+10	1.51E+10	1.28E+10

6.1.1.4.3 Service Building

Radiological surveys of the Service Building material and equipment are being conducted as per the requirement of the RP Program [31]. The surveys showed the presence of radionuclides in liquid waste system, active ventilation system, shield walls, disconnecting piping, and liquids within the tanks and pumps. Therefore, the RSZ classification of the Service Building is RSZ 2 with Radiation Zone 2 and Contamination Zone 2.

6.1.1.4.4 Spent Resin Storage Area

The HTPS and the MPS spent resins were removed from the G1WF in 2018 [40]. Based on the RSZ classification, the Spent Resin Storage Area has two types of zones. The accessible area of the Spent Resin Storage Area is RSZ 1 with Radiation Zone 1 and Contamination Zone 1. The lower vaults of the Spent Resin Storage Area are RSZ 3 with Radiation Zone 3 and Contamination Zone 3.

6.1.2 Chemical Hazards

Chemical hazards currently present at G1WF include combustible and flammable materials, laboratory supplies, oils, paints, adhesives, cement, bug repellents, and cleaning agents. These chemical products are stored in cabinets located in the Turbine Building maintenance shop. It is anticipated that most of these chemical hazards will be removed prior to the onset of Phase 3 Decommissioning (i.e., D&D).

During the ongoing SWS phase, designated substances and asbestos assessments have been conducted in the Reactor Building, Turbine Building, and Service Building [44] [45] [46] [47] [48]. The ACM has been removed from the Turbine Building and Service Building. The asbestos abatement campaign for the Reactor Building is in progress.

The hazardous materials currently present at G1WF are listed in Table 11. The hazardous materials are handled in accordance with the relevant provincial regulation [49] and CNL procedures [50] [51] [52] [53]. It is anticipated that most of the hazardous materials will have

been removed/abated through hazard reduction campaigns prior to the commencement of Phase 3 Decommissioning (i.e., D&D) activities.

Table 11: Hazardous Material present in G1WF

Hazardous Material	Location
ACM	• Heat insulation of Reactor Building • Roughcast within Turbine Building
Lead-containing and PCB-containing paints	All around the facility
Lead-containing products and equipment such as batteries, sheets, plates, shielding, and wool	All around the facility
Silica-containing materials such as concrete, mortar, masonry, ceramic, grout, slate, and asphalt	All around the facility
Mercury containing materials	All around the facility with the exception of the Turbine Building.
Ozone depleting refrigerant	Reactor Building dehumidifier

6.1.3 Industrial Hazards

Industrial hazards were removed significantly during Phase 1 Decommissioning (i.e., establishing a safe state) and being removed on an ongoing basis during Phase 2 Decommissioning (i.e., SWS) through hazard reduction campaigns. Hazards that are associated with specific maintenance activities are identified and evaluated through the *Integrated Work Control* (*IWC*) process [54]. Section 6.2.3 lists the industrial safety hazards that are associated with the routine and non-routine operations, as well as decommissioning activities.

6.1.4 Biological Hazards

Feces from animals that have entered the buildings may be present and precautions are to be taken to identify these hazards. As a part of routine surveillance monitoring, CNL will continue to perform proper housekeeping, planning and preparation during the current SWS phase and final decommissioning phase so that the growth of biological hazards will be prevented. On discovery of any biological hazard, CNL will act promptly and remove it safely.

6.1.5 Environmental Hazards

There is no forced ventilation at the G1WF. However, there are three (3) louvres (one 2 ft x 2 ft louvre in the Reactor Building and two (2) 15 ft x 9 ft louvres in the southern part of the Turbine Building) at the facility, which can potentially contribute to fugitive airborne emissions. To determine whether or not effluent monitoring and environmental monitoring are required at G1WF, the G1WF Effluent Monitoring Plan [26] assessed relevant information and supporting data in the SAR, ACMRs, and other reports that contained radiological sampling campaigns for airborne releases and corresponding analytical results, and found that any adverse effects from these fugitive airborne emissions are insignificant as it would require an implausible combined passive exhaust flow rate of 3,500 m^3/s through these louvres in order to trigger a dose to the public of 0.0005mSv/a. Therefore, there is minimal or no source for airborne radioactivity release from the routine operations of the G1WF.

There is a potential for a release of contaminated water into the G1WF drainage system as:

- The sump in Room S-012 of the Service Building may be contaminated by water coming from the moderator spent resins tank vault; and
- The sump in Room T-005 of the Turbine Building may be contaminated since the dehumidifier located in the Reactor Building discharges the condensate water in Room T-005.

Liquid collected in facility sumps are considered waste and are transferred into totes, which are sampled, analyzed, and then transported overland to and accepted as waste by HQ's G-2 NGS [39].

Given that the contents of these sumps are not discharged to the environment by the G1WF but are instead handled as liquid waste subject to HQ waste acceptance criteria and disposed of by HQ according to their specifications, they are not considered a liquid effluent stream.

6.2 Hazards during Decommissioning

All hazards associated with a decommissioning project will be identified and assessed for adverse impacts on the workers, on-site personnel, the public and the environment. These hazards will be removed, or the risks mitigated to an acceptable level before embarking on building demolition activities. To ensure safety of the workers, on-site personnel, the public and the environment, decommissioning activities will be carried out strictly in accordance with requirements set out in all CNL compliance programs and other standards listed in Section 8.

To support the future decommissioning of the buildings and structures, decommissioning safety assessments will be performed to examine the radiological and non-radiological hazards and associated risks as a result of decommissioning activities. The decommissioning safety assessment will support the development of DDPs and will be performed in accordance with a graded approach. The safety analysis will meet the requirements of CNSC REGDOC-2.11.2 [8], CSA N294:19 [6], and CNL's Safety Analysis documents [55] [56] [57] [58], which incorporate

CNL policies and procedures, licence requirements, Operating Experience (OPEX), and international best practices.

The types of hazards commonly expected during the execution of a decommissioning project include the following:

- Radiological hazards
- Chemical hazards
- Industrial hazards
- Biological hazards
- Environmental hazards

A comprehensive characterization plan will be prepared to identify all hazards, both radiological and non-radiological, associated with the buildings/structures located within each planning envelope. The comprehensive characterization plan can include scan/survey of all remaining process equipment/systems and building materials/structure, collection of samples as required and analyse them for contaminants of potential concern. The results of the characterization surveys including any significant gaps or uncertainties will be captured in a characterization report. These results will be the guiding factors to evaluating the risks and their mitigation measures, work controls, and selecting the waste management strategy.

All decommissioning and demolition field work will be prepared and controlled following the IWC process [54]. In the IWC process, controls are selected to mitigate or eliminate the risk of a hazard using the following hierarchy:

- Eliminate the hazards.
- Control the hazards through engineered controls (preference should be given to passive controls over active controls).
- Control the hazards through administrative controls.
- Control the hazards using Personal Protective Equipment and Clothing (PPE&C) to protect the workers from the hazard.

Therefore, any hazards related to a decommissioning project are identified, analysed, and mitigated/controlled via the IWC process to protect workers, on-site personnel, the public, and the environment.

General hazards are routinely encountered within a facility, and workers are trained in general safety and health requirements and expected to apply appropriate controls to address such hazards.

6.2.1 Radiological Hazards

Currently, the radiological hazards are located in the Reactor Building, Service Building, Turbine Building including SFCA and Spent Resin Storage Area (see Section 6.1.1). As a part of the decommissioning planning and execution (see Section 13), all stored waste will be removed, and the buildings/structures will be decontaminated prior to commencing the demolition activities. The following internal and external radiological hazards may be present during decommissioning activities:

- Radiation fields produced by the fission products and activation products that remain in systems and components.
- Radiation fields produced by the radionuclides in the LLW and ILW.
- Fixed contamination on SSCs.
- Loose surface contamination on tools, equipment, and systems that are opened during the decommissioning work.
- Airborne contamination generated during the decontamination/D&D work or the packaging of the waste.

Therefore, for each of the DDPs identified in Table 14, an Occupational Dose Estimate will be prepared upon:

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

Based on the Occupational Dose Estimate which will be conducted as part of the decommissioning planning of each Planning Envelope, the required necessary mitigation measures will be listed in their respective DDPs and associated Detailed Work Plan/s (DWP/s). These mitigation measures will be implemented during Phase 3 Decommissioning (i.e., D&D) work to ensure that dose to the workers and the public remain within dose acceptance criteria.

6.2.2 Chemical Hazards

Currently, the chemical hazards present at G1WF include ACM, lead, mercury, and ozone depleting refrigerant, and silica (see Section 6.1.2). Although most of these hazardous chemical substances will be removed as part of the hazard reduction campaigns and decontamination activities, some hazardous waste will remain and become part of the decommissioning waste. Therefore, based on the level of hazards, decommissioning workers will handle the hazardous waste in accordance with the relevant federal and provincial codes and standards.

Most likely, the following chemical hazards are expected during decommissioning activities:

- Cleaning Agents used for decontamination work.
- Concrete dust generated due to dismantling work.
- Airborne lead/mercury due to grinding of material covered with lead/mercury-based paints.
- Leaks and spills from heavy vehicles/equipment.

The mitigation measures for these chemical hazards will be put in place to ensure that the workers, on-site personnel, the public and the environment are protected during the decommissioning activities.

6.2.3 Industrial Hazards

Phase 3 Decommissioning (i.e., D&D) of G1WF will involve industrial hazards, typical of a demolition project. Examples of such hazards that may occur during dismantlement and demolition activities at G1WF are listed along with their mitigation measures in Table 12. Many of these industrial hazards are also relevant to both routine and non-routine operations of G1WF.

Table 12: General Industrial Hazards and Mitigation Measures

Industrial Hazards	Mitigation Measures
Sharp Objects: Cuts, Puncture, and Abrasions	• Specify the Cut/Puncture Protection Level of glove or sleeve required based on the anticipated degree of cut/puncture hazard (refer to American National Standards Institute *Hand Protection Classification* [59] for appropriate gloves for the job). • Plan and control work using DWP/ Engineering Dismantling and Demolition Work Plan (EDDWP) and CNL's *IWC* process [54] or using contractor's equivalent procedures that are subject to review and acceptance by CNL. • Workers to wear protective clothing, including appropriate gloves during material handling as per requirements identified in the *Job Hazard Analysis* (JHA) [60] and/or *Work Control Instructions* [61].
Chemicals	• PPE&C. • Material Safety Data Sheet (MSDS) will be provided for all chemicals that will be used during decommissioning. • Chemicals will be replaced with less hazardous chemicals, if possible.

Industrial Hazards	Mitigation Measures
Cutting: Dust	• Implement dust management procedures such as appropriate respiratory protection, housekeeping practice, and material specific controls.
Fire	• Comply with CNL's *Fire Protection Screening* Process [62], if applicable.
Ergonomics (Sprains, Strains and Pinch Points)	• Walk down task to consider ergonomics prior to start of work. • Use mechanical means to move material whenever feasible. • Wear appropriate gloves during material handling. • Keep hands clear of potential pinch points. • Use proper lifting techniques. • Beware of uneven walking surfaces.
Slip/Trip & Fall	• Ensure appropriate footwear is worn and the tread is in good condition. • Use extra caution and situational awareness when using slip on RP protective boot covers. • Adjust walking gait according to the site and weather conditions. • Maintain proper housekeeping throughout work phases to minimize Slip/Trip & Fall hazards. • Route/elevate any temporary electrical or pneumatic cords to minimize Slip/Trip & Fall hazards. • Follow CNL procedure, *Working at Heights* [63], OR contractor's equivalent procedures that are subject to review and acceptance by CNL. • Plan and control work using DWP/EDDWP and CNL's *IWC* process [54].
Excavation (cave-ins, underground services, and overhead power lines, etc.)	• Maintain Limits of Approach. • Follow CNL procedure *Excavations* [64] OR contractor's equivalent procedures that are subject to review and acceptance by CNL. • Plan and control work using DWP/EDDWP and CNL's *IWC* process [54], or using contractor's equivalent procedures that are subject to review and acceptance by CNL.

Industrial Hazards	Mitigation Measures
Heavy Equipment	• Assign/use trained Spotters to guide Heavy Equipment and any vehicles reversing or when vision is obstructed. • Workers wear high visibility clothing on site. • Establish Traffic Control Plan to allow a drive through vehicle flow wherever possible. • Establish Safe Work Areas to limit and control access. • Work planned and controlled using DWP and EDDWP. • Move heavy items using pallet trucks, forklifts, hoist, and cranes. • Assign only qualified personnel to complete all hoisting and rigging activities [65].
Hazardous Energy (Electrical, Pneumatic, Steam, etc.)	• Isolate equipment, if required, per CNL's *Hazardous Energy Control* procedure [66]. • Control electrical work according to CNL's *IWC* process [54] and CNL procedure, *General Electrical Safety Work Practices* [67] or contractor's equivalent procedure that is subject to review and acceptance by CNL.
Environmental conditions (e.g. wind, rain, snow, extreme temperatures, poor lighting etc.)	• Work will be scheduled/rescheduled to avoid period of extreme weather conditions. • Listen for and follow Public Address announcements from HQ indicating high wind or severe weather warnings.
Power Tool Injuries	• Use of power tools in accordance with CNL's requirements [68], or contractor's equivalent procedures that are subject to review and acceptance by CNL.
Motor Vehicle Accidents	• Establish/use a Traffic Control Plan to allow a safe drive through vehicle flow wherever possible and to delineate Construction zone. • Establish Safe Work Areas to control access. • Encourage alternate travel arrangement (e.g., delay travel) in the case of inclement weather. • Recommend using vehicles with winter tires during the winter season. • Workers wear high visibility clothing on site.

6.2.4 Biological Hazards

Biological hazards during decommissioning will be different from those that are currently present at the G1WF (see Section 6.1.4) but will not have any significant effect on the type and quantity of the waste that will be generated during decommissioning and demolition activities.

Biological organisms and materials that might be found on the site during decommissioning, could also produce hazards that include following:

- Stings and bites from insects, rodents, birds, or other animals that might live or nest inside accessible buildings.
- Toxins and antigens produced by molds and other fungi that might grow on surfaces (particularly those made of wood or other biological materials or in droppings from pigeons, starlings, blackbird, etc.
- Infections or adverse reactions resulting from exposure to organisms living in decaying biological material (such as carcasses, droppings, and animal feces), or their by-products.

The risks associated with these biological hazards will be mitigated by using proper technique and/or PPE&C [69], which will be determined through the IWC [54] process.

6.2.5 Environmental Hazards

An environmental review for Phase 3 Decommissioning (i.e., D&D) of G1WF will be performed which would fulfill the requirements of following:

1. *Impact Assessment Act* (IAA) Section 81 to 91 [70].
2. *Impact Assessment Guidance on Environmental Reviews for Projects on Federal Lands*.
3. CNSC Regulatory Document 2.9.1 *Environmental Protection: Environmental Assessments* [71].
4. CNL Procedure *Environmental Review of Non-Routine Work* [72].
5. CSA N288.6-12, *Environmental risk assessments at Class I nuclear facilities and uranium mines and mills* [73].

The results of the environmental review will be documented in an “Environmental Effects Review” report.

6.3 External Hazards

External hazards exist primarily from natural phenomenon. The impact of an event resulting from extreme environmental conditions (e.g. heavy precipitation, flood, tornado, etc.) will be mitigated by prompt emergency response actions, such as rescheduling planned work to avoid working outside during extreme environmental conditions or covering the contaminated areas within the decommissioning site. Project-specific Emergency Procedures will be prepared and referenced in the DWPs.

6.4 Unplanned Events

Unexpected events that may occur during Phase 2 Decommissioning (i.e., SWS) and Phase 3 Decommissioning (i.e., D&D) activities, radiological or otherwise, will be reported to line management, who will assess the events; categorize them according to their consequences; notify internal and external authorities (such as the CNSC) [74], as required; investigate the root cause [75]; devise corrective actions [76] and ensure their implementation, in order to prevent recurrence.

6.5 Emergency Response

Phase 3 Decommissioning (i.e., D&D) activities at G1WF will be performed by staff who are familiar with the radiological and non-radiological hazards present in the facility.

After all of the radioactive materials have been removed from the site, the potential emergency situations will come to closely resemble those that might occur during the course of a major construction project.

At all stages of the project, CNL will ensure that:

- The required emergency response plans, prepared in accordance with CNL's *Emergency Preparedness* (EmP) Program [77], and procedures are in place.
- The emergency response 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.
- The necessary equipment and supplies are available for use by emergency response personnel.

CNL will co-ordinate its response to a real or potential emergency situation with the appropriate federal, provincial, regional and municipal agencies.

7. Worker Protection

Decommissioning works at G1WF will be conducted in accordance with the *IWC* process [54] that meets the requirements of CNL compliance-based programs including RP [78], *Environmental Protection* (EnvP) [79], *Fire Protection* [80], *Occupational Safety and Health* (OSH) [81], and *Quality* [82].

As part of the *IWC* process [54], a Work Control Package (WCP) will be developed for each planned activity at the site, including DWPs, EDDWP, etc. This WCP will include the necessary preventative and protective measures needed to address potential hazards identified via a systematic review process (e.g., JHA [60]). Emphasis will be placed on the application of a "graded approach" in performing the tasks. Therefore, the hazard analysis process will consider different factors that affect the complexity and hazardous nature of each task/procedure so that the potential hazards associated with each task/procedure can be identified and controlled in a safe and cost-effective manner to protect workers, the public, and the environment.

7.1 Radiation Protection

All radiological hazards associated with the decommissioning of the given building/area in each planning envelope will be identified in accordance to the *IWC* [54] process and will be addressed through Radiological Hazard Assessments/Work Permit, which aligns with CNL RP Program requirements [31].

The RP Program [78] covers the following subject areas as applicable:

- Radiological hazard identification and assessment.
- Engineering controls to minimize exposures As Low As Reasonably Achievable (ALARA).
- Internal and external dosimetry.
- Usage of PPE&C.
- Personnel and source movement control.
- Work planning (*Radiological Work Assessment* (RWA) [83] / *Radiological Work Permit* (RWP)) [84].
- Worker designations, training, and qualification.
- RP equipment that will be used.

7.1.1 Dose Estimate

Prior to undertaking any non-routine radiological work associated with Phase 3 Decommissioning (i.e., D&D), RWAs or RWPs will be prepared identifying work-specific restrictions and dose estimate for the work as a whole if the work is expected not to pose any significant radiological hazards (i.e., committed effective dose is expected below Action Levels). Dose estimate will be calculated at the work package level when the radiological hazards and radiation exposures are expected to be considerable (i.e., committed effective dose may exceed Action Levels and may reach or exceed the regulatory dose limits). The doses for each

work package will be tracked against the dose estimate/RWA, and if there is a significant difference (+20%) from the dose estimate then an ALARA review would be carried out to ensure dose uptake is being optimized and not exceed the regulatory dose limits.

The G1WF Action Level for maximum individual effective dose is set at 5 mSv per calendar year [85]. Individual Dose Control Points (DCPs) and work control measures and/or restrictions should be revisited to reduce worker exposure below facility's Action Levels. Currently, all DCPs are set at 1 mSv/year for all workers at G1WF. No planned work shall be undertaken without the prior authorization of the Radiation Protection Program Manager if the individual exposure is anticipated to exceed the Action Level.

7.1.2 ALARA

All SWS (i.e., routine, non-routine, and hazard reduction) and Phase 3 Decommissioning (i.e., D&D) activities shall be planned and executed via the IWC process [54] which is in accordance with CNL's RP Program [78] and ALARA [86] principle to ensure radiological protection is optimized and personnel exposures are kept ALARA. This includes the development of specific work plans, RWAs to document the requirements, and engineering controls to be implemented for all work. It also includes the review of completed projects to help ensure any lessons learned are incorporated into future decommissioning DWPs.

It should be noted that ALARA optimisation is not dose minimisation. It is the result of an evaluation that carefully balances the detriment from the exposure and the resources available for the protection of individuals. Thus, the best option is not necessarily the one with the lowest dose. Specific work plans along with supporting RWAs will ensure that the tasks are clearly justified and appropriately optimized through various techniques. Examples include work scheduling (removing high activity equipment/materials first), work methods (use of remotely controlled equipment) and mitigating controls (PPE&C where worker activity is deemed essential), etc.

7.2 Occupational Safety & Health

The OSH program [81], OSH requirements [87], IWC process [54], and applicable federal and provincial regulations will be applied to all aspects of the work performed as part of the decommissioning work plan. A complete list of the topics covered by the OSH program is provided in [88]. The OSH program [81][87] [88] covers, but not limited to, the following topics:

- *Industrial Safety Hazard Assessment and Control* [89]
- *Hazardous Energy Control* [66]
- IWC [54] Work Permits [84]
- Training and Qualifications [90][91]
- Industrial Hygiene [92][93]
- *Hoisting and Rigging* [65]
- *Excavations* [64]

- Use of *Hand Tools* [68]
- *Digging, Drilling, Cutting, and Coring* [94]
- *Working at Heights* [63]/*Fall Protection Plan*[95]
- *Aerial Work Platforms* [96]
- *Scaffold*s [97]
- *Workplace Inspections* [98]and *Housekeeping* [99]
- *Personal Protective Equipment and Clothing* [69]

7.3 Emergency Preparedness and Site Emergencies

The *EmP* Program [77] comprises planning and response elements to ensure that processes are in place to control and mitigate the consequences of an emergency. Emergency procedures for the decommissioning work sites shall be prepared in accordance with CNL *EmP* Program requirements [100] prior to the commencement of building/facility removal activities. The emergency procedures shall include sheltering and response to site-wide emergencies. An emergency instruction will be posted at the entrances to the building/site to provide staff with sheltering and emergency contact information, emergency procedures will be reviewed during the daily pre-job briefs.

Supervision at the G1WF site during working hours shall be established to ensure that CNL work control requirements are being implemented to ensure proper emergency response.

7.4 Fire Protection

Work Control Packages developed during Phase 3 Decommissioning (i.e., D&D) project include Fire Screening Assessments done by the Fire Protection Engineering program staff [80] in accordance to the *Fire Protection Screening* process [62].

7.5 Security & Access Control

In addition to CNL's Security Program [101] [102], during decommissioning, CNL will continue to comply with the CNSC *Nuclear Security Regulations* [103]. Hydro-Québec will be responsible for the security of the site throughout the course of the decommissioning project and contractors will have to comply with the procedures regarding the physical security.

Road access to the G1WF will require that visitors and sub-contractors on the decommissioning project pass the fence boundaries of the Gentilly complex via security gates staffed and controlled by HQ personnel. These contractors will need authorization in accordance with established HQ procedures to access the G1WF.

Signage and/or barriers will be erected around the buildings/structures to keep site staff at a safe distance from the decommissioning work. Access to the work areas will be limited to staff approved for work in the areas or visitors being accompanied by authorized employee sponsors. Access for emergency and other vehicles will be maintained at all times unless an alternate route is available.

7.6 Operating Experience and Lessons Learned

The future DDPs will include OPEX (internal or external) and/or lessons learned from similar decommissioning projects.

8. Applicable Programs and Standards

Removal of buildings/facilities on the CNL sites shall be performed in accordance with the applicable CNL's Health, Safety, Security, Environment and Quality (HSSE&Q) programs, and applicable federal/provincial regulations, codes, and standards. While applying codes and standards, requirements of the respective revisions listed in the site/facility's LCH must be complied with. Also, it will be an opportune time to accommodate any new requirements/changes in the most recent revisions of these codes and/or standards or a related regulatory document if such (upcoming) changes have been communicated by the regulator (i.e., the CNSC).

8.1 CNL HSSE&Q Programs

CNL has a management system comprised of an integrated set of documented policies, expectations, standards, procedures, and responsibilities with respect to managing and executing work at all CNL sites. The Quality Assurance (QA) activities are integrated into work procedures to provide confidence that products and services shall meet specifications and perform as expected. At CNL, this is achieved by aligning its Management System [104] with the CSA N286-12, *Management system requirements for nuclear facilities* [105], and International Organization for Standardization (ISO) standards 9001 *Quality management systems - Requirements* [106] and ISO 14001 *Environmental management system – Requirements with guidance for use* [107].

Decommissioning shall be conducted in accordance with the Cleanup Program requirements and associated processes [35] [5][108] [109] while complying with applicable CNL Management System policies, protocols, and HSSE&Q programs and procedures including:

- Environmental Protection
- Emergency Preparedness
- Fire Protection
- Nuclear Materials and Safeguards Management
- Occupational Safety and Health
- Performance Assurance
- Quality
- Radiation Protection
- Security
- Transportation of Dangerous Goods
- Waste Management

Additionally, decommissioning planning documents such as DDPs shall be subject to independent safety review by CNL's Safety Review Committee (SRC) [37].

Decommissioning work at G1WF is managed through the *IWC* process [54], and is performed safely in accordance with the programs, policies, and procedures noted above. If the work is

contracted out with contractor assuming the responsibility for the work site, hazard identification, and work controls, the contractor will follow their health and safety programs and procedures that are acceptable to CNL and comply with applicable provincial regulations.

A discussion on CNL's applicable HSSE&Q programs and federal regulations that are to be followed in the execution of Phase 3 Decommissioning (i.e., D&D) work at the G1WF is provided in the following sub-sections.

8.1.1 Environmental Protection Program

The EnvP Program (ISO 14001 certified) for CNL is defined in the program description and program requirements documents [79][110].

CNL is legally obligated under the IAA [70] to ensure that projects are considered in a careful and precautionary manner to avoid significant adverse environmental effects. As such, CNL's *Environment* Policy [111] and EnvP Program requirements [110] are designed to ensure protection of the environment and the public with respect to its activities, products, and services. These requirements apply to all CNL-operated sites and their operations and activities that may affect the environment in and around the sites. A graded approach to requirements is applied based upon environmental risks/events that could occur at any given location. The EnvP Program also applies to all employees as well as other personnel (contractors, consultants, attached staff etc.) conducting work at CNL sites.

Operations and activities at CNL operated sites should conform to the environmental policies and objectives of the Government of Canada (GoC) for operation of federal facilities. In addition, to the extent practical, and to the extent that requirements do not conflict with applicable federal legislation, operations, and activities at applicable CNL sites in Canada should strive to conform to environmental legislation and associated requirements in force in the province and/or municipality in which the site is located.

The EnvP Program requirement document [110] provides the current list of authorized procedures that describe the organization, responsibilities, processes, controls, and requirements that are applicable to the projects and other activities of CNL including:

- Identification and assessment of significant environmental aspects related to CNL operations.
- *Management and Monitoring of Effluents and Emissions* [112].
- *Management of Land, Habitat, and Wildlife* [113].
- *Environmental Review of Routine Work* [114].
- *Environmental Review of Non-Routine Work* [72].
- *Acceptability Criteria for Routine and Non-Routine Discharge of Liquids at Canadian Nuclear Laboratory Sites* [115].
- *Managing Environmental Compliance Obligations* [116].
- *Environmental Incident Reporting, Investigation and Mitigation* [117].
- *Environmental Monitoring Program* [118].

- *Environmental Objectives and Performance Measures* [119].
- *Communication on Environmental Protection* [120].
- *Environmental Training, Awareness and Competence* [121].

In line with company-wide EnvP Program requirements and applicable federal and provincial environmental regulations, the G1WF has implemented facility-specific procedures and processes that are followed through to ensure and validate compliance with CNL's EnvP Program. These include:

- *Gentilly-1 Waste Facility Effluent Monitoring Plan* [26]
- *Gentilly-1 Waste Facility: Determination of Groundwater Protection and Groundwater Monitoring Requirements* [122]

For a complete list of Government policies, Provincial requirements and CNL EnvP program and processes that are related to the protection of the environment with respect to the CNL sites including G1WF, refer to [110] and [123].

8.1.2 Emergency Preparedness Program

The EmP Program for CNL is defined in the program description and program requirements documents [77] [100].

The CNL EmP Program provides an operational framework to implement CNL's *Safety and Health* [124] and *Environment* [111] policies with respect to necessary emergency response measures and compliance with company priorities identified in *AECL's Strategic Emergency Management Plan* [125]. The EmP Program focusses on prevention and mitigation of, preparedness for, response to, and recovery from abnormal or emergent events.

The EmP Program is required at all CNL business locations. A graded approach to the Program requirements [100] is applied based upon an assessment of the most credible events that could occur at any given location.

The EmP Program ensures personnel, equipment, and response facilities are maintained in a state of readiness to assure both response and site licensing requirements are met. CNL strives to protect life and minimize loss through its EmP Program which fulfills the following objectives to this effect:

- Ensure a state of readiness to mitigate the effects of an emergency/abnormal situation in order to protect the health and safety of workers, the public, and the environment.
- Confirm CNL's commitment to safely operate facilities and projects to a standard consistent with the type and degree of hazard associated with various operations.
- Prepare employees for emergency responses through training, documentation, exercises and drills.
- Establish liaison and coordination with federal, provincial, and municipal officials, and support response actions by off-site authorities and emergency organizations.

- Establish emergency plans and procedures for the mitigation of harmful effects of emergencies.

At the G1WF, the FA takes the overall responsibility to ensure the facility/building hazards are identified with strategies to respond to abnormal and emergent events. An Officer-in-Charge is assigned by the FA for the overall preparedness and management of emergent events. Employees are responsible to be familiar with their work area and building emergency procedures, and promptly respond to emergencies as trained or as requested. They shall conduct their work and use equipment, devices, and facilities in accordance with the program requirements [100]. Any contractors working in the G1WF must be working under their own supervision with CNL oversight.

8.1.3 Fire Protection Program

The Fire Protection Program for CNL is detailed in the program description and program requirements documents [80] [126]. The Fire Protection Program applies a risk graded approach to its operations and activities in so far as they may affect fire protection. The program applies to all CNL employees and contractors working at CNL sites.

As identified in the LCH [4], the G1WF is also required to adhere to the CSA N393-13, *Fire protection of facilities that process, handle, or store nuclear substances* [127]. A fully functional fire protection system at the G1WF remains response-ready at all times and ensures adherence to the CSA N393-13 [127] and CNL's Fire Protection Program requirements [126].

8.1.4 Nuclear Materials and Safeguards Management Program

The Nuclear Materials and Safeguards Management (NM&SM) Program for CNL is detailed in the program description and requirements documents [128] [129].

The NM&SM Program enables tracking of fissionable materials and supports international non-proliferation agreements. The NM&SM Program applies to all nuclear materials and safeguard management activities performed by CNL across all sites.

As identified in the LCH [4], the G1WF is required to have this program implemented and maintained to ensure safeguarding fissionable materials on site. All routine and non-routine work, including decommissioning activities at the G1WF, meets the NM&SM program requirements. The G1WF is also subject to periodic Compliance and Safeguards inspections/verifications by the regulatory bodies (International Atomic Energy Agency (IAEA) and CNSC).

8.1.5 Occupational Safety & Health Program

The CNL OSH Program is defined in the program description and program requirements documents [81] [87].

The OSH Program applies to all work performed by CNL employees and to work performed by others on sites or workplaces controlled by CNL. The OSH Program does not apply to workplaces controlled by contractors of CNL. Contractors follow either the requirements of the provincial regulation and/or the *Canada Labour Code* [130] In such cases, CNL uses its *Contractor Management* [131] process co-ordinate, manage and oversee the work executed by external contractors. It is a requirement that contractors demonstrate adequate health and safety programs of their own that are based on appropriate provincial [132] or federal [133] act and corresponding regulations through a program of comprehensive qualification, coordination, and oversight that holds contractors, under their individual safety programs, to laws applicable to contractors.

The OSH Program is based on the principles of identification and control of hazards, prevention, and continual improvement. The OSH program requirements document [87] defines the working level documentation, procedures, supporting documents, records, forms, and training to be used to achieve the objectives of the OSH Program. These allow for site- and project specific needs, while still ensuring consistency with the requirements of the OSH Program.

8.1.6 Performance Assurance Program

The Performance Assurance Program for CNL is detailed in the program description and program requirements documents [134][135].

The Performance Assurance Program documents serve as a single repository of all applicable regulatory, quality, safety, and contractual requirements that apply to CNL for the Performance Assurance Program. It incorporates the membership obligations for the World Association of Nuclear Operators (WANO) and the CANDU Owners Group (COG).

The program consists of the following elements:

- OPEX [136]
- Assessment [137]
- Human Performance [138]
- Improvement Action (ImpAct) Corrective Action Program [76]
- Performance Measures and Analysis [139]

8.1.7 Quality Program

The Quality Program for CNL is defined in the program description and program documents [140][141].

The Quality Program describes the requirements of the Management System and Quality Program for CNL.

The Management System and Quality Program are applicable across all CNL locations reflective of the activities carried out at the various locations. There are no exceptions.

8.1.8 Radiation Protection Program

The RP Program for CNL is described in the program description and requirements documents [78] [31].

The RP Program covers all activities involving ionizing radiation and provides requirements and guidelines for ensuring radiation safety in compliance with the Nuclear Safety and Control Act (NSCA) and associated regulations.

CNL's RP Program is designed to protect workers and members of the public from harmful effects of radiation exposure arising from CNL activities and to ensure that CNL complies with or exceeds, the level of radiation safety that is required by the NSCA and CNSC regulations. The objective of the RP Program is to define the requirements, processes, and procedures for:

- Organization and administration of the program.
- Radiation protection training and qualification of workers and radiation protection personnel.
- Dose limitation.
- Radiation protection provision in facility design.
- Workplace radiation and contamination monitoring.
- Control of radiation and contamination exposure.
- Monitoring of workers for radiological exposure.
- Provision of radiation protection instrumentation and equipment.
- Management of radioactive materials and radiation emitting devices.
- Response to radiological unplanned events and emergencies.

8.1.9 Security Program

The Security Program for CNL is detailed in the program description and program requirements documents [101] [102] to ensure compliance with all applicable legal and corporate requirements.

CNL recognizes the need to ensure security is considered in all aspects of its business activities. CNL supports Canada's interest in ensuring the protection of assets, information, safeguarding of the public and personnel and resumption of business. The program requirements apply in respect to the operation and activities that may affect security in and around CNL sites and apply to all employees and other personnel (visitors, contractors, attached staff) conducting work at CNL sites.

The CNL Protective Services provides physical protection against unauthorized access and malicious damage to nuclear and non-nuclear facilities, and to specified nuclear materials that are used, processed, stored, or possessed by CNL. CNL maintains processes to prevent unauthorized disclosure, destruction, removal, modification, or loss of classified, sensitive, designated, or valuable assets, whether in physical or electronic form.

Work at the G1WF is subject to CNL's Security program requirements [102] as mandated by the facility's licence conditions [4]. All Contractors must be security-cleared through CNL Security before working at the G-1 site and must comply with *Hydro-Québec* access control requirements [142]. The physical security at the site is provided by HQ Security personnel, whose program meets the requirements of CNL's Security Program. Since road access to G1WF requires that all personnel pass through the HQ security gate, visitors, and contractors to the G1WF also require authorization in accordance with established HQ procedures. Canadian Nuclear Laboratories periodically performs site security and threat risk assessments for the G1WF and acts on the findings as required. The routine inspections, testing, and maintenance of security systems at the G1WF are performed.

8.1.10 Transportation of Dangerous Goods Program

The Transportation of Dangerous Goods (TDG) Program for CNL is detailed in the program description and program requirements documents [143] [144].

The TDG Program provides an operational framework for the safe transport of dangerous goods by conforming to all applicable laws, regulations, company policies and procedures. It enables an effective, consistent, and comprehensive application of international standards.

Mandatory by all sites for all off-site transport of dangerous goods, the program encompasses all operations associated with the movement of dangerous goods including classification, documentation, packaging, safety marks, security, emergency response, training, and regulatory permits and licences.

8.1.11 Waste Management Program

The Waste Management (WM) Program for CNL is detailed in the program description and program requirements documents [145] [146].

The WM Program applies to all operations and activities that result in the generation, transportation, treatment, storage, and/or disposal of wastes (i.e., the lifecycle of waste) generated by CNL or received by CNL from an external organization. The program applies to all CNL employees, including other personnel (contractors, attached staff, consultants, etc.) for WM activities conducted on behalf of CNL.

8.2 Human Factors

Canadian Nuclear Laboratories has programs in place to address Human Factors (HF), including human performance aspects identified in the CNSC regulatory document, *Human Performance* [147]. These programs and measures include organizational and management structures, work requirements and controls [54], ECC for design modifications [36], OPEX [136] and *Human Performance Program* [134] [135], [148], the design of written procedures [149], training requirements [91] [150], and the physical work environment [87][31].

The CNL programs, noted in the previous paragraph, will account for much of the HF influence on any given project or work package when complied with throughout the planning and execution stages of that project/work package. Furthermore, to address Human Factors Engineering aspects of decommissioning work packages/work plans, CNL Environmental Remediation Management (ERM) business unit has developed an overall *Human Factors Engineering Program Plan for Decommissioning Projects at Canadian Nuclear Laboratories* (HFEPP) [151], which defines the graded approach for all decommissioning projects. The HFEPP was prepared in accordance with the requirements in the CNSC REGDOC-2.2.1 [147], REGDOC-2.11.2 [8], and REGDOC-2.5.1 [152]. The HFEPP is applicable to both CNL employees as well as external contractors while executing work at all CNL sites including G1WF.

As part of the HFEPP [151], for each decommissioning project, the applicability of HF and appropriate level of effort should be identified by completing the "HF Applicability" and "Level of HF Effort" checklists. The results of the checklists will identify the HF requirements which will be documented in the corresponding DDP and will also be listed in the corresponding Work Plans, as appropriate. Note that the ECC process applies to both CNL and Contractor Work Plans.

8.3 Acts, Regulations, Codes, and Standards

CNL maintains a consolidated listing of the *Codes, Regulations, Standards, and Other Documents* [153] that are required for the operation of the Company and with which the Management System documentation provides identification of functional governance and compliance expectations through implementing documentation. Decommissioning work shall comply with the requirements of all applicable Codes, Standards, Acts, and associated Regulations. The G1WF LCH [4] specifies relevant Acts, Regulations, Codes, and Standards with their use being either mandatory and complied or recommended and used as guidance in the conduct of licensed activities at the G1WF.

Applicable Federal Acts, Regulations, and Codes, the CNSC Regulatory and Guidance Documents, CSA Standards, and the *IAEA Safeguards Agreements* and other guidance documents are listed in Section 8.3.1, Section 8.3.2, Section 8.3.3, and Section 8.3.4 respectively. This list is not an exhaustive list of all applicable codes and standards; there could be other standards with which compliance might be required as per the *CNL Management System Manual* [104] and its sub-tier documents. Compliance with the relevant Acts and Regulations noted in Section 8.3.1 is mandatory. The CNSC Regulatory documents generally include two (2) kinds of information: requirements and guidance. When included in the licensing basis, requirements are mandatory and must be met by the licensee. The CNSC Guidance documents provide direction to licensees and applicants on how to meet requirements. Similarly, compliance with the CSA standards is mandatory when referenced as a requirement in the licensing basis or via another regulatory requirement. As such, adherence to LCH listed CNSC documents and the CSA standards is enforced at the G1WF during the SWS period, and while planning for and executing decommissioning projects.

Federal and provincial regulatory bodies will be involved, or may be contacted, with respect to the conduct of decommissioning projects at the G1WF. The requirements for invoking such regulatory bodies depend on the nature of the decommissioning project (e.g., a designated project or not), who performs the Phase 3 Decommissioning (i.e., D&D) work (i.e., CNL or its contractor), and decommissioning outcomes including any unplanned events or incidents. A list of potential agencies is given below:

- Atomic Energy of Canada Limited
- Canadian Nuclear Safety Commission
- Employment and Social Development Canada
- Natural Resources Canada
- Environment and Climate Change Canada/Canadian Wildlife Service
- Health Canada
- Transport Canada
- Fisheries and Oceans Canada
- Canada Industrial Relations Board
- Canadian Endangered Species Conservation Council
- Commission des normes de l'équité de la sante sécurité au travail – CNESST

8.3.1 Federal and Provincial Acts, Regulations, and Codes

- Nuclear Safety and Control Act, S.C. 1997, c. 9
- General Nuclear Safety and Control Regulations, SOR/2000-202
- Class I Nuclear Facilities Regulations, SOR/2000-204
- Radiation Protection Regulations, SOR/2000-203
- Nuclear Substances and Radiation Devices Regulations, SOR/2000-207
- Nuclear Security Regulations, SOR/2000-209
- Packaging and Transport of Nuclear Substances Regulations, SOR/2000-208, 2015
- Transportation of Dangerous Goods Regulations, SOR/2001-286
- National Building Code of Canada 2015, National Research Council of Canada[2]
- National Fire Code of Canada 2015, National Research Council of Canada
- Canada Labour Code Part 2, R.S.C., 1985, c. L-2
- Canada Occupational Health and Safety Regulations, SOR/86-304
- Canadian Environmental Assessment Act 2012, S.C. 2012 (Chapter 19, Section 52)
- Species at Risk Act, S.C. 2002, c.29
- Migratory Birds Convention Act, 1994, S.C. 1994, c.22
- Migratory Birds Regulations, C.R.C., c. 1035
- PCB Regulations, SOR/2008-273

[2] Applicable to new construction and design modifications to existing structures.

- Land Protection and Rehabilitation Regulation, Q-2, r.37

8.3.2 CNSC Regulatory and Guidance Documents

- *Safety Culture*, REGDOC-2.1.2, 2018 April
- *Human Factors*, REGDOC-2.2.1, Version 2, 2023 December
- *Nuclear Criticality Safety*, REGDOC-2.4.3, Version 1.1, 2020 September
- *General Design Considerations: Human Factors*, REGDOC-2.5.1, 2019 March
- *Aging Management (Fitness for Service)*, REGDOC-2.6.3, 2014 March
- *Environmental Protection: Environmental Protection Policies, Programs and Procedures*, REGDOC-2.9.1, 2013 September
- *Environmental Protection: Environmental Principles, Assessments and Protection Measures*, REGDOC-2.9.1, Version 1.1, 2017 April
- *Nuclear Emergency Preparedness and Response*, REGDOC-2.10.1, Version 2, 2016 February
- *Framework for Radioactive Waste Management and Decommissioning*, REGDOC-2.11, Version 2, 2021 March
- *Waste Management, Volume III: Assessing the Long-Term Safety of Radioactive Waste Management*, REGDOC-2.11.1, 2021 January
- *Decommissioning,* REGDOC-2.11.2, 2021 January
- *Site Access Security Clearance*, REGDOC-2.12.2, 2013 April
- *Security of Nuclear Substances: Sealed Sources*, REGDOC-2.12.3, 2013 May
- *Safeguards and Nuclear Material Accountancy*, REGDOC-2.13.1, 2018 February
- *Reporting Requirements, Volume 1: Non-Power Reactor Class I Facilities and Uranium Mines and Mills*, REGDOC-3.1.2, 2018 January
- *Public Information and Disclosure*, REGDOC-3.2.1, 2018 May
- *Indigenous Engagement*, REGDOC-3.2.2, Version 1.1, 2019 August
- *Financial Guarantees for Decommissioning of Nuclear Facilities and Termination of Licensed Activities*, REGDOC-3.3.1, 2021 January
- *Regulatory Fundamentals*, REGDOC-3.5.3, 2018 August
- *Glossary of CNSC Terminology*, REGDOC-3.6, 2023 February

8.3.3 CSA Standards

- General requirements for pressure-retaining systems and components in CANDU nuclear power plants/Material Standards for reactor components for CANDU nuclear power plants, N285.0, 2018 August
- *Management system requirements for nuclear facilities*, N286-12, 2012 June (reaffirmed 2017)
- Commentary on N286-12, Management system requirements for nuclear facilities, N286.0.1: (2014), 2014

- Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities, N288.1-14, Update No. 3, 2018 June (reaffirmed 2019)
- Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills, N288.4-10, 2010 May, (reaffirmed 2015)
- Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills, N288.5-11, 2011 April, (reaffirmed 2016)
- Environmental risk assessments at Class I nuclear facilities and uranium mines and mills, N288.6-12, 2012 June, (reaffirmed 2017)
- Groundwater protection programs at Class I Nuclear Facilities and Uranium Mines and Mills, N288.7, 2023 August
- Groundwater protection programs at Class I nuclear facilities and uranium mines and mills, N288.7-15, 2015 June
- *Establishing and implementing action levels for releases to the environment from nuclear facilities*, N288.8-17, 2017 February
- *General principles for the management of radioactive waste and irradiated fuel*, N292.0:19, 2019 March
- *Interim dry storage of irradiated fuel*, N292.2-13, 2013 July, (reaffirmed 2018)
- *Management of low- and intermediate-level radioactive waste*, N292.3:14, 2014 May, (reaffirmed 2019)
- *Guideline for the exemption or clearance from regulatory control of materials that contain, or potentially contain, nuclear substances*, N292.5-11, 2011 June (R2016)
- *Long-term management of radioactive waste and irradiated fuel*, N292.6-18, 2018 March
- Fire protection for facilities that process, handle, or store nuclear substances, N393:13, 2013 December, (Reaffirmed 2016)
- *Decommissioning of facilities containing nuclear substances*, N294:19, 2019 November.
- *Quality management systems-Requirements*, CAN/CSA-ISO 9001:16, February 2016, (Reaffirmed 2020)
- *Environmental Management System – Requirements with Guidance for Use*, CAN/CSA-ISO 14001:16, February 2016, (Reaffirmed 2021)

8.3.4 IAEA Guidance Document and Safeguards Agreements

- *Safety Assessment for Facilities and Activities*, General Safety Requirements, No. GSR Part 4, Revision 1, 2016 February
- *Safety of Nuclear Fuel Cycle Facilities,* Specific Safety Requirements, No. SSR-4, 2017 October
- Canada/IAEA Safeguards Agreements:
  - *Treaty on the Non-Proliferation of Nuclear Weapons*, INFCIRC/140, 1970 April;

- *Agreement Between the Government of Canada and the International Atomic Energy Agency for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons*, INFCIRC/164, 1972 June; and
- Protocol Additional to the *Agreement between Canada and the International Atomic Energy Agency for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons*, INFCIRC/164/Add. 1, 2000 October.

9. Training and Qualifications

Canadian Nuclear Laboratories' *Training and Development* Program [90][91] provides employees with the knowledge, skills, and competencies required to safely and successfully perform the work they are responsible for. The program scope also includes building and sustaining employees' skill set in order to maintain and achieve CNL's corporate objectives, and creating and maintaining an efficient and effective investment in training on a company-wide basis that is planned and budgeted. The program supports career and individual development through experience, mentoring, and training.

The Project Manager is responsible for ensuring that generic personnel training is provided to all project staff according to the corporate training requirements [150]. The Project Manager, in consultation with the FA and the FM, will review, identify, and approve the training requirements for each project position. Project/task-specific training will be arranged by the Project Manager and a training matrix will be developed for each work plan to document this.

If work activities are being undertaken by contractors, the contractors shall provide qualified personnel to perform assigned tasks, and their staff training records to the Project Manager.

10. Environmental Protection

Decommissioning work undertaken shall comply with CNL's EnvP Program [79] to ensure the protection of the environment and the public with respect to CNL's activities, products, and services. The program requirements are detailed in the Environment Protection requirement [110], and include where applicable:

- Identification and assessment of significant environmental aspects related to CNL operations and decommissioning [72] [114].
- *Management and Monitoring of Effluents and Emissions* [112].
- Radiological Effluent Monitoring [154] and Environmental Monitoring [155].
- *Management of Land, Habitat and Wildlife* [113].
- *Environmental Incident Reporting, Investigation, and Mitigation* [117].

10.1 Environmental Review

An Environmental Review on decommissioning of PE-A and PE-B will be conducted to ensure that environmental aspects, associated with the decommissioning of the buildings/structures, are identified and that mitigation measures are in place to eliminate or reduce any negative impact on the environment.

10.2 Environmental Monitoring and Protection

The *Gentilly-1 Waste Facility Effluent Monitoring Plan* [26] operates under the CSA N288.5, *Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills* [154]. The *Gentilly-1 Waste Facility Effluent Monitoring Plan* [26] reflects the current facility status, objectives of the verification monitoring program, liquid effluent streams and monitoring criteria, and updated references.

The non-radiological Effluent Monitoring Program at G1WF consists of following:

- An annual check against the *National Pollutant Release Inventory (*NPRI*)* reporting requirements.
- An annual check against the *Greenhouse Gas Reporting Program (*GHGRP*)* reporting requirements.
- Monitoring and reporting any losses of halocarbon refrigerants and fire suppressants over 10 kg, in compliance with the Federal Halocarbon Regulations.

The *Gentilly-1 Waste Facility: Determination of Groundwater Protection and Groundwater Monitoring Requirements* [122] report demonstrates that G1WF does not meet the criterion from CSA N288.7, *Groundwater protection programs at Class I nuclear facilities and uranium*

mines and mills [156], for the need of a groundwater protection program or a groundwater monitoring program.

Both radiological and non-radiological emissions from the facility during routine operations are minimum and do not meet the reporting thresholds for non-radiological effluent monitoring. The facility continues to provide substantial protection of the environment.

Based on the environmental review of decommissioning activities of each planning envelope both radiological and non-radiological monitoring programs of G1WF will be updated and the proposed mitigation measures will be in place to eliminate or reduce any negative impact on the environment.

Common mitigating measures for decommissioning project that are applicable to the G1WF decommissioning are presented in Table 13.

Table 13: Environmental Mitigation Measures for the Decommissioning Project

Project Activities	Mitigation Measures
1. **Planned/Normal Radioactive & Non-Radioactive Emissions to the Environment**	
The activities of draining, pumping, and transporting residual liquid and sludge from piping, tanks and sumps may result in radiological and non-radiological releases to air, land, or water. b) Equipment removal (all phases), IH Hazard abatement, demolition activities, waste disposal, transportation activities, and fuel equipment operation may cause hazardous releases (air, land, or water), radiological air emissions, non-radiological particulate air emissions, and green-house gas emissions.	A characterization survey will confirm the presence of contaminated liquids and sludge in soil, tanks, pipes, or drums and abandoned chemical and/or active drains. Obtain IH-related clearance forms in the IWC process [54] to ensure proper controls and monitoring are used for abatement activities of all hazardous materials including, ACM, mercury, PCBs, and lead. Use of qualified Asbestos abatement workers following Ontario Asbestos Regulation O-Reg 278/05. Approved work plans, waste management plan(s) (reviewed by Decommissioning Environmental Specialists) and a related Work Authorization must be in place for decommissioning activities in order to assess the need for additional mitigation measures. All activities, including workplace air monitoring, may be conducted according to an approved RWA. If discovered, any radiological waste will be monitored and characterized to determine appropriate disposal route prior to transport. Vehicles/equipment will be maintained in good working order. Equipment using fuel and generating emissions should not be left idling when not in use. Dust suppression techniques (water spray/misting during demolition) should be used for controlling airborne particulate

Project Activities	Mitigation Measures
	emissions without causing surface runoff into the nearby storm drain or erosion impacts. Storm drains are to be covered during demolition water spraying activities.
2. Radioactive and Non-Radioactive Emissions to the Environment during Abnormal Events	
The removal, packaging, and treatment of tank/piping solutions and sludge, if present, could result in radiological and chemically hazardous releases to the environment causing air, soil, surface water and groundwater contamination. Possible leaks from valves, fittings, totes and mobile equipment can result in radioactive and hazardous releases to the environment.	Buildings and/or storm drains will be isolated and or covered to prevent the release of any spilled contaminated water and fluids outside of the buildings. In the event of any accidents and/or spills involving mobile equipment (fuel, lubricants, etc.) and hazardous material of radioactive waste, contamination will be cleaned up in accordance with CNL emergency procedures and processes. Standalone spill kits are to be made readily available and stocked to ensure appropriate use. Mobile spill kits should be carried on all heavy equipment, and mobile equipment should be immediately shutdown (and spill contained) in the event of a hydraulic oil leak or fuel spill. In the event of a spill/leak that could impact the environment outside the boundaries of the project area, immediately contact CNL Emergency Services (ext. 5555), the Project Leader, and Facility Manager. For spills of a minor nature, the Project Manager and Decommissioning Environmental Specialist are to be notified of the event. The spill will be cleaned up and an Impact will be raised documenting the material spilled, the quantity, location, clean-up measures, and disposal pathway for the waste.
3. Waste Generation and Management	
The generation of liquid and solid, non-radioactive, hazardous, and non-hazardous waste will occur throughout all decommissioning activities. b) Soil excavation, backfilling, and concrete removal activities could result in	Non-routine liquid discharges must meet requirements of *Acceptability Criteria for Routine and Non-Routine Discharge of Liquids at CNL Sites* [115]. All waste including contaminated soil (if encountered) from excavations shall be characterized and managed according to the approved WMP. All liquid waste containers will be clearly labelled with the appropriate information (contents, radioactivity, chemical reactivity, contact person). Waste sorting and size reduction (including packaging) should be practiced to the extent possible during all phases of activities.

Project Activities	Mitigation Measures
generation of contaminated waste. c) Waste will be generated from non-structural decommissioning and structural dismantling and demolition including building materials, consumables, and PPE&C. d) Hazardous waste will be generated from the removal of ACM, mercury, PCBs, lead, etc. e) Generation of radioactive waste from legacy contamination (soil, vegetation, equipment, and pipes) could be generated/encountered during soil excavation work.	Radioactive or chemically contaminated sludge and soil must be stored and transported in drums or other suitable containers with no stockpiling in the field. ACM waste will be managed in accordance with CNL's procedure *Asbestos Management* [157]. Hazardous waste will be managed according to Waste Management Plans developed from characterization and IH surveys and relevant procedural requirements.
4. Storage of Material	
Storage of petroleum and other hazardous materials (i.e., fuel, lubricants, chemicals, fixatives, cleaners, degreasers, spray paints, compressed gases).	Storage of extra fuel shall be in labelled, CSA-approved containers and shall be kept in secondary containment away from storm drains and shall be sheltered from the elements. All refueling shall take place over a catch tray or absorbent cloth away from storm drains, watercourses, and wetlands. Chemicals shall be clearly labeled and stored in appropriate chemical storage containers. Incompatible materials shall not be stored together. Compressed gases shall be secured in a ventilated and labeled compressed gas storage cage with signage indicating the flammable/explosive nature of the hazard if applicable. Work areas and material lay-down areas shall be maintained in a clean state. Waste materials shall be segregated and identified. Supplies and equipment shall be stored so as to minimize the risk of potential releases to the environment. The spill response and mitigation measures identified in Part 2 of this table will apply.

Project Activities	Mitigation Measures
5. Land and Property Management	
Soil excavation activities have the potential to generate contaminated soil from legacy events. Excavation and heavy equipment usage have the potential to degrade vegetation, cause soil erosion and destabilize slopes and embankments.	Soil excavation activities are to be managed as described in under Part 3 of this table: Waste Generation and Management. Dust control measures for stockpiled contaminated soil will be utilized to prevent uncontrolled releases of radioactive particulates. Examples of dust control measures include full enclosures, tarping, and/or the use of a dust suppressant approved by Environmental Protection. Decommissioning activities shall be confined to designated work areas. All soil, (regardless of contamination) will be kept away from manhole and storm drains. As per the requirements of procedure, *Management of Land, Habitat and Wildlife* [113], appropriate filtering/erosion control measures will be used to prevent soil/sediment from running into water systems including manholes and storm drains. Examples include silt fences, staked straw bales, erosion blankets and/or discharge bags. If water accumulates in soil excavation areas, (i.e., rain water, surface water, groundwater, etc.), the water must be sampled and analyzed to determine disposal route following *Acceptability Criteria for Routine and Non-Routine Discharge of Liquids at CNL Sites* [115].
6. Use/Consumption of Material & Natural Resources	
Heavy and small equipment use for the duration of the project. Electricity and water use for various decommissioning activities.	Ensure all equipment is maintained in a good working condition with no leaks or mechanical issues (including subcontractor equipment). Use biodegradable oil or environmentally friendly oil where possible in the equipment and tooling. Avoid unnecessary idling of vehicles and use of electricity or water when not required.
7. Other	
Heavy duty and other operating equipment will generate noise typical of demolition activities. Noise will be localized and not have any off-site impacts.	Ensure all equipment is in proper working order and mufflers working properly. Wear appropriate hearing protection and follow IH and OSH personal protective measures.

11. Public and Indigenous Engagement

CNL is developing a project-specific public communications plan and Indigenous engagement plan for the decommissioning of the Gentilly-1 Waste Facility. These plans will describe how CNL will share the details of CNL's application to amend the G1WF licence with stakeholders, the public, and Indigenous nations and organizations, and provide opportunities for feedback on that information. The plans will be executed in alignment with CNL's corporate *Public Information Program for Canadian Nuclear Laboratories* (PIP) [158] and will follow the requirements and guidance set out in CSA Standard N294:19, *Decommissioning of facilities containing nuclear substances* [6], CNSC REGDOC-3.2.1, *Public Information and Disclosure* [159], and CNSC REGDOC-3.2.2, *Indigenous Engagement* [160].

The public communications plan and Indigenous engagement plans will cover communications and engagement activities leading up to the date of the CNSC hearing on the licence amendment applications. Through its corporate PIP, CNL will continue to provide Indigenous nations and organizations, the public, and other stakeholders with information on the decommissioning and cleanup of the G1WF, as well as opportunities for feedback, until the project is completed.

11.1 Public Information Program

The public communications for G1WF are being planned and executed by following CNL's PIP [158]. The objectives of public communications on the G1WF are to:

1. Proactively and transparently share information with stakeholders and the public on CNL's application to the CNSC to amend the G1WF licence to include decommissioning of the reactor and the site, and on how to participate in the licence renewal process.
2. Provide opportunities for stakeholders and the public to discuss with CNL and give feedback on the licence amendment application and other related topics.
3. Build and maintain, at all levels of political leadership, active support for and confidence in CNL's ability to safely undertake the decommissioning of the facility.
4. Position CNL as the primary source for accurate project information.
5. Clarify for target audiences the mandates and timelines of CNL and Hydro-Québec related to the G-1 and G-2 facilities.
6. Meet regulatory-based communication and engagement requirements.

Target audiences will include:

- Municipal governments/local communities
- Local elected officials
- Regulators/agencies

- Media
- Federal and provincial government agencies
- Environmental/non-governmental organizations/citizens groups
- Local industry
- Nuclear industry
- Research and academia

11.2 Engagement with Indigenous Communities

As part of its corporate, environmental, and social responsibility, CNL recognizes that meaningful engagement to build strong working relationships with Indigenous nations and organizations is a key element of a successful nuclear decommissioning project. CNL will work closely with AECL, as its client and a federal Crown corporation, on Indigenous engagement.

CNL will strive to ensure that Indigenous engagement at the G1WF:

- Accommodates the needs, timeframes and capacity of Indigenous nations and organizations and is supported by appropriate capacity building.
- Supports long-term relationship-building and advances reconciliation.
- Follows principles for communication and engagement that have been mutually agreed to by CNL and Indigenous nations and organizations.
- Respects the uniqueness of each Indigenous community.
- Aligns with the proposed regulatory schedule.

Target audiences for Indigenous engagement will include:

- Indigenous nations with constitutional and treaty rights related to the G1WF site and their representatives.
- Indigenous nations and organizations that identify an interest in the G1WF site and decommissioning project.

11.3 Engagement to Date

While no engagement activities were carried out related to the G1WF in 2021 or 2022, planning activities for Indigenous engagement were initiated in 2023. Introductory engagement began in April 2023 at the Public, Stakeholder, and Indigenous levels.

Through its future engagement activities, CNL will capture and track feedback from Indigenous nations and organizations, as well as public feedback on the plans to apply for a licence amendment to permit decommissioning of the G1WF and will adjust communication tactics if feedback indicates this is warranted. Comments, questions, concerns and other feedback and

input from Indigenous nations and organizations, the public and other stakeholders, as well as CNL's responses, will be documented and retained according to CNL documentation and records retention procedures. Measurable statistics will be maintained on activities such as website hits, number of emails opened/responded to, and number of social media responses. CNL will evaluate this information as part of assessing the effectiveness of this plan.

CNL will use feedback received to further refine project planning and project messaging. An open two-way dialogue loop will be maintained throughout the engagement process.

A final report on the methods and outcomes of this engagement plan will be produced and submitted to the CNSC. A separate report, also to be submitted to the CNSC, will summarize the outcomes of engagement with Indigenous Nations and communities.

12. Decommissioning Strategy

After attaining full power for two (2) short periods in 1972 followed by the intermittent operation of 183 full power days in 1978, it was determined that the Gentilly-1 NGS requires certain modifications and considerable repairs. AECL put the Gentilly-1 NGS in a lay-up state in 1980. In July 1982, AECL decided not to rehabilitate G-1 NGS on economic ground. In March 1983, decommissioning alternatives were evaluated to determine which would provide the most benefit, based on consideration of economic and protection of public. At that time, following standard IAEA options were available and discussed:

- Storage With Surveillance (Stage I)
- Restricted Site Release (Stage II
- Unrestricted Site Usage (Stage III)

In March 1984, it was concluded that delaying final dismantlement of the Gentilly-1 NGS to Stage III condition by at least 50-80 years represented the optimal solution, for the following reason:

1. Decommissioning to Stage III is not justified with an adjacent operational plant (Gentilly-2) with almost its full design life ahead, that is, the site would not be releasable for unrestricted use in any case.
2. There is, at present, in Canada no commercial radioactive waste disposal site capable of accepting all the radioactive wastes associated with plant decommissioning. In the meantime, both the Reactor Building and the Turbine Building lend themselves well as structures for long term radiological waste storage.
3. Most of the activity in the form of contaminants (approx. 70%) in the plant is due to ^{60}Co which has a half-life of 5.27 years. This activity will have decayed by a factor of 700 after 50 years. This will leave ^{137}Cs and ^{94}Nb as the predominant radionuclide contaminant and the activated components as the radiological hazards at that time.
4. It is anticipated that during the coming decades the technology of decommissioning will continue to be improved. It should be noted, though, that adequate technology is available today to carry out complete dismantling, should such an option be considered as being absolutely necessary.
5. The maintenance cost of the station is reduced from approximately $2.5 Million to less than $0.5 Million annually.

As a result of this conclusion, AECL decided to carry out a two (2) year decommissioning program, beginning in April of 1984, to bring the G-1 NGS to a state meeting the IAEA definition of Stage II. Portions of the G-1 NGS hosting the major inventories of radionuclides would be isolated and the remainder of the G-1 NGS would be used for other purposes, as appropriate, or be retired in a safe condition.

Throughout 1984 and the early part of 1985, HQ and AECL negotiated to replace their original 1966 agreement with a new one for the G-1 NGS. These negotiations led to the May 1985 agreement which defines the long term "static state" for the G-1 NGS beyond April 1, 1986, after the two (2) years decommissioning program is terminated. The details of the long term "static state" has been described in *Gentilly-1 Waste Storage Facility: Licensing Overview Document* [11].

12.1 Decommissioning Approach

12.1.1 Phase 1 – Establishing a Safe Shutdown State

Phase 1 Decommissioning has brought the Gentilly-1 NGS (now G1WF) to a safe, sustainable, shutdown state. This was achieved by 1986 [11]. The heavy water was drained. All major radioactive or radioactively contaminated components were consolidated and securely stored onsite in the Reactor Building and Turbine Building. Other non-radioactive hazardous materials were also identified and removed. All other G-1 NGS buildings/structures that possessed no significant residual contamination or radioactive materials were decontaminated followed by appropriate radiological surveys. These buildings/structures were classified as uncontaminated areas and have become HQ property under the terms of the 1994 letter of agreement between AECL and HQ.

The primary radiological hazards remained at the G1WF (previously G-1 NGS) are associated with the following:

- Spent fuel in the SFCA
- Reactor and its associated components stored within the Reactor Building
- Turbine System
- Spent Resin Tank and Vaults

12.1.2 Phase 2 – Storage with Surveillance

Phase 2 is a SWS period that began in 1985 and is expected to last for 50 years until 2035 (see Section 16.1 for details). During this timeframe, G1WF will be monitored and maintained prior to final decommissioning [14]. The details of SWS activities are described in Section 5. The benefits of the SWS period include:

- A reduction in the dose commitment associated with the handling of radioactive materials due to the decay of short-lived fission and activation products that remain on site.
- Additional planning time, which may result in more effective long-term management of the wastes generated as a result of decommissioning activities (PE-A and PE-B).

- The potential implementation of lessons learned from other waste management and decommissioning activities within CNL and internationally.

The duration of the SWS period for PE-A and PE-B may be different, based on following:

- Health, Safety, Security and Environment (HSSE) concerns.
- Structural stability/integrity of the Reactor Building.
- Costs of SWS versus the final cost of decommissioning.
- Advances in technology.
- Business needs of CNL, including any agreements made with HQ.
- Availability of a national long-term solution to the management of decommissioning wastes.

12.1.3 Phase 3 – Decommissioning and Demolition

Prior to transition from Phase 2 Decommissioning (i.e., SWS phase) into Phase 3 Decommissioning (i.e., D&D), CNL will submit a licence amendment application to the CNSC requesting to amend the G1WF Decommissioning Licence and authorize CNL to proceed with final decommissioning. The scope of the final decommissioning consists of decommissioning of all above ground and underground buildings and structures of G1WF which belong to CNL (see Section 1.3). All other aboveground and underground buildings and structures of G1WF which have previously returned to HQ and all aboveground and underground buildings and structures associated with G-2 NGS are out of scope of the Phase 3 Decommissioning (i.e., D&D) (See Section 1.4 for details) of G1WF.

Two planning envelopes have been identified and all are classified as Nuclear (see Figure 19 and Table 14). The PE-A consists of the basement portions of the Service Building including Spent Resin Storage Area and southern portion of the Turbine Building including SFCA. The PE-B consists of the Reactor Building (Clear-Out including Calandria and Bioshield, Dome, and Containment Structure). Associated DDP for each planning envelope will be prepared and submitted to the CNSC for their acceptance. No Phase 3 Decommissioning (i.e., D&D) activity shall be executed in any planning envelope prior to the acceptance of its associated DDP by the CNSC.

The complete decommissioning of each planning envelope will be accomplished using a CNSC accepted dedicated DDP. The scope of the DDP will be broken into Work Packages that describes a high-level work execution. Work Packages will be executed under a series WCP. Each WCP will include descriptions of the work to be done, considering waste management, QA, and RP, as required. To assist in the preparation of the DDP, a characterization report will be prepared beforehand, which will document the current radiological, chemical, and industrial conditions that will be encountered during decommissioning activities. Unlike the standard CANDU design, the G-1 reactor design is unique. It is a boiling light water reactor with vertically

oriented pressure tubes containing light water as coolant and moderated with heavy water. Due to the use of light water, the tritium hazard should be much less of a hazard as it should only be present in the moderator system. This could perhaps lead to unique hazards that need to be mitigated during decommissioning.

Decontamination will be performed prior to dismantling and demolition whenever cost effective, to reduce worker exposure, to render equipment acceptable for reuse, or to release materials for non-radioactive waste disposal. Appropriate contamination control measures will be used when work is performed, including the use of temporary enclosures, local ventilation, personal protective equipment, and contamination monitoring.

Decommissioning will be complete when all of the buildings and structures located within the decommissioning boundary (PE-A and PE-B) are removed and resulting waste sent to either a storage facility or an approved off-site disposal facility, if available, or are sent for recycling, and the impacted footprint area has been restored to a state acceptable to HQ. Surveys will be conducted to verify that the G1WF site meets the necessary clearance levels.

Following completion of decommissioning and footprint area restoration, CNL will update the end-state conditions in a project close-out report and apply to the CNSC seeking termination of G1WF licence [1]. G1WF footprint will then be turned over to HQ, who will apply for a Licence to Abandon when G-2 NGS decommissioning is complete.

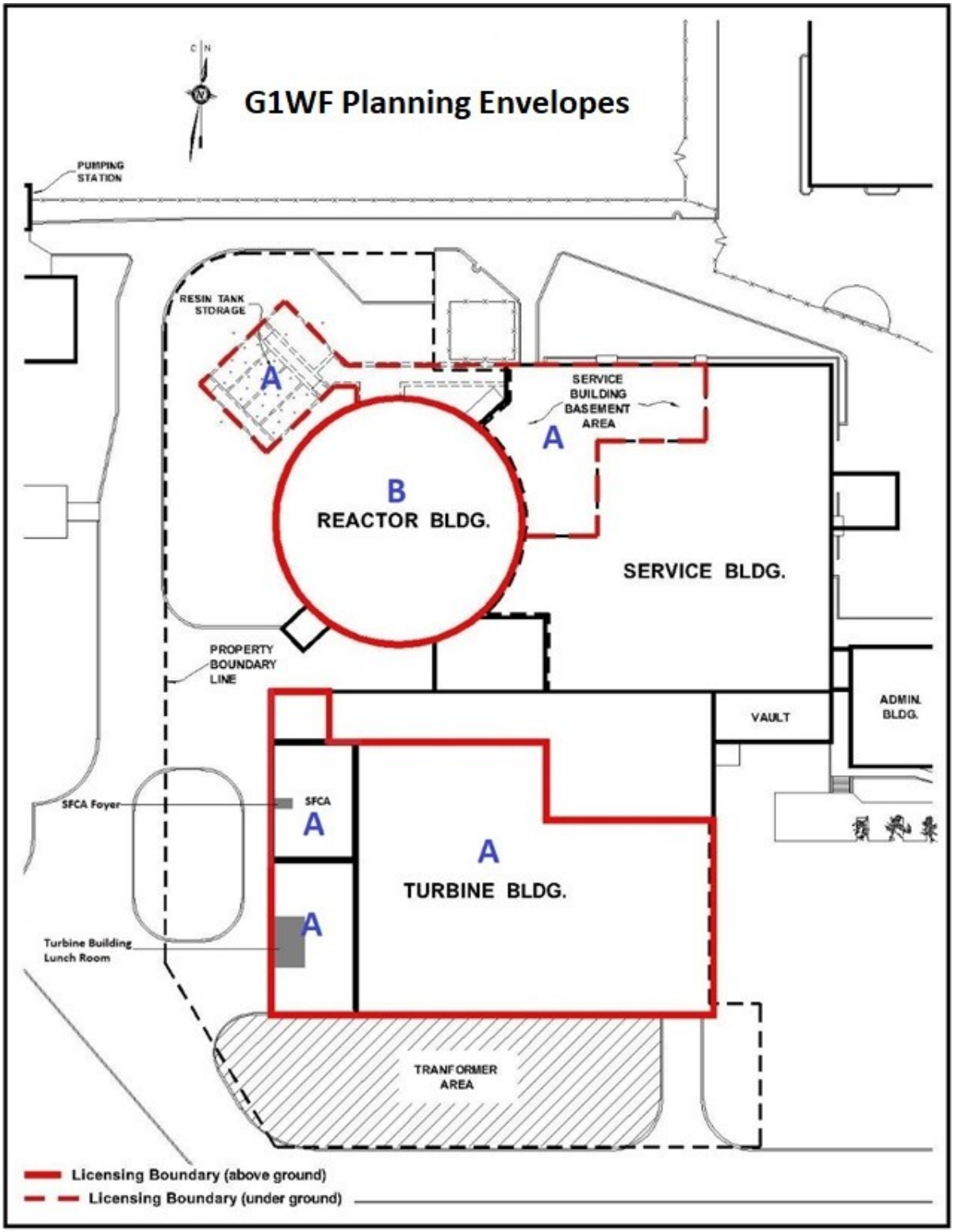

Figure 19: G1WF Decommissioning Planning Envelope Layout

Table 14: Decommissioning Planning Envelopes for G1WF

Planning Envelope	Description	Non-Nuclear/Nuclear	DDP Volume
Planning Envelope A	• Southern Portion of Turbine Building including Tunnel to Reactor Building and Spent Fuel Canister Area • Basement Portion of Service Building including Spent Resin Storage Area	Nuclear	Volume 2
Planning Envelope B	Reactor Building: • Clear-Out including Calandria and Bioshield • Dome and Containment Structure	Nuclear	Volume 3

12.2 Interim End-State Objectives

The interim end-state objectives for the buildings and areas of each planning envelope include following:

- Drain, de-energize, and remove all subsurface structures to a minimum depth of one meter below grade or to bedrock subject to no adverse vibration effects on the adjacent buildings, with the exception of the inactive drainage system.
- Perform a radiation survey of the impacted areas (see Section 12.3 for details) to ensure no contamination is present above the reference background level (i.e., Derived Concentration Guideline Levels (DCGLs)).
- For the freshly uncovered footprint area and the one-meter vicinity, seal all holes, voids, and channels deeper than one meter from the grade level and grout them to an elevation that is one meter below grade.
- Backfill and grade the area with clean gravel/soil and topsoil, and landscape the area.
- Update the *Gentilly-1 Waste Facility Interim End State Report* [15] to capture any significant deviations from each DDP and the decommissioning strategy outlined in this document (i.e., G1WF DDP Volume 1: Program Overview).

The affected footprint area within each planning envelope is expected to be free of soil contamination. If radiation survey discovers contamination in the impacted area, contaminated soil having radiation field above the background level will be removed, packed in suitable containers, and shipped to a radioactive waste management facility as soon as possible. If

interim storage is necessary prior to shipping, the contaminated soil will be stored in a suitable location within the G1WF.

The restored area upon completion of decommissioning of each planning envelope will remain as RSZ 1 (see also Section 13.4).

12.3 Radiation Survey

A radiation survey (i.e., surface scan) of the footprint area of the buildings and the surrounding soil (minimum 1 m from the building perimeter) will be performed for each planning envelope following the completion of its decommissioning activities. The survey ensures that the radiation fields are at the background level and there are no 'hot spots' in the impacted area. Any contaminated soil above background level will be removed and stored in suitable containers for interim storage and managed appropriately as per CNL procedure [161]. The excavated area will be backfilled with clean gravel/soil and topsoil.

13. Work Packages

Decommissioning and Demolition of nuclear buildings/structures in each planning envelope of G1WF will be achieved by implementing a systematic approach to decommissioning [108], which includes four (4) distinct stages as noted below:

Stage 1: Project Planning

Stage 2: Completion of Pre-requisites to Decommissioning and Demolition

Stage 3: Physical Execution of Work Package(s)

Stage 4: Interim Site Restoration and Project Close-Out

Each DDP volume covering a planning envelope will provide all information related to its four (4) stages of decommissioning. However, high-level details of these four (4) stages are provided in the following subsections.

13.1 Stage 1: Project Planning

During project planning stage, a DDP and its supporting documents (such as Environmental Effects Review, Waste Inquiry Form, Decommissioning Safety Assessment, etc.) for each planning envelope will be prepared, reviewed by Subject Matter Experts (SMEs) and approved by CNL management. It also includes a review of past reports that assessed the radiological and non-radiological hazards within the specific building/area. The DDP specific to each planning envelope will be submitted to the CNSC for their review and acceptance as part of the decommissioning planning process.

The project planning phase also includes enabling work (i.e., mobilization) that will be required to support the execution of Work Packages. The enabling work will include but are not limited to following:

- The acquisition of materials and equipment (e.g., fencing, signage, trailers, enclosures, waste containers, etc.) to support the decommissioning project.
- Staging the work area (e.g., lay-down areas, trailer set-up, erecting barriers/fencing and signage, and setting up Construction Island as required).
- Installation of alternative washroom/shower facilities.
- Installation of temporary construction power and lighting, if required.
- Temporary fire detection/suppression arrangements.

13.2 Stage 2: Completion of Pre-requisites to Decommissioning and Demolition

The pre-requisites must be completed prior to commencing physical dismantlement and/or demolition activities of each planning envelope. The pre-requisites will vary depending on the building/area of each planning envelope. Examples of the pre-requisite activities include but are not limited to following:

- Characterization [162]
- Decontamination
- Removal of waste (radioactive/hazardous/clean) [161]
- Reconfiguration of services
- Isolation of obsolete services
- Readiness checks

13.3 Stage 3: Work Package Execution

The physical execution of the decommissioning activities of each planning envelope will occur only after the acceptance of the relevant DDP by the CNSC. The physical dismantling and/or demolition of buildings/structures of each planning envelope will be carried out by implementing a series of Work Packages and DWPs, which will describe the details and sequence of decommissioning activities. Detailed decommissioning planning including the preparation of DWPs that underpin each of the Work Packages will be undertaken in accordance with CNL Decommissioning Process guidelines. The individual Work Package and associated DWPs together with the supporting documents such as Technical Scope of Work, RWAs, JHA, Waste Inquiry Form, etc. form the WCP and will ensure the safe execution of the work under the given Work Package.

13.4 Interim Site Restoration and Project Close-Out

The interim site restoration and project close-out stage will restore the affected area that is surrounded by the trench. The work includes a final radiation survey of the entire affected area under each planning envelope to ensure no radiological contamination above background level is present in the soil and backfilling and grading of the excavated area with clean gravel/soil and topsoil followed by seeding or sodding. The radiation survey of the entire affected area of each planning envelope will be conducted in accordance with a plan approved by a CNL Health Physicist [163]. The project lead will also prepare a Project Close-Out/Completion Report including lessons learned and a description of the interim end-state achieved for the G1WF site after completion of decommissioning activities of each planning envelope.

In summary, interim site restoration and project close-out stage for each planning envelope will include the following:

- Removing any remaining structures (including buildings that were not contaminated and temporary structures) using conventional demolition techniques.
- Perform a final overall radiation survey of the area freed-up by the removal of the buildings and structures to ensure the area remains as RSZ 1.
- Backfill and grade the entire area within the planning envelopes with clean gravel/soil and topsoil, and landscape the area (seeded/sodded), if not executed earlier as part of the individual work packages (if this activity was deferred during Stage 2: Work Package Execution).
- Remove project's site access control.
- Complete Project Close-Out/Completion Report including any relevant ImpActs and lessons learned, and any deviations from the approach outlined in each DDP.
- Complete closure paperwork and file all the records in CNL's electronic document records management system (i.e., ATOM).

The waste produced during site restoration will be handled in accordance with the waste management plan as described in Section 15.

14. Remediation Strategy

Environmental remediation is an integral part of the CNL *Land Use Process* [164] and complements the overall decommissioning process [108]. Site remediation ensures that the site is suitable for next land use and meets the defined final end-state criteria. The remediation process draws guidance from the CNL *Environmental Remediation Process* [165] and complies with CSA N294:19 [6] requirements, which in turn apply to all facilities containing nuclear substances.

In the context of decommissioning, the G1WF is owned, operated, and licensed to CNL but the site land belongs to HQ. Therefore, an agreement between CNL and HQ will have to be reached in alignment with CNL's *Land Use Process* [164] requirements on the expected conditions for returning the land to HQ so that it is in a state suitable for other HQ uses. Once the G1WF site meets the HQ agreed site clearance requirements, then CNL will request the CNSC to terminate G1WF decommissioning licence and the land will be transferred to HQ.

14.1 Final End State Objectives

An agreement between CNL and HQ will have to be reached in alignment with CNL's *Land Use Process* [164] requirements on the expected conditions for returning the land to HQ so that it is in a state suitable for other HQ uses. For planning purposes, CNL assumes that the Gentilly site will be available for industrial re-use after decommissioning and therefore, the cleanup criteria will be based on the following radiological, chemical, and physical objectives:

- In terms of radiological activity, the intent is to remove all contaminated structures or clean them to free release level [31]. However, if contamination has entered the geosphere and it is impractical to completely decontaminate, CNL will use clean-up criteria that meet a dose constraint no more than 300 µSv in a year as recommended in the International Commission on Radiological Protection (ICRP) Publication 82, *Protection of the public in situations of prolonged radiation exposure* [166], see Section 14.2 for details.
- With respect to chemical contaminants, Québec Contaminated Sites clean up criteria listed in Schedule IV of the Land Protection and Rehabilitation Regulation [49] will be used.
- Regarding the end-state physical state of the site, all aboveground structures and underground structures including foundations to a depth of one meter below grade will be removed, backfilled and graded with gravel and topsoil, and landscaped (with sod or seeded).

Upon completion of the Phase 3 Decommissioning (i.e., D&D) and achieving the final end-state as agreed with HQ, CNL will return G1WF land to HQ. CNL will request the CNSC to terminate CNL's G1WF decommissioning licence.

To achieve the final end-state of G1WF as agreed with HQ, the following activities will have to be completed:

- All G1WF SSCs including the buildings have been dismantled/demolished and removed from the site.
- All subsurface structures have been drained, de-energized, and removed to a minimum depth of one meter below grade (consistent with industry practices).
- All excavated areas have been backfilled with clean soil, graded with topsoil, and sodded/seeded.
- Any contaminated underground structures that are accessible but left in-situ (i.e., buried structures and services below the one-meter depth from the grade) have been decontaminated to levels ALARA and grouted in cement matrix.
- Below-grade holes, voids, or channels into the bedrock at a depth more than one meter from the grade have been filled with grout, and the top one-meter layer backfilled and graded with clean soil and topsoil.
- All radioactive wastes, hazardous waste materials, and radiological and non-radiological contaminations in excess of the established clearance levels have been removed from the site.
- All spent fuel and SFCA have been removed from the G1WF site.
- G1WF site has been remediated/restored to conditions specified in the facility-specific or building specific DDPs and is ready for return to HQ/alternative use.
- Completion of the Final Status Survey of the site (and any remaining structures, if applicable), which confirms that the concentrations of any remaining radiological or chemical contaminants in the impacted areas are below the release criteria for the proposed designation of the site/area by HQ.
- Completion of the (final) End-state Report.
- G1WF site has met the criteria established by the CNSC for licence termination.
- CNSC has accepted CNL's application to terminate the WFDL of the G1WF.

14.2 End State Survey

At the completion of Phase 3 Decommissioning (i.e., D&D) of G1WF (i.e., decommissioning of all two (2) planning envelopes completed), a Final Status Survey (FSS) of the G1WF site will be performed to ensure the protection of future receptors on the property. If contamination has entered the geosphere and it is impractical to completely decontaminate the impacted area, CNL will follow the ICRP recommended clean-up criteria that limit dose no more than 300 µSv in a year to future receptors on the site and in the vicinity. Compliance with the dose constraint (i.e., dose objective of 300 µSv/year) will be demonstrated through site-appropriate intake

pathway modelling for the critical population group. The model determines the DCGLs for various radioisotopes that are contributing to the residual radioactivity on site. The FSS sampling and analyses results will compare against the respective DCGLs and demonstrate compliance (or lack thereof) with respect to the selected site clearance criteria. If the FSS fails to pass the release criteria, additional remediation measures may become necessary. Following a successful FSS outcome, CNL will request to the CNSC to terminate CNL's G1WF decommissioning licence and return G1WF land to HQ.

14.3 Institutional Controls

The G1WF site is owned, operated, and licensed to CNL but the Gentilly site land belong to HQ. Therefore, upon completion of Phase 3 Decommissioning (i.e., D&D) of G1WF and meeting the HQ agreed end-state objectives, CNL will request the CNSC to terminate the G1WF decommissioning licence. Upon acceptance of G1WF licence termination request, CNL will return G1WF land to HQ. The HQ as a Gentilly site landowner will be responsible for G-2 NGS decommissioning, site remediation for future land use, and long-term institutional controls, if required by the CNSC.

15. Waste Management Plan

This section provides a summary of the waste types and estimated quantities of the waste that is currently stored at G1WF and the waste that will be generated due to the Phase 3 Decommissioning (i.e., D&D) activities. Furthermore, it also describes an overview of the waste management practices that will be applied to both stored and decommissioning wastes.

15.1 Stored Waste

The stored wastes defined herein as inventory consist of loose materials stored in the Facility. It excludes all equipment (reactor, turbine, generator, tanks, pumps, motors, pipes, cabinets, conduits, cables, etc.) that are installed in the various buildings at the G1WF. Table 15 summarizes the waste stored in G1WF as of 2021 December 31.

Table 15: Stored Waste Inventory at G1WF

Waste Type	Source	Total Estimated Volume (m^3)	Total Estimated Radioactivity (Bq)	Primary Radionuclides
Low Level Waste (LLW)	Four (4) drums located in Reactor Building Room 107 suspected to contain legacy LLW resins.	1	Unknown	Unknown
	One (1) drum located in Reactor Building Room 107 that contains a few inches of liquid.	0.01	Unknown	Unknown
Intermediate Level Waste (ILW)	Shielded flask located in Reactor Building Room 009[a] suspected to be containing CSTs and flux detectors	1	Unknown	Unknown
	Shielded flask located in Reactor Building Room 403[b] suspected to be containing CSTs	1	Unknown	Unknown

a This flask is suspected to contain ILW, as found during historical documentation research to identify Reactor Building Room 009 flask content.

b This flask was discovered while removing the waste from Room 009 vault in the Reactor Building as part of the hazard reduction campaign. It was left in place until further investigation is conducted.

15.2 Decommissioning Waste

At G1WF, the waste generated from the decommissioning activities will be identified and accounted for under the following three (3) categories:

- Potentially Clearable Waste (i.e., clean waste or likely clean waste)
- Radioactive Waste (ILW, LLW)
- Hazardous Waste (e.g., ACMs, Lead, Mercury, Silica, etc.)

Furthermore, wastes generated in each category mentioned above will be grouped into the following waste streams:

- Concrete
- Masonry Waste (bricks, concrete blocks)
- Miscellaneous Construction Materials (wood, door/window, floor tiles, roofing, siding, counters, cupboards, etc.)
- Mechanical and Electrical Waste (piping, ductworks, wirings, light fixtures, systems, equipment, etc.)
- Rebar
- Structural Steel & Miscellaneous Metals
- Hazardous Waste (ACMs, Lead, Mercury, Silica, etc.)
- Excavated Material (Excavated soil to expose foundation)

The hazardous waste will be accounted neither as stored waste nor as decommissioning waste but will be labelled as waste arising from the pre-Phase 3 Decommissioning (i.e., D&D) activities. The hazardous waste will be removed and disposed of before the commencement of the decommissioning and demolition activities (see Section 6.2.2 for details). Therefore, decommissioning waste inventory is expected to include radioactive waste (i.e., ILW and LLW) and potentially clearable waste only.

Estimates have been prepared of the types and quantities of materials and waste that will be generated from the decommissioning of the equipment and structures at G1WF and are documented in *Class 3 Cost Estimate Gentilly-1 Waste Facility Decommissioning & Demolition* [167]. Table 16 provides a high-level summary of the waste streams along with their quantities for each planning envelope.

Table 16: Summary of G1WF Decommissioning Waste Estimate

Planning Envelope (PE)	PE-A					PE-B					Total Waste
Waste Stream	Potentially Clearable Waste	Hazardous Waste	Radioactive Waste		Total	Potentially Clearable Waste	Hazardous Waste	Radioactive Waste		Total	
			LLW	ILW				LLW	ILW		
Concrete (m^3)	12,574	0	428	0	13,002	14,883	0	0	260	15,143	28,145
Masonry (m^3)	205	0	0	0	205	20	0	0	0	20	225
Misc. Construction waste (m^3)	935	0	0	0	935	164	0	0	0	164	1,099
Excavated Materials (m^3)	20,291	0	0	0	20,291	4,353	0	0	0	4,353	24,644
Total (m^3)	34,005	0	428	0	34,433	19,420	0	0	260	19,680	54,113
Structural Steel and Misc. Metals (MT)	1,638	0	0	0	1,638	1,363	0	0	238	1,601	3,239
Rebar (MT)	1,259	0	0	0	1,259	2,317	0	0	25	2,342	3,601
Mechanical & Electrical (MT)	1,234	0	157	0	1,391	851	0	214	108	1,173	2,564
Total (MT)	4,131	0	157	0	4,288	4,531	0	214	371	5,116	9,404
Note: MT stands for metric ton											

High level waste is not anticipated to be generated during Phase 3 Decommissioning (i.e., D&D). The spent fuel will be transferred from the G1WF to the CRL WMA [20] for interim storage under the Phase 2 decommissioning licence [1]. The final disposition of the spent fuel will not take place until a decision is made on the ultimate strategy for the disposal of High-Level Waste and Irradiated Fuel in Canada.

The radioactive waste (i.e., LLW and ILW) generated during the Phase 3 Decommissioning (i.e., D&D) of G1WF buildings and structures will consist of concrete, process components (mechanical, electrical and communications) and architectural and structural materials. The principal sources include following:

- Component parts of the reactor assembly
- Calandria shell and tubes, pressure tubes, and biological shield
- Heat Transport System
- Moderator System
- Pumps and piping
- Resin tanks and vault

The main and auxiliary equipment will be decontaminated and will be disposed as clean waste.

Radioactive waste (i.e., ILW and LLW) will be shipped to an appropriate off-site waste management facility for processing/storage/disposal. The off-site waste management facilities will be designated in each DDP and Decommissioning Work Plans.

Table 17 shows a detailed breakdown of the G1WF decommissioning waste estimate at the facility/building level. In total, the Phase 3 Decommissioning (i.e., D&D) activities will produce approximately 54,113 m^3 and 9,404 MT waste. Out of 54,113 m^3 waste volume, 98.7% waste will be clearable and 1.3% will be radioactive of which 62.2% LLW and 37.8% ILW. Out of 9,404 MT waste weight, 92.1% waste will be clearable and 7.9% radioactive of which 50% LLW and 50% ILW. The Phase 3 Decommissioning (i.e., D&D) activities at G1WF will produce seven (7) waste streams. A brief summary of the estimated seven (7) decommissioning waste streams is given below:

- 28,145 m^3 Concrete Waste (97.6% potentially clearable and 2.4% radioactive which is 62.2% LLW and 37.8% ILW)
- 225 m^3 Masonry Waste (100% potentially clearable)
- 1,099 m^3 Miscellaneous Construction Waste (100% potentially clearable)
- 24,644 m^3 Excavated Materials (100 % potentially clearable)
- 3,239 MT Structural Steel and Miscellaneous Metals (92.7% potentially clearable and 7.3% radioactive which is 100% ILW)

- 3,601 MT Rebar (99.3% potentially clearable and 0.7% radioactive which is 100% ILW)
- 2,564 MT Mechanical & Electrical Waste (81.3% potentially clearable, and 18.7% radioactive which is 77.4% LLW and 22.6% ILW)

Table 17: Breakdown of G1WF Decommissioning Waste Estimate

Planning Envelope (PE)	PE-A								PE-B		TOTAL WASTE	
Waste Stream	Spent Resin Tank and Vaults		Spent Fuel Canisters		Service Building Basement		Turbine Building Southern Section		Reactor Building - Clear-Out including Calandria and Bioshield - Dome and Containment Structure			
Potentially Clearable Waste												
Concrete (m^3)	515		13		2,141		9,905		14,883		27,457	
Masonry (m^3)	0		4		0		201		20		225	
Misc. Construction waste (m^3)	0		19		0		916		164		1,099	
Excavated Materials (m^3)	1,179		0		3,043		16,069		4,353		24,644	
Total (m^3)	**1,694**		**36**		**5,184**		**27,091**		**19,420**		**53,425**	
Structural Steel and Misc. Metals (MT)	1		30		2		1,605		1,363		3,001	
Rebar (MT)	52		1		215		991		2,317		3,576	
Mechanical & Electrical (MT)	13		0		4		1,217		851		2,085	
Total (MT)	**66**		**31**		**221**		**3,813**		**4,531**		**8,662**	
Hazardous Waste												
Concrete (m^3)	0		0		0		0		0		0	
Masonry (m^3)	0		0		0		0		0		0	
Misc. Construction waste (m^3)	0		0		0		0		0		0	
Excavated Materials (m^3)	0		0		0		0		0		0	
Total (m^3)	**0**		**0**		**0**		**0**		**0**		**0**	
Structural Steel and Misc. Metals (MT)	0		0		0		0		0		0	
Rebar (MT)	0		0		0		0		0		0	
Mechanical & Electrical (MT)	0		0		0		0		0		0	
Total (MT)	**0**		**0**		**0**		**0**		**0**		**0**	
Radioactive Waste												
	LLW	**ILW**	**LLW**	**ILW**	**LLW**	**ILW**	**LLW**	**ILW**	**LLW**	**ILW**	**LLW**	**ILW**
Concrete (m^3)	43	0	385	0	0	0	0	0	0	260	428	260
Masonry (m^3)	0	0	0	0	0	0	0	0	0	0	0	0
Misc. Construction waste (m^3)	0	0	0	0	0	0	0	0	0	0	0	0
Excavated Materials (m^3)	0	0	0	0	0	0	0	0	0	0	0	0
Total (m^3)	**43**	**0**	**385**	**0**	**0**	**0**	**0**	**0**	**0**	**260**	**428**	**260**
Structural Steel and Misc. Metals (MT)	0	0	0	0	0	0	0	0	0	238	0	238
Rebar (MT)	0	0	0	0	0	0	0	0	0	25	0	25
Mechanical & Electrical (MT)	22	0	0	0	23	0	112	0	214	108	371	108
Total (MT)	**22**	**0**	**0**	**0**	**23**	**0**	**112**	**0**	**214**	**371**	**371**	**371**

Note: MT stands for metric ton

15.3 Soil

The overall zoning of G1WF buildings and structures ranges from RSZ 1 to RSZ 3. Therefore, the probability of contamination presents within the surrounding he foundations and in the immediate vicinity of G1WF buildings and structures cannot be discounted. After completion of the demolition activities, the radiation surveys of the affected areas including building footprint of each of the buildings and structures will be conducted to ensure the affected areas are cleared of contamination and meet the criteria for RSZ 1 designation.

If radiation surveys reveal no contamination or contamination below the clearance level in the soil, then the areas will be backfilled and/or graded. On the other hand, if contamination is found in the soil above the clearance level, the contaminated soil will be removed, categorized [168], and packaged in appropriate containers for interim storage and subsequent transfer to a radioactive waste storage or disposal facility as per the CNL procedure, Management of Waste [161].

If the excavated gravel/soil is free of contamination but not suitable for re-use (i.e., for backfilling), it will be hauled away and, for proper compaction, new gravel/soil will be used to backfill the excavated areas. Any deep voids (i.e., below bedrock level) created by the removal of building foundations, footings, and/or buried services will be filled with grout up to the level of the bedrock.

15.4 Waste Management Practices

Stored waste and decommissioning waste at G1WF will be managed as outlined below:

- Both stored and decommissioning wastes will be reduced in volume to the extent practicable by following ALARA principle and packaged appropriately for their intended destination. The disposition of the waste will be determined, using the following list of options, in the order of decreasing preference:
  - Reuse or Recycle (off-site)
  - Salvage (off-site)
  - Send to off-site inactive landfill
  - Transfer to an appropriate off-site waste management facility.
- Prior to commencing the demolition of G1WF buildings and structures, the Stored waste present within these buildings will be monitored, segregated, packaged or contained, and shipped for either processing, storage, or disposal as appropriate and in accordance with the *Waste Management Plan for the Gentilly-1 (G-1) Prototype Reactor Site* [169].
- Consideration will be given to control dismantling techniques, decontamination, contamination control, segregation of waste materials, reduction of active secondary wastes, and effective processing in order to minimize the amount of materials that need to go to an active Waste Management Facility (WMF). Wherever possible, materials will be decontaminated to allow for unrestricted release or disposal in an inactive landfill.

- Wherever practical, dismantled debris will be released for recycling and reuse.
- The decommissioning waste of the G1WF will be monitored, segregated, packaged, or contained, and shipped for either processing, storage, or disposal as appropriate and in accordance with project-specific waste management plan, referred to as *Waste Enquiry Form* (WEF) [170].
- All waste will be adequately characterized to meet CNL's *Waste Management* Program requirements [146].
- The characterized waste will be classified as clearable, hazardous, radioactive, and mixed waste [161][171][172].
- Clearable waste will be separated by material type and dispositioned utilizing the CNL's disposal strategy (i.e., prevent, reduce, re-use, recycle, dispose – given in the order of the most preferred to the least preferred option), which is consistent with the requirements of the project-specific *WEF* [170]and *Canadian Nuclear Laboratories Integrated Waste* Strategy [173].
- Hazardous/designated materials will be removed completely before the commencement of decommissioning work (see Section 13 for details). Therefore, hazardous/designated waste is not expected as a part of decommissioning waste. However, if hazardous/designated materials (e.g., hazardous building materials that remain as part of the building structure) are discovered during decommissioning, these will be removed, packaged, and disposed in accordance with the project-specific WEF [170],*Waste Management Plan for Hazardous and Mixed Waste at CNL* [172], *Management of Designated Toxic Substances* [53], and *Asbestos Management* [50] procedures.
- The ILW and LLW will be segregated, packaged, and shipped to one of the CRL WMAs for interim storage or to a licensed off-site facility for processing in accordance with CNL *Waste Management* [146] program, Radiation Protection [31] program, and *Transportation of Dangerous Goods* [144] program requirements.
- To meet the requirements of CNL's *TDG* Program [144] and the regulatory requirements for waste transport, 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.

The stored waste is being removed from the Facility through hazard reduction campaigns. The G1WF must satisfy the CNSC regulatory requirements pertaining to waste management during hazard reduction campaigns as well as Phase 3 Decommissioning (i.e., D&D) [174][175][176].

16. Funding, Schedule, and Costs

16.1 Schedule

As discussed in Section 12.1.3, the Phase 3 Decommissioning (i.e., D&D) is grouped into two (2) planning envelopes which are being scheduled while taking into account HSSE and ALARA considerations and other business factors. The SWS activities at G1WF will continue until the completion of its Phase 3 Decommissioning (i.e., D&D).

The schedule may need to be revised for reasons, including:

- Decision to advance decommissioning activities.
- Timetable delays, e.g., due to operational priorities or changes at G-2.
- Delays in availability of waste disposal site.

Table 18 shows the planned project milestones related to the decommissioning of G1WF. A conceptual schedule is also shown in Figure 20. The planning envelopes are defined in Table 14 and are shown in Figure 19 (Section 12.1.3). Work packages for each of these planning envelopes are defined in Section 13.

The G1WF is currently in a Phase 2 Decommissioning (i.e., SWS phase). The SWS phase will continue during Phase 3 Decommissioning (i.e., D&D) activities to return the G1WF to a defined end state as agreed upon with the HQ and the regulator (i.e., CNSC). More detailed schedules of decommissioning activities will be provided in the future DDPs and associated DWPs.

The PE-A includes Turbine Building (south section including SFCA) and Service Building Basement including Spent Resin Storage Area. The decommissioning of PE-A will require DDP Volume 2 preparation, submission, and acceptance by the CNSC. The decommissioning of PE-A will occur during 2026-2030 period.

The PE-B includes Reactor Building Clear-out including Calandria and Bioshield and decommissioning of Reactor Building dome and Containment Structure. The decommissioning of PE-B will require DDP Volume 3 preparation, submission, and acceptance by the CNSC. The decommissioning of PE-B will occur during 2027-2034 period.

Following the completion of the physical decommissioning of each planning envelope, final survey and project close-out documentation will be prepared and submitted to the CNSC for information. Upon completion of Phase 3 Decommissioning (i.e., D&D) of G1WF site, CNL will submit the application for G1WF Licence Termination, which will then result in the transfer of the G1WF site to HQ in 2035.

Table 18: Planned Project Milestones related to the G1WF Decommissioning

Event	Date (year)
Planning Envelope A	
Preparation, Submission, and Acceptance of the Detailed Decommissioning Plan (DDP Volume 2) describing the work to be performed during Dismantling, Demolition, Disposal, and Site Restoration along with other supporting documentation including Environmental review report.	2023-2026

End of Safe Storage and beginning of preparations for Dismantling, Demolition, Disposal, and Site Restoration for:
• The south section of the Turbine Building
  ➢ Including the SFCA
• Service Building Basement
  ➢ Including Resin Storage Vaults
	2026

End of decommissioning, demolition, waste disposal, and completion of site restoration.	2030
Survey and Close-Out Documentation/Interim End-State Report.	2030
Planning Envelope B	
Preparation, Submission, and Acceptance of the Detailed Decommissioning Plan (DDP Volume 3) describing the work to be performed during Reactor Building Clear-out and decommissioning of Reactor Building Dome and Containment Structure, along with other supporting documentation including Environmental review report.	2025-2027
End of Safe Storage and beginning of preparations for Dismantling, Demolition, Disposal, and Site Restoration for Reactor Building Clear-out.	2027
End of decommissioning, demolition, waste disposal, and completion of site restoration.	2034
Final Survey and Close-Out Documentation	2034
Final End-State Report for the G1WF Site	
Submission of Final End-State Report.	2035
Application to Terminate G1WF Licence	
Submission and Acceptance of Application to Terminate G1WF Licence.	2035
Site Transfer	
Site transfer and termination of MoU between CNL/AECL and Hydro-Québec.	2035

Actvities	Duration (Year)	1984-1986	1987-2022	2023-2024	2025-2026	2027-2028	2029-2030	2031-2032	2033-2034	2035
Safe Shutdown Activities	3	→								
Storage with Surveillance	49		→	→	→	→	→	→	→	→
Licence Amendment + DDP Vol 1	3			→	→					
Planning Envelope A (DDP Vol 2)	8			→	→	→	→			
Planning Envelope B (DDP Vol 3)	12				→	→	→	→	→	
Final End State Report	1									→
Licence Termination and Site Transfer	1									→

Figure 20: Conceptual Schedule of G1WF Decommissioning

16.2 Cost Estimate

In 2019, the G1WF Decommissioning Cost Estimate (DCE) was updated [167]. The 2019 DCE was completed under the International Structure for Decommissioning Costing (ISDC) format using the DECOM ISDC Excel (ISDCEX) computer code, which has an expected accuracy of -20% to +30%. A detailed description of the ISDC cost methodology is provided in [177]. This model is considered by the estimator as a Class 3 estimate per The Association for the Advancement of Cost Engineering (AACE) International listed in Appendix B. The cost estimate meets the requirements of the CSA N294:19 [6] and the CNSC REGDOCs including REGDOC 3.3.1 *Financial Guarantees for Decommissioning of Nuclear Facilities and Termination of Licensed Activities* [7] and REGDOC-2.11.2 *Waste Management: Decommissioning* [8].

The 2019 DCE [167] of the G1WF used unit rates which included labour and materials, equipment, subcontractor's overheads, and profits. Each unit rate was based on the work to be performed, the individual steps required, the duration of the work, equipment, tools, and consumables as needed. The cost for performing the physical dismantling and demolition work was estimated using a composition of work crew consisting of one Foreman, one General Foreman (part-time on site), three Labourers, two Craftsmen, one Health Physics Technician and one Fire Watch. The labour rates were based on the then-current (i.e., 2019 Canadian dollars) rates as recommended by the Canadian Union of Skilled Workers (CUSW) and the Electrical Power Systems Construction Association (EPSCA) at Nuclear Waste Operations Bruce Site. The labour rates were calculated as a blended rate based on the proposed decommissioning team composition and included the base salary and social and health benefits such as vacation, union fees and other contributions, insurance, pension, small tools and vehicle allowances, travel costs (including room and board), and overhead and profit. All trades resources were assumed to be sourced locally. The cost estimate also utilized the RS Means Building Construction Cost Handbook 2017 to determine and establish percentage breakdown composition for labour, equipment, materials, and consumables in the dismantling and demolition unit rates.

The costs of each decommissioning activity, per ISDC specification, are subdivided into three (3) cost categories:

- Decommissioning Hard Cost
- Decommissioning Soft Cost
- Other Costs

The Decommissioning Hard Cost has two sub-cost elements i.e., the Engineering, Procurement, and Construction (EPC) Contractor Cost and the Allowances. It covers costs related to Stage 2: Completion of Pre-requisites to Decommissioning and Demolition (as described in Section 13.2), Stage 3: Executing Work Package Execution (as described in Section 13.3), and Stage 4: Interim Site Restoration and Project Close-Out (as described in Section 13.4). Some of the main activities of Stages 2, 3, and 4 include decontamination and dismantling, waste processing and storage of radioactive waste (used fuel not applicable), site restoration, including clean-up &

landscaping, and long-term management including disposal of radioactive waste. The Decommissioning Soft Cost is CNL cost which accounts for the ensuing six (6) sub-cost elements, i.e., Preparations of Decommissioning, Project Management and Support Group, Care and Maintenance (Routine), Care and Maintenance (Non-Routine), Hydro-Quebec Services, and Additional CNL Labour (during Schedule Gaps). The Preparations of Decommissioning covers the cost of activities associated with the Stage 1: Project Planning (as described in Section 13.1) such as documentation related to characterization, waste management, communications, project execution, procurement, engineering demolition and enabling works. The Project Management and Support Group covers the costs linked to management oversight of the overall project, SME support, administrative support such as procurement, and other resources. The Care and Maintenance (both Routine and Non-Routine) covers the SWS costs. The Hydro-Quebec Services covers costs associated with the HQ services. Additional CNL Labour (during Schedule Gaps) covers costs incurred due to delay in the projects. The Other Costs include a Risk and Management Reserve to accommodate project risks and an escalation allowance to compensate for inflation due to delayed start of select projects. The Hard Cost, Soft Cost, and the Management Risk Reserve collectively constitute the Direct Cost which is often referred to as the unburdened cost.

It should be noted that miscellaneous expenditures such as owner costs (e.g., licensee fees, utilities, etc.), taxes (local and/or federal taxes), and insurances including any nuclear liability insurance are considered part of the operating cost of the G1WF site as a whole and hence not included in this cost estimate. Following the completion of PE-A decommissioning project the G1WF site will continue to comply with the existing site licence and remain in the SWS phase pending the decommissioning of PE-B. The costs related to long-term monitoring and maintenance of the site and institutional control, if required, will be included within the scope of the PE-B decommissioning cost estimate.

The 2019 DCE [167] included the cost for complete decommissioning of all existing G1WF buildings and structures. The 2019 DCE also included the cost of restoring the site to a brown field for industrial use. A cash flow analysis for the projected planned spending for the D&D (i.e., decommissioning hard cost) of all buildings and structures of the PE-A and PE-B was conducted as part of the cost estimate and the results were provided in Section 6 of the 2019 DCE [167]. The 2019 DCE does include the cost associated with the disposal of the ILW and LLW that will be incurred as a result of the D&D activities during the Phase 3 Decommissioning (i.e., D&D). This 2019 DCE, however, does not include the following:

- Québec Sales Tax.
- Goods and Service Tax.
- Cost associated with the disposition of the spent fuel.
- Indirect Cost which includes costs associated with operating the site such as the infrastructure, utilities, insurance, CNSC site licence fee, and providing the CNL Corporate services and HSSE&Q program support.

Provision for contingencies (i.e., unforeseeable elements or events within the defined project scope) was included in the 2019 DCE [167] of the G1WF and the allocated amounts were captured under Job Condition Factors, Location Factors, Uncertainty Allowance, Post-Contract/Change Order Allowance, and Risk and Management Reserve. All contingencies except the Risk and Management Reserve contingency were calculated as a percentage of the Total Net Decommissioning Cost less the General Contractor Overhead & Fee, grouped under Allowances in Table 19 and added to Total Net Decommissioning Cost to obtain the Total Decommissioning Hard Cost as reflected in table. Further explanation on contingencies and their percentage rates are provided in Section 3 of the 2019 DCE [167] of G1WF. Cost related to risk contingency was separately assessed in a meeting/workshop of key stakeholders and the assessment details were provided in Section 8 and Appendix J of the 2019 DCE [167] of G1WF.

16.2.1 Costing Assumption

The general assumptions that formed the basis of the cost estimate for decommissioning of the G1WF [167] are listed below:

- Building services/utilities to be disconnected and capped at a minimum of 1 meter away from the building.
- Designated substances (e.g., asbestos) present in the Reactor and Turbine Building will be abated prior to any decommissioning/dismantling work.
- No radiological or active waste hazard is expected to be generated as part of building removals in the Service Building and the North Turbine Building (HQ portion).
- Radioactive waste hazard is expected to be generated in the Reactor and Turbine Building equipment.
- Contaminated process equipment and decommissioned materials will be removed/dismantled prior to building demolition.
- Large tanks and equipment will be segmented and cut such that they could be transported through the facility egress routes. For the removal of larger equipment, a suitable opening will be provided.
- An amount of $3M (before allowances) has been included for special tools and equipment that will be required to dismantle the Reactor.
- Building structure dismantling/demolition will be done by mechanical demolition equipment.
- Low level wastes are to be packaged and transported to CRL WMA and will be placed in the NSDF once it is available.
- The waste generated from the reactor core components, regardless of classification, are excluded from the Waste Acceptance Criteria (WAC) of NSDF, therefore these will be

sent to either CRL WMA or an external approved waste storage facility other than the NSDF for the disposition.

- High level wastes (i.e., spent fuel) will be shipped to CRL WMA for the interim storage.
- Radioactive wastes are to be packaged and transported to CNL CRL WMA for interim storage.
- Clean demolished wastes are to be hauled and disposed to an appropriate landfill near Gentilly or recycled/re-used.
- It is assumed that excavated soil to expose building foundations, utilities, and process lines is not contaminated.
- The building footprints will be backfilled and compacted with clean imported fill material.
- The site will be regraded and landscaped with seeding/sodding with topsoil.
- All trades resources will be sourced locally and/or out of town. Travel and room and board are included in the labour rates.

16.2.2 Breakdown of Cost Estimate

A breakdown of the estimated costs for the decommissioning of G1WF is shown in Table 19.

The cost of decommissioning G1WF is estimated at $265 Million (in 2019 Dollars) which excludes Escalation Allowance, Risk and Management Reserve, and taxes. The Direct Cost includes $135 Million in decommissioning hard costs (i.e., EPC Contractor cost) and $130 Million in decommissioning soft costs (i.e., CNL project-related costs), and $25 Million in CNL Risk and Management Reserve. The Risk and Management Reserve was allocated following a detailed risk analysis exercise which reviewed all reasonable major risks that could impact the cost, schedule, and delivery of the project. The cost estimate also includes an escalation allowance to cover the increase in cost due to delay in the schedule. An escalation rate of 4% was applied to the project cost to compensate for inflation resulting from delayed start of select projects and any long, multi-year decommissioning projects; see Section 7 Escalation Analysis in [167]. The Escalation Allowance which covers the delay in the decommissioning is estimated to be $296 Million which is about 50.5% of the total Direct Cost. Therefore, the total G1WF decommissioning project cost is estimated to be $586 Million.

The cost estimate provided herein will be revised when:

- Changes occur to the costing and planning assumptions – see Section 16.2.1 and Appendix B respectively.
- More up-to-date information becomes available.

Table 19: G1WF Decommissioning Cost Breakdown Estimate

Cost Elements	Spent Resin Tank and Vaults	Spent Fuel Canisters	Service Building Basement	Turbine Building Southern Section	Reactor Building Clear-out, Shell, Core Components & Dome	TOTAL
	Decommissioning Hard Cost					
EPC Contractor Cost						
Decommissioning Cost[a]	$955,247	$3,941,901	$1,456,216	$15,499,035	$39,898,427	$61,750,826
General Contrator: General Requirments	$191,050	$788,380	$291,243	$3,124,369	$7,979,686	$12,374,728
General Contrator: O/H & Fee	$88,666	$364,878	$138,625	$1,633,674	$4,206,916	$6,432,759
Total - Net Decommissioning Cost	**$1,234,963**	**$5,095,159**	**$1,886,084**	**$20,257,078**	**$52,085,029**	**$80,558,313**
Allowances[b]						
Job Condition Factor	$168,514	$675,168	$326,057	$6,428,791	$17,108,957	$24,707,487
Location Factor	$114,630	$473,028	$174,746	$1,874,620	$4,787,811	$7,424,835
Uncertainty Allowance	$229,259	$946,056	$349,492	$3,749,241	$9,575,623	$14,849,671
Post Contract/Change Order Allowance	$114,630	$473,028	$174,746	$1,874,620	$4,787,811	$7,424,835
Total - Allowances	**$627,033**	**$2,567,280**	**$1,025,041**	**$13,927,272**	**$36,260,202**	**$54,406,828**
Total - Decommissioning Hard Cost	**$1,861,996**	**$7,662,439**	**$2,911,125**	**$34,184,350**	**$88,345,231**	**$134,965,141**
	Decommissioning Soft Cost					
CNL Cost						
Preparations of Decommissioning[c]	$558,599	$2,298,732	$873,338	$10,292,146	$26,503,570	$40,526,385
Project Management and Support Group	$372,399	$1,532,488	$582,225	$6,861,430	$17,669,046	$27,017,588
Care and Maintenance-Routine	$55,860	$229,873	$87,334	$1,029,214	$2,650,357	$4,052,638
Care and Maintenance-Non-Routine	$37,240	$153,249	$58,223	$686,143	$1,766,905	$2,701,760
HQ Services	$617,132	$2,539,605	$3,458,276	$12,104,238	$29,280,749	$48,000,000
Additional CNL Labour (during Schedule Gaps)	$96,427	$396,813	$540,356	$1,891,287	$4,575,117	$7,500,000
Total - Decommissioning Soft Cost	**$1,737,657**	**$7,150,760**	**$5,599,752**	**$32,864,458**	**$82,445,744**	**$129,798,371**
Total - Decommissioning Hard and Soft Cost	**$3,599,653**	**$14,813,199**	**$8,510,877**	**$67,048,808**	**$170,790,975**	**$264,763,512**
	Other Costs					
Other Costs						
Escalation Allowance	$346,331	$3,206,731	$1,449,107	$17,027,384	$273,870,220	$295,899,773
Risk and Management Reserve (P80)	$339,491	$1,397,064	$800,022	$6,302,588	$16,107,654	$24,946,819
Qubec Sales Tax (QST)	Excluded	Excluded	Excluded	Excluded	Excluded	Excluded
Goods & Services Tax	Excluded	Excluded	Excluded	Excluded	Excluded	Excluded
Total - Other Costs	**$685,822**	**$4,603,795**	**$2,249,129**	**$23,329,972**	**$289,977,874**	**$320,846,592**
Total Project Cost	**$4,285,475**	**$19,416,994**	**$10,760,006**	**$90,378,780**	**$460,768,849**	**$585,610,104**

[a] It covers cost related Completing the Pre-requisites (Stage 2), Physical execution of Work Packages (Stage 3), and Interim Site Restoration and Project Close-out (Stage 4) which are described in Section 13.2, 13.3, and 13.4 respectively. Note that it also includes expenses related to consumables, spare parts, tools, etc. but not taxes or insurance.

[b] It represents costs related to contingencies (minus risk contingency which is captured as Risk and Management Reserve under Other Costs).

[c] It covers cost related to Project Planning (Stage 1) which is described in Section 13.1. This cost is estimated at 30% of the Total Decommissioning Hard Cost.

16.3 Funding

Funding for GoC Legacy liabilities, which include the G1WF, is administered by AECL on behalf of Natural Resources Canada and Government of Canada [178]. Canadian Nuclear Laboratories will manage the work to discharge the legal liability by cost effectively decommissioning the buildings. Canadian Nuclear Laboratories' ERM program office will monitor and report to AECL the progress made on meeting the deliverables.

AECL will retain ownership of the liabilities related to G1WF under the new GoCo model, contractor-operated arrangements [179].

17. Project Management Structure

17.1 Organization

The G1WF is currently under Decommissioning and Environmental Remediation (D&ER) business unit with the responsibility for the facility delegated to G1WF FA. CNL or a contractor hired by CNL will execute the decommissioning work plans. The current organizational reporting structure for the SWS activities and Decommissioning projects is shown in Figure 21. The major responsibilities of each position with respect to the G1WF SWS activities and decommissioning projects are given below.

The Vice President, Stewardship and Renewal Group (SRG), is the Project Authority.

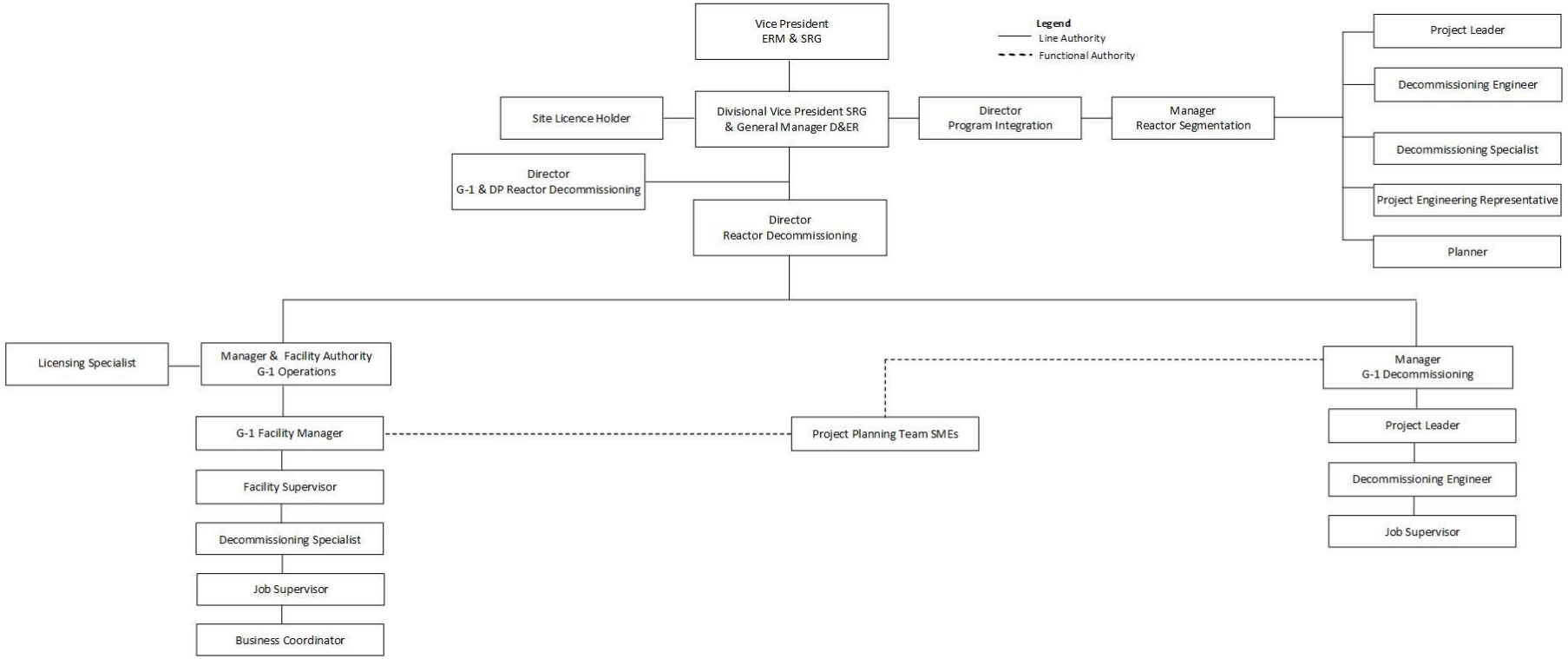

Figure 21: G1WF SWS Activities and Decommissioning Project Execution Team

17.2 Vice President

The Vice-President, Environmental Remediation Management and Stewardship and Renewal Group is responsible for following:

- Ensuring the safe conduct of licensed activities associated with the nuclear facilities, and radioisotope laboratories at Chalk River (under ERM control), NPD, DP, G-1, Whiteshell Laboratories (WL), and the Historic Waste Programme (HWP) at Port Hope.
- Managing decommissioning, waste management, and environmental remediation facilities and services, and related projects at company sites.
- Overseeing of the Liability Cost Estimate, which is the funding provided to address legacy responsibilities associated with the GoC and CNL's operations.
- Overseeing the Low-Level Radioactive Waste Management Office, funded by the GoC, to address historic wastes at specific sites in Canada.
- Overseeing the Port Hope Area Initiative Management Office, the federal operating agency declared by the GoC to implement the Legal Agreement of the Port Hope Area Initiative on its behalf.
- Providing associated support resources to the CRL site, including maintenance trades, planning and assessment services, logistics, and fleet.
- Delivering site maintenance services that ensures high reliability and availability of nuclear facilities and site infrastructure facilities.
- Managing commercial waste management and decommissioning undertakings.
- Leading the organizational unit of Environmental Remediation Management and Stewardship and Renewal Group with the following departments: Historic Waste Program Management, WL Closure Project, and SRG.
- Establishing, maintaining, assessing, and continuously improving the company-wide processes and programs for the following Functional Support Areas: Cleanup, TDG, and Waste Management.

17.3 Divisional Vice President and General Manager

The Divisional Vice President of SRG and General Manager (GM) of D&ER reports to the Vice President, SRG and has the overall responsibility of the SRG and D&ER business units which include all the AECL owned reactors. Following are the responsibilities of the Divisional Vice President of SRG and GM of D&ER:

- Act as a Divisional Vice President of SRG.
- Act as a GM of D&ER.
- Act as the Site Licence Holder of the prototype reactor sites (NPDWF, DPWF & G1WF).

- Act as a Designated Representative of the Licensee (DROL). As a DROL, the GM is designated and authorized to make and submit the unplanned situation or event reports to CNSC Staff.
- Assign work planning & control program roles and responsibilities.
- Ensure work activities are adequately funded.

17.4 Director Reactor Decommissioning

The Director of the Reactor Decommissioning has the overall responsibility for work at the G1WF. Following are the responsibilities of Director of the Reactor Decommissioning:

- The overall safe operation, maintenance, and use of a facility in compliance with all the applicable licences, permits, laws and regulation, policies, and procedures.
- Being familiar with the facility hazards, environmental impacts, operations, licensing requirements, and Official contact with regulatory authorities in matters that relate to decommissioning of the Facility.
- Deliver on the CNL reactor decommissioning strategy.
- Overall safety of the sites covered under his scope of duties.
- Stopping work when it is deemed necessary.

17.5 Director Reactors Strategic Planning

The Director of the Reactors Strategic Planning reports to Divisional Vice President of SRG and GM of D&ER. Following are the Director's responsibilities:

- Further develop the G1WF decommissioning strategy.
- Manage effective communication with clients, citizen groups and other stakeholders.
- Participate in national and international nuclear decommissioning industry to exchange ideas and strategies applicable for Canada's nuclear reactor decommissioning future endeavour.

17.6 Director Program Integration

The Director of the Program Integration reports to Divisional Vice President of SRG and GM of D&ER. Following are the Director's responsibilities:

- Participate in developing the G1WF reactor decommissioning strategy, with emphasis on the reactor core and bioshield.
- Participate in national and international nuclear decommissioning industry to exchange ideas and strategies applicable for Canada's nuclear reactor decommissioning future endeavour.

17.7 Operations Manager and Facility Authority

The G-1 Operations Manager and FA reports to the Reactor Decommissioning Director and is responsible for ensuring all operations at the G1WF site, including all projects, inspections and testing, and the reporting thereof, are carried out in full compliance with the respective site licences and associated Licence Conditions Handbooks. The general responsibilities of the Operations Manager and FA are to ensure that the overall safe operation including decommissioning activities, maintenance, and use of the facility are within the applicable licences and regulations. Other responsibilities include:

- Enforce management expectations regarding safe work practices, consequences of not following safe work practices, and performance management issues in their respective branches.
- Ensure all activities are performed in compliance with the CNL's Management System and Compliance Programs requirements and in accordance with the applicable quality programs, procedures, and Governing Document Indexes. This is ensured through activities such as field visits to monitor work, review and approval of documents, oversight, self-assessment and auditing, monitoring of ImpAct process, implementation of corrective actions, etc.
- Ensure that audits and self-assessment plans for the Facility are prepared and implemented.
- Review WCP for compliance and completeness.
- Stop work when it is deemed necessary.
- Lead the licensing effort to obtain CNSC approval for decommissioning of G1WF, which includes leading all regulatory filings, reports, correspondence, license amendments and exemptions.
- Maintain effective interaction with clients, regulators, citizen groups and other stakeholders.
- Develop the safety culture at the sites, and provision of an environment of trust throughout the teams (G1WF staff, other CNL support, and the multitude of engaged contractors).
- Ensure an adequate and qualified staff to fulfill the regulatory and business needs of the project.
- Being familiar with employees' roles and responsibilities, and major work in progress and in planning.
- Review contractor's procedures to ensure line management's responsibility for safety, clearly defined roles and responsibilities, competence commensurate with responsibility, and a clearly documented hazard analysis process.

- Maintain the knowledge base of decommissioning expertise and ensuring that decommissioning expertise and experience gained is available to projects, operations. and contracts.
- Ensure facilities are decommissioned within the requirements of the decommissioning documents (i.e., DDP, SAR, and the licence).
- Acting as the Incident Authority or appointing an Incident Authority for incidents originating in or affecting the Facility.
- Ensuring unplanned events are reported through the *ImpAct* process [76] and notifying the CNSC of significant unplanned events as per the requirements of the licence.
- Review and approve (or authorize a delegate to review and approve) all requests for work.
- Participate in the development of WCPs.
- Review WCPs for compliance and completeness.
- Authorize Work Plans and Work Plan Changes for execution (i.e., to decommission SSCs).
- Authorize planned shutdown of machinery, equipment, and systems.
- Authorize return to work after a stand-down has occurred.

17.8 Manager G-1 Decommissioning

The G1WF Decommissioning Project Manager has overall responsibility for planning and delivery of G1WF projects as approved by the FA. The Manager reports to and is accountable to the Director Reactor Decommissioning for safe delivery of assigned projects. Other responsibilities include:

- Plan and manage decommissioning project and operating funding.
- Ensure, through oversight activities, that projects are planned and implemented in accordance with CNL policies and procedures, and project management processes, to meet customer requirements.
- Appoint a qualified Project Leader to manage and lead a particular project.
- Screen requests for work, ensuring work scope and associated boundaries are clearly defined.
- Ensure all resources (equipment and trained personnel) for safe performance of work are available before approving work.
- Ensure the safety and health of workers during the implementation of work activities.
- Manage contracts and contract documents and interface with procurement.

- Review incoming requests for work for project impact.
- Ensure SMEs identified as part of the planning team concur and participate in development of the WCPs and WCAFs for decommissioning related activities.
- Ensure the proper level of review and approval is identified and obtained for different types of WCPs for decommissioning related activities.
- Ensure WCPs for decommissioning related activities are ready prior to execution.
- Ensure WCPs for decommissioning related activities have been properly completed and closed out.
- Approve the activity-related schedule and any changes.
- Resolve obstacles to schedule execution.
- Ensure the feedback process is effectively implemented.
- Conduct periodic assessments of the work control process in accordance with the CNL procedure, *Self Assessment* [137].

17.9 G-1 Facility Manager

The G-1 FM is responsible for the safety of day-to-day work and for the protection of HSSE&Q aspects at the G1WF. The G-1 FM reports to Operations Manager & FA G-1 Operations. Other responsibilities include:

- Review incoming requests for work for project/site/Facility impact and recommend work control document type.
- Ensure a complete understanding of the work scope and work environment where the work will be performed in order to effectively execute assigned responsibilities.
- Ensure activities affecting systems or components that require independent verification have been identified.
- Ensure proper release of equipment and work areas.
- Participate in the development of WCPs and WCAFs.
- Review approved WCPs and WCAFs including Work Plans, to ensure conditions for performing the work are established, verify the work is authorized, and approve release of work as per CNL's *IWC* process [54].
- Maintaining the knowledge base of decommissioning expertise and ensuring that decommissioning expertise and experience gained is available to projects, operations, and contracts.
- Oversee decommissioning project activities within the facility, ensuring work area conditions reflect good safety and housekeeping practices.

- Authorise work plan field changes.
- Ensure facilities are decommissioned within the requirements of the decommissioning documents (i.e., DDP, Environmental Review, SAR, etc.) and the licence.
- Stopping work when it is deemed necessary.
- Authorize return to work after a safe back-out.
- Ensure monitoring, surveillance and maintenance activities are being completed in a safe and compliant manner as required and/or the facility configuration updated/documented as SSCs are removed or taken out of service from the facility.

17.10 Manager Reactor Segmentation

The Reactor Segmentation has overall responsibility of safely removing reactor cores from all CNL sites including G1WF from their current configuration to an approved waste storage end state. The Reactor Segmentation Manager reports to and is accountable to the Director Reactor Strategic Planning for safe delivery of assigned projects. Specific responsibilities of the Reactor Segmentation Manager include:

- Manage the delivery of medium to high-risk decommissioning projects to meet schedule, cost, quality, and safety objectives to the full satisfaction of customers.
- Projects planning, budgeting, and resource allocation through discussions with internal clients to define the scope of the project, deliverables, and timing.
- Lead the Reactor Segmentation Program Portfolio.
- Support the project team in defining scope of work and determining project priorities and division of responsibilities.
- Review the project with the project team and regularly meets with the project team for updates on deliverables against plan.
- Secure seconded resources through resource/functional managers to execute the project.
- Control the project scope and manages the risks. This includes proper management of deliverables within an estimated timeframe and notifying management of issues which could potentially impact the cost and timing of the project.
- Assist the project team in establishing and administering project budgets and schedules and approving changes to scope of work within project management guidelines.
- Lead the ongoing delivery of project objectives including setting project-related performance objectives, and regular monitoring of project/contract progress in terms of quality, scope, schedule, and cost constraints.

17.11 Project Engineering Representative

The Project Engineering Representative is responsible for:

- Providing oversight of changes in the field during the implementation activities in the project portfolio.
- Preparing detailed work packages, technical documents, work scopes, procedures, and estimates and schedules in support of reactor segmentation projects.
- Providing innovative solutions to dismantling and waste management challenges.
- Performing field walk downs to verify status of facilities against documented plans.
- Coordinating and monitoring services provided to the team by external suppliers,
- Participating or leading Pre/Post Job reviews.
- Interfacing with design participants, operations engineers, technical staff, and other SMEs and obtain technical input, as required, to meet Project and Client requirements.
- Ensuring deliverables meet the quality objectives of the project and ensure deliverables are completed on schedule and within budget.
- Identifying, assessing, and initiating changes to approved design, work scope, budgets, and schedules following applicable change control processes.
- Traveling to external sites as required, to effectively execute the implementation phases of the project.

17.12 Facility Supervisor

The G1WF Supervisor is responsible for:

- Participating in the WCPs and WCAFs development for decommissioning related activities.
- Authorizing and providing Support for WCAF (listing Hot Work permit, Digging, Drilling, Cutting, and Coring permit, etc.) for decommissioning related activities.
- Participating as a planning team member in the WCAF walk-down or roundtables for decommissioning related activities, as needed.
- Ensuring the prerequisites for work have been completed.
- Ensuring hazard controls are implemented.
- Ensuring assigned workers have received the required training to execute WCAFs for decommissioning related activities.
- Participating in the initial pre-job brief (project roll-out) as necessary, as WCAF area owner designate.
- Ensuring personnel executing the work have attended the pre-job briefing or are briefed separately and are fit to perform work.

- Ensuring workers are aware of their responsibility to stop work/perform a safe back-out and notify supervision whenever changing conditions or unidentified hazards are encountered or work practices compromise quality or safety.
- Ensuring the Master Copy of the WCAF is available and followed.
- Stopping work when it is deemed necessary.
- Ensuring good housekeeping practices are followed during performance of work and work areas are cleaned and restored after completion of work or work-activity cycle.
- Conducting/participating in daily pre-job briefings to review scope of work, hazards, and controls with assigned workers.
- Conducting/participating in post-job reviews at the end of the workday.
- Notifying G1WF FM and FA if an unplanned event occurs in the facility.

17.13 Project Leaders

The Project Leaders ensure that projects assigned to them are performed according to approved plans and timelines and in accordance with applicable project management processes to meet client requirements. Following are the specific responsibilities of the project leaders:

- Provide integrated planning input, as applicable.
- Ensure the work planning process is aligned to decommissioning governing plans (DDP, facility characterization, environmental review, waste management plan, etc.).
- Identify new training and development requirements to support the work package.
- Ensure resources are available to support all scheduled work.
- Prepare Readiness Review documentation and plan RR meeting in accordance with RR process outlined in the *IWC* procedure [54].
- Lead the ongoing delivery of the project objectives, including setting project related objectives (such as through the project QA Performance Checklist), providing regular feedback and guidance to project staff.
- Continuously monitor project performance and take action to address any issues.
- Implement QA surveillance during performance of the work using the QA surveillance checklist.
- Ensure the safety and health of workers during the implementation of work activities.
- Monitor and report overall progress of projects, conducting reviews to verify outputs are aligned with plans, and ensuring that significant variances and trends are investigated.

- Ensure that any Program/Process-specific quality records, or End-State/Interim End-State supporting records generated as a result of the decommissioning activities, are regularly monitored and are linked to the decommissioning facility/project files.

17.14 Job Supervisors

The Job Supervisor reports to the Project Manager and works closely with the Project Leader and WCAF authorizer to oversee the daily work activities on a decommissioning project. Following are the responsibilities of the Job Supervisor:

- Participate in the work site job walk-downs, roundtables, JHA and control selection.
- Participate in WCPs and WCAFs development for decommissioning related activities.
- Day-to-day supervision/oversight of decommissioning staff and decommissioning activities by trades support personnel.
- Ensure the prerequisites for work have been performed.
- Ensure the WCAF for decommissioning related activities is approved and released for use.
- Ensure referenced documents are current prior to start of work.
- Participate in WCAF workability walk-down prior to start of work to ensure the adequacy of the WCAF consistent with this procedure.
- Participate in the pre-job briefing [172] and do not perform work until properly briefed and the scope of work and hazard control strategies are clearly understood.
- Ensure assigned workers have received the required training to execute WCAFs.
- Prepare and deliver the initial pre-job brief (project roll-out) using the Pre-Job Brief [180].
- Ensure that OPEX Lessons Learned [175] is incorporated with regards to similar projects.
- Ensure personnel executing the work have attended the pre-job briefing or are briefed separately and are fit to perform work.
- Ensure the workability walk-down is conducted.
- Concur with the WCAF, confirming workability, as part of the approval process.
- Ensure workers are aware of their responsibility to stop work/perform a safe back-out and notify supervision whenever changing conditions or unidentified hazards are encountered or work practices compromise quality or safety.
- Ensure the Master Copy of the WCAF is controlled and the chain of custody is up-to-date.

- Ensure compliance with WCAF, including working within scope, documentation of work, and feedback during execution.
- Initiate the Work Plan Change process when the work plan requires additional steps that introduce new hazards.
- Stop work, when it is deemed necessary,
- Co-ordinate waste handling/segregation under the guidance of the Waste Advisor.
- Ensure equipment and instruments important for the safety of workers, the public and the environment is maintained.
- Ensure good housekeeping practices are followed during performance of work and work areas are cleaned and restored after completion of work or work-activity cycle.
- Ensure the Work Plan Status Log is maintained throughout the duration of the work.
- Conduct daily pre-job briefings to review scope of work, hazards, and controls with assigned workers.
- Ensure post-job reviews are conducted for completed work.
- Supervise work activities to meet WCAF requirements.
- Ensure all required close-out sections of the work package/work plans are completed prior to Turnover to the Project Leader.
- Return redline (marked up) drawings to the Engineering.
- Notify G1WF FM and FA if an unplanned event occurs in the facility.

17.15 Planning and Control Coordinator

The Planning and Control Coordinator is responsible for leading the planning and control of all G1WF work to meet applicable CNL policies and procedures and project management processes.

17.16 Licensing Specialist

The Licensing Specialist reports to G-1 Operations Manager and FA. The Licensing Specialist is responsible for:

- Preparing and reviewing safety and licensing submissions as required.
- Providing input to strategic decisions and support strategic initiatives by reviewing and summarizing CNL, CNSC, and other requirements and proposing optimal solutions to minimize licensing risk, while meeting project/program constraints.
- Drafting presentations for the CNSC.
- Revising safety and licensing procedures and processes as required.

- Drafting responses to CNSC questions/comments.
- Preparing licensing protocols, progress reports, and other licensing submissions as required.

17.17 Decommissioning Specialist/Engineers

The Decommissioning Specialists/Engineers are accountable to the Project Manager for ensuring that documents, methods, procedures, and practices are done in compliance with company and regulatory procedures. The Decommissioning Specialists/Engineers are responsible for:

- Ensuring that their actions and reviews address health, safety, security, and environmental requirements of CNL.
- Preparing and addressing comments on documents in support of activities and training,
- Working closely with the G1WF FM, G1WF Supervisor, G1WF PM, and Health Physicist to satisfy various requirements and develop the best solutions.
- Identifying/Establishing and updating drawing lists.
- Ensuring Contractor's marked-up/redlined drawings reflect "as-built" conditions.
- Submitting marked-up drawings to Engineering and ensuring that CNL will submit the revised (affected) drawings from the Contractor that require Technical Standards and Safety Authority (TSSA) registration to TSSA for registration.

17.18 Planner

The Planner for Reactor Decommissioning is accountable to the Manager of Reactor Segmentation and has primary duties to ensure that documents, methods, procedures, and practices are executed in compliance with company and regulatory procedures. In particular, the Planner will ensure that their actions, documents, methods, and plans address health, safety, security, environmental, and quality requirements for Reactor Decommissioning activities. The Planners are responsible for:

- Responding to situations to contain/mitigate short-term risk in accordance with established procedures.
- Regular checks and balances on work,
- Escalating issues outside of guidelines and processes.
- Ensuring the safety and compliance of people on the site.
- Complying with safety and QA standards and troubleshooting when issues arise.
- Preparing technical reports, researching tools, equipment, and techniques.
- Reviewing documents and provides comments.

- Prioritization of tasks and deliverables according to defined timelines.
- Providing assistance in preparation of work and bid evaluations.
- Working with trades, project staff, radiation protection, operations, and other support groups to resolve problems and issues related to planning and scheduling of the Reactor Decommissioning and CNL's D&ER programs.

17.19 Project Planning Team Subject Matter Expert

Decommissioning project planning and support team can include personnel from CNL programs and Support services such as Radiological Protection, Health Physics and Dosimetry, Industrial Hygiene, Environmental Protection, Fire Protection, Engineering Programs and Services, Emergency Preparedness, Engineering (including Decommissioning Field Engineers), Radioactive Material Transport, QA, OPEX, Security, Waste Management, and OSH. These SMEs are either part of the ERM organization, or work for a support organization within the Company. Their responsibilities include:

- Participate in the work-site job walk-downs, roundtables, JHA [60], and control selection.
- Participate in WCPs and WCAFs development as part of the planning team.
- Support in reviewing WCPs and WCAFs to ensure that the hazard controls have been incorporated, consistent with the requirements.
- Review SME area Lessons Learned for applicability to the work to be performed. Ensure lessons learned from dose estimate memos, including any conclusions drawn from noted discrepancies with the comparison of estimated and actual dose values are considered and incorporated into new plans.
- Contribute to the development of WCAF instructions, ensuring that steps with CNL compliance program/process requirements are properly incorporated and SME-specific items are verified complete.
- Ensure controls based on the hierarchy of control principles (that is engineered, administrative, and/or PPE&C) are clearly delineated in the WCAFs or supporting documents.
- Ensure planning decisions meet CNL compliance program requirements.
- Specify inspections, acceptance criteria, and hold and witness points.
- Review SME discipline-related, contractor-prepared submittal documents for suitability.
- Support in reviewing applicable completed WCPs and WCAFs to ensure that required data are properly recorded in accordance with programmatic requirements.
- Concur with the WCPs and WCAFs as part of the approval process.

17.20 Administrative Assistant

The duties of an Administrative Assistant include:

- Create WCPs and WCAF binders with appropriate sections/tabs.
- Issue and control assigned area WCPs and WCAFs which include:
  - Maintaining a chain of custody log for the Master Copy for all work packages.
  - Creating the Master copy by stamping and notarizing each page of the work plan/work package.
  - Filing the completed Master Copy of the WCP/work plans/WCAF as an informal record in Electronic Document and Records Management System (EDRMS).
  - Ensure completed WCPs and WCAFs are filed in EDRMS as per CNL procedure [181].

18. Records Management

18.1 General Requirements

Canadian Nuclear Laboratories maintains a systematic control of Information Assets (IA) with respect to their creation or acquisition, classification and capture, usage and dissemination, retention and preservation, and disposition through the use of mandatory standards across the company [149][181]. All individuals who conduct work on behalf of CNL in all management system functions, missions, projects, and line organizations are required to ensure the standards herein are applied consistently. Records identified as "permanent records" and pertaining to Pressure Boundary systems and components [182] or relating to Class I and Class II nuclear facilities [105] are maintained for the life of the plant, or the life of the particular item concerned. CNL procedures ensure that records are appropriately identified, maintained, stored, retained, and routinely inspected to preserve and protect them from loss, deterioration, or destruction [149][181].

18.2 Decommissioning Records

The historical records related to G-1 NGS were predominantly stored as hard-copy/paper records. Information Management has converted most of the hardcopy records to electronic media for safe and secure long-term storage in the ATOM, and the digitizing process is ongoing. Records pertaining to the Phase 3 Decommissioning (i.e., D&D) will be captured, stored, and preserved electronically in accordance with the CNL Procedures [149][181]. Records of unplanned events are documented in accordance with CNL's OPEX Procedure [136].

Decommissioning records related to the removal of the buildings and structures include, but not limited to, the following:

- DDP Volume 1: Program Overview (this document).
- Future DDPs (i.e., DDP Volume 2 & 3).
- Licences and permits required for the decommissioning work and related regulatory correspondence.
- Characterization of buildings and structures for radiological and non-radiological hazards.
- Public and Indigenous consultation/communication records.
- Environmental Review reports.
- EDDWP and DWPs used to execute the decommissioning and demolition work.
- ECC documents including Field Change Requests, approved Deviations from plans and procedures, etc.
- Results and interpretation of environmental monitoring programs.

- Characteristics, storage, or disposal routes of wastes (clearable, hazardous, and radioactive) that are being generated during hazard reduction campaigns and will be generated during future Phase 3 Decommissioning (i.e., D&D) activities.
- Decommissioning cost estimates.
- Schedule and the progress achieved in meeting the schedule.
- Reports and other documents related to any unplanned or unusual occurrences.
- Radiation survey results.
- Occupational dose records.
- Status of each worker's qualifications, re-qualifications, and training.
- Project Close-Out Reports.

18.3 Records Retention Periods

The retention periods for decommissioning records depend on the type and complexity of the decommissioning project, regulatory requirements, and other legal obligations. The *Nuclear Safety and Control Act* [183] and *Class I Nuclear Facilities Regulations* [2] specify retention periods for certain decommissioning records pertaining to Class I nuclear facilities. The *Nuclear Substances and Radiation Devices Regulations* [184] requires that the licensee shall retain the records pertaining to nuclear substances and radiation devices for the period ending three years after the earlier of the expiry date and the date of revocation, if any, of the licence. CNL complies with the regulatory retention periods for all records in its custody, pertaining to Class I and Class II nuclear facilities and prescribed equipment, and maintains a *Retention Schedule* [185] for all information assets it creates and/or captures including those related to decommissioning projects.

The retention periods for records pertaining to the removal of the PE-A and PE-B buildings and structures of G1WF are provided in Table 20.

Table 20: G1WF Decommissioning Records and Retention Periods

Decommissioning Records Pertaining to:	Retention Period (years)	Requirements
• The progress achieved in meeting the schedule for the decommissioning. • The implementation and results of the decommissioning. • The manner in which and the location at which any nuclear or hazardous waste is managed, stored, disposed of, or transferred. • The name and quantity of any radioactive nuclear substances, hazardous substances, and radiation that remain at the G1WF after completion of the decommissioning.	10	Per requirements of *Class I Nuclear Facilities Regulations* [2], these records shall be retained for 10 years after the expiry date of the licence to abandon issued in respect of the G1WF.
• The status of each worker's qualifications, re-qualifications and training, including the results of all tests and examinations completed in accordance with the G1WF licence [1].	5	Per requirements of *Class I Nuclear Facilities Regulations* [2], these records shall be retained for the period that the worker is employed by the licensee and for five (5) years after the worker ceases to be so employed.
• Detailed Decommissioning Plans. • Licences and Permits and Related Regulatory Correspondence. • Procedures and Work Plans (i.e., WCP) used to execute D&D. • RWAs. • Instrument Calibration.	100	Per requirements of CNL standard, *Retention, Preservation, and Disposition of Information Assets* [181] and as provided in the *Retention Schedule* [185], these records are to be retained for 100 years since the creation or capture of such records.

Decommissioning Records Pertaining to:	Retention Period (years)	Requirements
• Deviations from Plans and Procedures. • Radiological and Hazardous Materials Characterization Results. • Regulatory Inspections. • Dosimetry Measurements. • Occupational Dose Records. • As-built Drawings. • Up-dated Drawings. • Project Close-Out Reports.		
• Unplanned and unusual occurrences during decommissioning.	30	Per requirements of CNL standard, *Retention, Preservation, and Disposition of Information Assets* [181] and as provided in the *Retention Schedule* [185], these records are to be retained for 30 years since the creation or capture of such records.
• Media Relations and External Engagements including Stakeholder Management. • Employee Health Records (Injury reports, Claim inventory, Physician's referral, etc.). • Environmental Review Reports. • Cost Estimates. • Transportation of Clearable waste (Bill of Lading, shipping documents, etc.). • Contract management (administration of all forms of agreements/contracts with the Suppliers).	6	Per requirements of CNL standard, *Retention, Preservation and Disposition of Information Assets* [181] and as provided in the *Retention Schedule* [185], these records are to be retained for six (6) years since the creation or capture of such records.

Decommissioning Records Pertaining to:	Retention Period (years)	Requirements
• Procurement (acquiring goods and services from Suppliers) records.		

19. References

[1] *Waste Facility Decommissioning Licence, Gentilly-1 Waste Facility*, WFDL-W4-331.00/2034, 61-508760-130-000-0005, Revision 0, 2019 February, 53820503

[2] *Class I Nuclear Facilities Regulations*, SOR/2000-204, Statutes of Canada, 2017 September, Website link.

[3] *Gentilly-1 Waste Facility Preliminary Decommissioning Plan*, 61-508310-PDP-001, Revision 3, 2021 December, 53687463

[4] Licence Conditions Handbook WFDL-LCH-W4-331.00/2034 Prototype Waste Facilities – Waste Facility Decommissioning License, Gentilly-1 Waste Facility, 61-00580-HBK-001, Revision 0, 2019 July, 50152177

[5] *Cleanup*, 900-508300-PRD-001, Revision 5.1, 2023 August, 51675464

[6] *Decommissioning of facilities containing nuclear substances*, N294:19, Canadian Standards Association, 2019 November, Website link.

[7] *Financial Guarantees for Decommissioning of Nuclear Facilities and Termination of Licensed Activities,* REGDOC-3.3.1, 2021 January, Canadian Nuclear Safety Commission, Website link.

[8] *Waste Management: Decommissioning*, REGDOC-2.11.2, Canadian Nuclear Safety Commission, 2021 January, Website link.

[9] *Glossary of CNSC Terminology*, REGDOC-3.6, Canadian Nuclear Safety Commission, 2023 February, Website link.

[10] *Glossary of Controlled Terms and Acronyms,* Website link.

[11] *Gentilly-1 Waste Storage Facility: Licensing Overview Document,* 61-06105-730-007*,* Revision 1, 1986 February, 11910640

[12] *Parc Industriel Et Portuaire de Bécancour*, Québec, Website link.

[13] *Gentilly-1 Dry Irradiated Fuel Storage Facility: Safety Report,* 61-06105-730-004, Revision 0, 1985 July, 11939221

[14] *Gentilly-1 Waste Facility Decommissioning Storage with Surveillance Plan*, 61-508330-SWS-001, Revision 2, 2020 June, 52444465

[15] *Gentilly-1 Waste Management Facility Interim End-State Report*, 61-508350-IES-001, Revision 0, 2014 August, 12268418

[16] *Characterization Report for Material and Equipment in the G-1 Service Building Basement*, 61-79000-REPT-004, Revision 1, 2020 November, 53295952

[17] *POSITION PAPER IN SUPPORT OF DRY CANISTER STORAGE-(F)*, 61-06105-730-001, Revision 2, 1985 May, 11939224

[18] *G-1 Turbine and Ancillary Systems Characterization Report*, 61-509410-REPT-001, Revision 0, 2019 March, 47767376

[19] *Gentilly-1 Spent Fuel Dry Storage Canisters Turbine Building Room T-110 Layout General Arrangement*, GA-C-N98130-10001, Revision 0, 2007 April

[20] *Safety Assessment – Spent Fuel Retrieval from G1WF Concrete Canisters*, 61-508770-NSN-001, Revision 2, 2022 April, 57015946

[21] *Long Term Storage of Spent Resin Tanks*, 61-06179-722-002, Revision 0, 1985 November, 11910631

[22] *Safety Analysis Report for the Gentilly-1 Waste Facility*, 61-03610-SAR-001, Revision 2, 2019 July, 50119041

[23] *2018 Annual Compliance Monitoring Report for Douglas Point and Gentilly-1 Waste Facilities*, 3640-00521-ACMR-2018, Revision 0, 2019 May, 48733516

[24] *Gentilly-1 Spent Resin Storage Structure Characterization Report*, 61-79140-REPT-011, Revision 0, 2021 March, 54274225

[25] *Surveillance des silos d'entreposage du combustible usé de Gentilly-1*, 61-106160-MP-001, Revision 0, 2022 September, 57796492

[26] *Gentilly-1 Waste Facility Effluent Monitoring Plan,* 61-509200-PLA-001, Revision 1, 2021 October, 55614079

[27] *Health Guideline and Radiation Protection Standards*, 61-06101-722-126, Revision 3, October 1985, 11915314

[28] *Waste Facility Decommissioning Licence for Prototype Waste Facilities*, WFDL-W4-332.01/2034, Expiry Date: 2034 December 31.

[29] *Record of Proceedings and Licence - Atomic Energy of Canada Limited,* WDLW4332.00/2034, 3640-NOAC-14-0005-L, Revision 0, 2014 July 16, 22458147

[30] K. Kehler, Letter to H. Tadros, *Request to Separate the Waste Facility Decommissioning Licence, WFDL-W4-332.01/2034 to Three Separate Licences for Douglas Point, Gentilly-1, and Nuclear Power Demonstration Waste Facilities*, 140-CNNO-18-0003-L, 2018 July 11, 40540388

[31] *Radiation Protection,* 900-508740-PRD-001, Revision 5, 2023 December, 40766658

[32] *Radiation and Contamination Workplace Monitoring Routines*, 900-508740-MCP-040, Revision 0.1, 2023 October, 57136113

[33] *Gentilly-1 Radiation Protection Staff Routine Duties,* 61-03400-PRO-001, Revision 0, 2022 October, 58302326.

[34] *Radiological Safety Zone Plan for Gentilly-1 Waste Management Facility*, 61-03431-ZP-001, Revision 2, 2017 February, 11885709

[35] *Cleanup*, 900-508300-PDD-001, Revision 5, 2023 June, 52080159

[36] *Engineering Change Control,* 900-508130-MCP-001, Revision 5.1, 2024 April, 49242229

[37] *Independent Technical and Readiness Reviews*, 900-514300-MCP-002, Revision 1, 2020 April, 52058514

[38] *Radiological Areas and Zones*, 900-508740-MCP-027, Revision 2, 2019 December, 50931395

[39] *Gentilly-1 Waste Facility Annual Compliance Monitoring Report for 2021 under Licence* WFDL-W4-331.00/2034, 61-00521-ACMR-2021, Revision 0, 2022 May, 57278958

[40] *2018 Annual Compliance Monitoring Report for Douglas Point and Gentilly-1 Waste Facilities*, 3640-00521-ACMR-2018, Revision 0, 2019 May, 48733516

[41] *Nuclear Criticality Safety,* REGDOC-2.4.3, Canadian Nuclear Safety Commission, Version 1.1, 2020 September, Website link.

[42] *Nuclear Criticality Safety*, 900-508550-PRD-001, Revision 3.1, 2023 September, 52931473

[43] *Neutron Activation of Reactor Components at Gentilly-1*, 153-120100-ANL-000, Revision 0, 2022 May, 57250498

[44] *Gentilly-1 Waste Facility – Designated Substances Survey*, 61-510400-REPT-001, Revision 0, 2018 March, 40834662

[45] *Characterization of Materials Likely to Contain Asbestos Turbine and Service Buildings – 2019 Feb*, 61-95000-REPT-002, Revision 1, 2019 March, 47995412

[46] *Characterization of Materials and Dust Likely to Contain Asbestos*, 61-95000-REPT-001, Revision 0, 2014 July, 12133039

[47] *Asbestos Abatement Specifications, Gentilly-1 Reactor and Turbine Buildings (Decommissioning)*, 61-505220-510-000-0001, Revision 0, 2016 June, 12314016

[48] *Gentilly-1 (G-1) Asbestos Waste*, 61-508600-WMP-004, Revision 0, 2019 August, 50275471

[49] *Land Protection and Rehabilitation Regulation*, Q-2, r.37, Government of Quebec, 2024 January, Website link.

[50] *Asbestos Management*, 900-510400-STD-026, Revision 0.1, 2023 December, 54947372

[51] *Lead Management*, 900-510400-STD-014, Revision 0, 2019 June, 47353747

[52] *Hazardous and Mixed Waste Management*, HWP-508620-OP-006, Revision 3, 2014 June, 23195389

[53] *Management of Designated Toxic Substances*, 900-509200-STD-013, Revision 1, 2022 August, 44166860

[54] *Integrated Work Control*, 900-514100-STD-002, Revision 4.1, 2024 April, 51505551

[55] *Safety Analysis for Environmental Remediation Management*, 900-508770-STD-001, Revision 2, 2023 May, 40772318

[56] *Safety Analysis*, 900-508770-MCP-001, Revision 2, 2021 October, 50035305

[57] *Safety Analysis*, 900-508770-PDD-001, Revision 5, 2022 October, 52705850

[58] *Safety Analysis*, 900-508770-PRD-001, Revision 6.1, 2024 April, 52738121

[59] *Hand Protection Classification*, ANSI/ISEA 105-2016, American National Standards Institute, 2016, Website link.

[60] *Job Hazard Analysis*, 900-514100-FM-008, 51737882

[61] *Work Control Instructions*, 900-514100-FM-010, Revision 3, 2022 July, 51893492

[62] *Fire Protection Screening*, 900-508720-MCP-003, Revision 1, 2024 March, 12614126

[63] *Working at Heights*, 900-510400-STD-018, Revision 0.2, 2023 August, 51829621

[64] *Excavations*, 900-510400-STD-013, Revision 1, 2019 August, 49844973

[65] *Hoisting and Rigging*, 900-510400-STD-007, Revision 2.1, 2024 April, 50129350

[66] *Hazardous Energy Control*, 900-510400-MCP-001, Revision 2, 2022 February, 12598693

[67] *General Electrical Safety Work Practices*, 900-508150-STD-001, Revision 0, 2021 August, 54424242

[68] *Hand Tools*, 900-510400-MCP-010, Revision 0, 2017 August, 12621867

[69] *Personal Protective Equipment and Clothing*, 900-510400-STD-003, Revision 1.1, 2024 April, 40837367

[70] *Impact Assessment Act*, S.C. 2019, Chapter 28, Section 1, Statutes of Canada, 2019 August, Website link.

[71] *Environmental Protection: Environmental Assessments*, REGDOC-2.9.1, Canadian Nuclear Safety Commission, September 2020, Website link.

[72] *Environmental Review of Non-Routine Work*, 900-509200-MCP-001, Revision 2, 2021 August, 12602866

[73] *Environmental Risk Assessments at Class I Nuclear Facilities and Uranium Mines and Mills*, N288.6-12, Canadian Standards Association, Reaffirmed in 2017, Website Link.

[74] CNL *Reporting to Regulatory Agencies*, *900-51*4300-MCP-006 Revision 0.3, 2023 July, 4154361

[75] *Root Cause Analysis*, 900-514000-MCP-013, 48667847

[76] Improvement Action (Impact) Corrective Action Program, 900-514000-MCP-004, Revision 4, 2023, March, 40772346

[77] *Emergency Preparedness*, 900-508730-PDD-001, Revision 3, 2022 November, 50982494

[78] *Radiation Protection,* 900-508740-PDD-001, Revision 3.1, 2023 November, 12487852

[79] *Environmental Protection*, 900-509200-PDD-001, Revision 4.1, 2023 October, 40788125

[80] *Fire Protection*, 900-508720-PDD-001, Revision 4, 2023 September, 40793276

[81] *Occupational Safety and Health*, 900-510400-PDD-001, Revision 4, 2024 February, 40761159

[82] *Quality,* Program Description Document, 900-514200-PDD-001, Revision 3, 2024 May, 47487865

[83] *Radiological Work Assessment*, 900-508740-FM-017, 50338314

[84] *Radiological Work Permit,* 900-508740-FM-027, Revision 3, 2020 March, 51801535

[85] *Radiation Protection Action Levels*, 900-508740-LST-002, Revision 1, 2021 April, 52638715

[86] *ALARA*, 900-508740-STD-013, Revision 0, 2022 May, 42071926

[87] *Occupational Safety and Health*, 900-510400-PRD-001, Revision 2.1, 2023 June, 12487835

[88] *Occupational Safety and Health*, 900-510400-GDI-001, Revision 1, 2022 November, 12487839

[89] *Industrial Hazard Assessment and Control*, CW-510400- ASD-001, Revision 0, 2005 February, 12471591

[90] *Training and Development*, 900-510200-PDD-001, Revision 5, 2023 August, 51748477

[91] *Training and Development*, 900-510200-PRD-001, Revision 5, 2023 September, 48238602

[92] *Hazard Prevention Program*, 900-510400-STD-019, Revision 0, 2020 October, 53150378

[93] *Hazard Identification and Assessment*, 900-510400-MCP-023, Revision 1, 2021 April, 12614160

[94] *Digging, Drilling, Cutting, and Coring,* 900-510400-STD-012, Revision 4, 2023 March, 50080313

[95] *Fall Protection Plan*, 900-510400-FM-030, Revision 0, 52567751

[96] *Aerial Work Platforms,* 900-510400-MCP-019, Revision 0, 2017 November, 35267778

[97] *Scaffolds,* 900-510400-STD-008, Revision 0, 2018 March, 40814076

[98] Workplace Inspections, 900-510400-STD-003336, 2023 December, 63640952

[99] *Housekeeping,* 900-510400-STD-020, Revision 1, 2021 May, 52382998

[100] *Emergency Preparedness Requirements*, 900-508730-PRD-001, Revision 2.2, 2024 January, 50046216

[101] *Security,* Program Description Document, 900-508710-PDD-001, Revision 5.1, 2023 March, 50823241

[102] *Security,* Program Requirements Document, 900-508710-PRD-001, Revision 4.1, 2023 June, 51689228

[103] *Nuclear Security Regulations*, SOR/2000-209, Statutes of Canada, 2015 June, Website link.

[104] *CNL Management System Manual*, 900-514100-MAN-001, Revision 3.1, 2023 August, 12489834

[105] *Management system requirements for nuclear facilities*, N286-12, Canadian Standards Association, 2012 June, Reaffirmed in 2017, Website link.

[106] *Quality management systems - Requirements*, CAN/CSA-ISO 9001:16, Canadian Standards Association, February 2016, Reaffirmed in 2020, Website link.

[107] *Environmental Management System – Requirements with Guidance for Use*, CAN/CSA-ISO 14001:16, Canadian Standards Association, February 2016, Reaffirmed in 2021, Website link.

[108] *Decommissioning Process*, 900-508300-STD-003, Revision 0.1, 2023 June, 54298095

[109] *Cleanup*, 900-508300-GDI-001, Revision 7, 2024 April, 51723887

[110] *Environmental Protection*, 900-509200-PRD-001, Revision 5, 2023 May, 40792906

[111] *Environment*, 900-509200-POL-001, Revision 3.1, 2023 November, 12489856

[112] *Management and Monitoring of Effluents and Emissions*, 900-509200-STD-009, Revision 1, 2022 December, 40812070

[113] *Management of Land, Habitat, and Wildlife*, 900-509200-STD-006, Revision 1, 2024 January, 40811284

[114] *Environmental Review of Routine Work*, 900-509200-MCP-002, Revision 1, 2021 July, 12606149

[115] *Acceptability Criteria for Routine and Non-Routine Discharge of Liquids at CNL Sites*, 900-509200-MCP-005, Revision 1, 2021 February, 47096217

[116] *Managing Environmental Compliance Obligations*, 900-509200-MCP-003, Revision 1, 2021 March, 12614132

[117] *Environmental Incident Reporting, Investigation, and Mitigation*, 900-509200-STD-005, Revision 1, 2021 November, 35263599

[118] *Environmental Monitoring Program*, 900-509200-STD-010, Revision 0, 2018 October, 41555346

[119] *Environmental Objectives and Performance Measures*, 900-509200-MCP-004, Revision 0, 2018 April, 40842317

[120] *Communication on Environmental Protection*, 900-509200-STD-004, Revision 1, 2021 February, 35285103

[121] *Environmental Training, Awareness and Competence*, 900-509200-STD-001, Revision 1.1, 2023 March, 12646524

[122] *Gentilly-1 Waste Facility: Determination of Groundwater Protection and Groundwater Monitoring Requirements*, 61-509200-PLA-002, Revision 0, 2021 May, 54146593

[123] *Environmental Protection*, 900-509200-GDI-001, Revision 6, 2023 September, 47137474

[124] *Safety and Health*, CNL Corporate policy, 900-510400-POL-001, Revision 4.1, 2023 November, 42016931

[125] *AECL's Strategic Emergency Management Plan*, CW-508730-ERP-001, Revision 1, 2012 December, 12461783

[126] *Fire Protection*, 900-508720-PRD-001, Revision 1, 2020 August, 12489833

[127] *Fire protection for facilities that process, handle, or store nuclear substances,*N393-13, Canadian Standards Association, 2016 May, Website link.

[128] *Nuclear Materials and Safeguards Management*, 900-508510-PDD-001, Revision 4, 2022 October, 47487725

[129] *Nuclear Materials and Safeguards Management*, 900-508510-PRD-001, Revision 4, 2022 September, 47376026

[130] *Canada Labour Code*, R.S.C., 1985, c. L-2.

[131] *Contractor Management,* 900-505210-STD-009, Revision 0, 2022 June, 56638909

[132] *Occupational Health and Safety Act,* R.S.O. 1990, Chapter O.1, Ontario, 2022 July, Website link.

[133] *Canada Occupational Health and Safety Regulations*, SOR/86-304, Statutes of Canada, 2023 December, Website link.

[134] *Performance Assurance,* 900-514000-PDD-001, Revision 2, 2023 December, 12494609

[135] *Performance Assurance,* 900-514000-PRD-001, Revision 3, 2024 March, 12489867

[136] *Processing Internal and External Operating Experience*, 900-514000-MCP-001, Revision 0, 2017 March, 12496502

[137] *Self-Assessment,* 900-514200-MCP-003311, Revision 0, 2024 March, 64508919

[138] *Assessment Plan Template*, 900-514000-FM-002, 12606134

[139] *Trend Analysis,* 900-514000-STD-001, Revision 1, 2020 December, 40780883

[140] *Quality*, 900-514200-PDD-001, Revision 3, 2024 May, 47487865

[141] *Quality,* 900-514200-PRD-001, Revision 3, 2022 May, 50321640

[142] *Visitor's Pre-registration Form for Hydro-Québec*.

[143] *Transportation of Dangerous Goods*, 900-508520-PDD-001, Revision 3.1, 2023 January, 50491264

[144] *Transportation of Dangerous Goods*, 900-508520-PRD-001, Revision 3.1, 2023 February, 50318478

[145] *Waste Management*, 900-508600-PDD-001, Revision 5, 2023 June, 51793801

[146] *Waste Management*, 900-508600-PRD-001, Revision 4, 2023 April, 51423339

[147] *Human Performance,* REGDOC-2.2.1, Version 2, Canadian Nuclear Safety Commission, 2023 December, Website link.

[148] *Employee Hiring Standard*, 900-510000-STD-001011, Revision 0, 2023 February, 59858879

[149] *Creation, Capture and Use of Information Assets*, 900-511300-STD-003, Revision 4, 2022 September, 50746207

[150] *CNL Role Specific Consolidated List of Training Requirements*, CW-510200-178-000-0018, Revision 9, 2024 April, 64840386

[151] *Human Factors Engineering Program Plan for Decommissioning Projects at Canadian Nuclear Laboratories*, 3600-508140-HFP-001, Revision 0, 2017 August, 22848419

[152] *General Design Considerations: Human Factors,* REGDOC-2.5.1, Canadian Nuclear Safety Commission, 2019 March, Website link.

[153] *Codes, Regulations, Standards, and Other Documents,* 900-514100-LST-002, Revision 1.3, 2023 November, 49883204

[154] *Effluent Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills*, N288.5-11, Canadian Standards Association, 2011 April, Reaffirmed in 2021, Website link.

[155] *Environmental Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills*, CAN/CSA N288.4-10, Canadian Standards Association, 2010 May, Reaffirmed in 2015, Website link.

[156] *Groundwater protection programs at Class I Nuclear Facilities and Uranium Mines and Mills*, N288.7, Canadian Standards Association, 2015 June, Website link.

[157] *Asbestos Management*, 900-510400-STD-026, Revision 0.1, 2023 December, 54947372

[158] *Public Information Program for Canadian Nuclear Laboratories*, CW-513430-REPT-001, Revision 9, 2024 March, 53749225

[159] *Public Information and Disclosure,* REGDOC-3.2.1, Canadian Nuclear Safety Commission, 2018 May, Website link.

[160] *Indigenous Engagement*, REGDOC-3.2.2, Version 1.1, Canadian Nuclear Safety Commission, 2019 August, Website link.

[161] *Management of Waste*, 900-508600-MCP-004, Revision 3, 2022 December, 51445741

[162] *Characterization Procedure for Facilities Decommissioning*, 3600-508330-PRO-001, Revision 1, 2018 September, 40840437

[163] *Radiological Survey Processes for Facilities Decommissioning*, 3600-508740-PRO-002, Revision 1, 2018 May, 40549702

[164] *Land Use Process*, 900-508300-STD-002, Revision 1, 2022 December, 52034637

[165] *Environmental Remediation Process*, 900-508300-STD-001, Revision 1.2, 2023 December, 44164061

[166] *Protection of the public in situations of prolonged radiation exposure*, Publication 82, ICRP, 1999 September, Website link.

[167] *Class 3 Cost Estimate Gentilly-1 Waste Facility Decommissioning & Demolition, Bécancour, Quebec*, 61-00430-REPT-001, Revision 0, 2019 March, 47186525

[168] *Excavation and Categorization of Radioactive Contaminated Soil*, OG-601, Revision 0, 1999 June, 22749817

[169] *Waste Management Plan for the Gentilly-1 (G-1) Prototype Reactor Site*, 61-508600-WMP-001, Revision 3, 2020 April, 51952965

[170] *Waste Enquiry Form,* 900-508600-FM-013, Revision 1.1, 2023 July, 54156710

[171] *Waste Acceptance Criteria for On-Site Generators*, WMA-508600-WAC-001, Revision 0, 2015 February, 22375700

[172] *Waste Management Plan for Hazardous and Mixed Waste at CNL*, CW-508600-WMP-003, Revision 0.1, 2022 December, 55963717

[173] *Canadian Nuclear Laboratories Integrated Waste Strategy*, CW-508600-PLA-002, Revision 2.1, 2023 October 60215932

[174] *Framework for Radioactive Waste Management and Decommissioning*, REGDOC-2.11, Version 2, Canadian Nuclear Safety Commission, 2021 March, Website Link.

[175] *Waste Management, Volume I: Management of Radioactive Waste*, REGDOC-2.11.1, Volume 1, Canadian Nuclear Safety Commission, 2021 January, Website Link.

[176] *Waste Management, Volume III: Safety Case for the Disposal of Radioactive Waste*, REGDOC-2.11.1, Volume 3, Canadian Nuclear Safety Commission, 2021 January, Website Link.

[177] *International Structure for Decommissioning Costing (ISDC) of Nuclear Installations*, OECD/NEA No. 7088, Nuclear Energy Agency, 2012, Website link.

[178] *S.B Kenny, Letter to H. D'Arcy Financial Guarantee for NPD, Douglas Point and Gentilly-1 Waste Facilities*, 3640-CNNO-15-0012-L, Revision 0, 2015 October 01, 22456854

[179] *Hon G. Rickford, Letter to M. Binder*, 145-NRCANNO-15-0001-L, Revision 0, 2015 July 31, 22449416

[180] *Pre-Job Brief*, 900-514100-FM-022, Revision 0, 2022 July, 58978736

[181] *Retention, Preservation and Disposition of Information Assets*, 900-511300-STD-004, Revision 1, 2019 October, 50742658

[182] *General requirements for pressure-retaining systems and components in CANDU nuclear power plants/Material Standards for reactor components for CANDU nuclear power plants*, N285.0, Canadian Standards Association, 2018 August, Website link.

[183] *Nuclear Safety and Control Act*, S.C. 1997, c. 9, Statutes of Canada 2017 January, Website link.

[184] *Nuclear Substances and Radiation Devices Regulations*, SOR/2000-207, Statutes of Canada, 2015 March, Website link.

[185] *Retention Schedule*, 900-511300-LST-001, Revision 2, 2022 January, 50514511

Appendix A CNL's Effective Dose Limits and Action Levels for G1WF

Table A-1 Effective Dose Limits [A-1]

Application	Dose limit	
	Occupational	Public
Effective Dose[3]	50 mSv·a^{-1} and 100 mSv in 5 years	1 mSv·a^{-1}
Annual equivalent dose in:		
Lens of the eye	50 mSv	15 mSv
Skin	500 mSv	50 mSv
Hands and feet	500 mSv	50 mSv

Table A-2 Action Levels for G1WF [A-2]

Application – Dose to Workers Organ or Tissue	Action Level[1]	Exposure Period
Effective Dose	5 mSv	Calendar Year
External Dose to the Whole Body	0.5 mSv	Single Exposure Event[2]
Equivalent Dose to the Skin (Shallow Dose)	50 mSv	Calendar Year
Equivalent Dose to the hand or foot (Extremity Dose)	50 mSv	Single Exposure Event[3]
	100 mSv	Calendar Year[4]
Equivalent Dose to the Skin (Skin Contamination)	50 mSv	Single Exposure Event[5,6]
Committed Effective Dose (Internal Exposure)	1 mSv	Single Exposure Event[7]
		Chronic Exposure[8]
Effective Dose for Pregnant NEW	0.3 mSv	Quarterly
	0.7 mSv	Balance of Pregnancy
Effective Dose for non-NEWs	0.3 mSv	Quarterly
	0.7 mSv	Calendar Year

Notes:

1. Planned work for which exposures are anticipated that will or could exceed the Action Levels given in this table, shall not be undertaken without prior authorization from the Radiation Protection Program Manager.
2. Unplanned exposure to the whole body resulting from a work activity during a day shift (i.e., 8 to 12 hour shift). The exposure is taken to be 0.5 mSv greater than what is

[3] For pregnant Nuclear Energy Workers, the annual effective dose limit is 4 mSv for the balance of the pregnancy.

established as an appropriate margin for the conduct of the work as measured on the Personal Alarming Dosimeter (e.g., 0.5 mSv greater than Personal Alarming Dosimeter Dose Alarm).

3. Applies to an unplanned exposure from a single extremity TLD measurement dose result.
4. Accumulated extremity dose from multiple extremity TLD measurements during the calendar year.
5. Applies to dose from a single skin contamination event, excluding dose to the skin and extremity monitored by a dosimeter.
6. When the skin is unevenly irradiated, the averaging area shall not be less than 1 cm^2 even in the case of a hot particle. When the skin is unevenly irradiated, the equivalent dose received by the skin is the average equivalent dose over the 1 cm^2 area that received the highest equivalent dose.
7. Applies to an unplanned acute intake for which the exposure can be treated as instantaneous for the purpose of assessing the resulting committed dose.
8. Applies to intakes received over an extended period of time which is not treated as a single instantaneous intake for the purposes of assess the resulting committed dose. The chronic intakes action level does not include the sum of separate assessed doses from multiple unplanned acute intake events.

References

[A-1] *Radiation Protection Regulations*, SOR/2000-203, Website link.

[A-2] *Radiation Protection Action Levels*, 900-508740-LST-002, Revision 1, 2021 April, 52638715

Appendix B Planning Assumptions

Planning assumptions for decommissioning of the G1WF is based on the following fundamental assumptions:

- The dates set out in the conceptual schedule (see Table 18) are based on the dates set out for the decommissioning of G-2, as per HQ plan.
- G1WF will be maintained in a SWS period until decommissioning ends in 2035.
- AECL will retain ownership of the site throughout the course of the decommissioning.
- AECL staff will be responsible for all work conducted during the SWS Phase.
- A DOC, a company or consortium selected on the basis of experience, safety record, overall approach and cost, will perform all work during the Dismantling, Disposal and Site Restoration Phase of the decommissioning program.
- A long-term WMF suitable for the receipt of decommissioning wastes will be available by the start of decommissioning.
- "Clearance Levels" based on international practice and acceptable to the regulator will be developed prior to the decommissioning. These will permit the 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.
- Above-ground structures will be surveyed for contamination, decontaminated if required and demolished.
- Sub-surface structures will be surveyed for contamination, decontaminated if required and consistent with international practices, dismantled to a nominal depth of one meter below grade, back filled with imported (i.e., from outside the G1WF site), clean concrete rubble and/or soil and graded over.
- The site will be made available for other HQ uses after completion of decommissioning.

Appendix C Table of Contents for the G1WF Interim/Final End-State Report[4]

[4] Each Level-2 section may further be expanded into Level-3 sections as necessary.