DECOMMISSIONING OF AECL WHITESHELL LABORATORIES: PROGRESS FROM FIRST FIVE YEARS OF LEGACY FUNDING

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ABSTRACT

In 2006, the Government of Canada adopted a new long-term strategy to deal with the nuclear legacy liabilities and initiated a five-year start-up phase. The objective is to safely and cost-effectively reduce these liabilities, and associated risks, based on sound waste management and environmental principles in the best interests of Canadians. AECL's Whiteshell Laboratories is part of the long-term strategy and decommissioning activities are underway. Several redundant non-nuclear buildings have been removed/decommissioned, and redundant nuclear facilities (hot cell facilities, radiochemical laboratories) are being decontaminated and prepared for demolition. This paper describes the progress in the first five-year funding period (2006 April to 2011 March).

1. INTRODUCTION

AECL operates two nuclear Research and Development laboratories in Canada, Chalk River Laboratories (CRL) near Ottawa, Ontario, and Whiteshell Laboratories (WL), near Winnipeg, Manitoba. AECL Whiteshell Laboratories is a Nuclear Research and Test Establishment that has been in operation since the early 1960s. In the late-1990s, AECL began to consolidate research and development activities at CRL and began preparations for decommissioning WL.

WL occupies 4400 ha of land and employed more than 1000 staff up to the mid-1990s. Nuclear Research and Development programs carried out at WL during the more than 40 years of operating history included the 60 MW WR-1 organic liquid-cooled research reactor, which operated from 1965 to 1985, shielded facilities, materials science, post irradiation examination, reactor safety research, small reactor development, chemistry, biophysics and radiation applications. The Canadian Nuclear Fuel Waste Management Program was conducted at WL and also at the nearby Underground Research Laboratory. Figure 1 is an aerial view of the Whiteshell Laboratories main site, showing the Winnipeg River in the background. The Waste Management Area and inactive landfill are located approximately 3 km and 4 km respectively from the main site.

In preparation for decommissioning, a comprehensive environmental assessment was successfully completed [1] and the Canadian Nuclear Safety Commission (CNSC) subsequently issued a decommissioning licence for WL starting in 2003 - the first decommissioning licence issued for a Nuclear Research and Test Establishment in Canada. The WL Decommissioning Project scope encompasses all the site buildings, facilities, land and infrastructure associated with the WL site. Initially, the Project is focused on decontaminating and modifying nuclear facilities, laboratories and the associated service systems and removing redundant buildings to reduce risk and operating costs. Following the final decommissioning of facilities and infrastructure, stored wastes will eventually be removed from the site.

The initial strategy to decommissioning the WL site was to place the majority of the nuclear facilities into a safe shutdown condition (storage with surveillance) and an extended deferment period prior to final decommissioning. In 2006 June, the Government of Canada adopted a new long-term strategy – the Nuclear Legacy Liabilities Program (NLLP) [2]. The objective of the NLLP is to safely and cost-effectively reduce the nuclear legacy liabilities, and associated risks, based on sound waste management and environmental principles. The NLLP endorsed an accelerated approach to WL decommissioning, which meant advancing the full decommissioning of buildings and facilities that were being decontaminated and prepared for storage-with-surveillance.

As well, the NLLP endorsed the construction of enabling facilities – facilities that employ modern waste handling and storage technology on a scale needed for full decommissioning of the large radiochemical laboratories and other nuclear facilities. The design, construction and operation of enabling facilities are fully underway. Site utilities are being decommissioned and reconfigured to reduce site operating costs. New waste handling and waste clearance facilities have been constructed, and two new waste storage facilities have been constructed - a large shielded modular above ground storage (SMAGS) for storage of low-level solid radioactive waste, and a soil storage compound for storage of low-level contaminated soil. Enabling facilities will not be further discussed, and this paper will focus on the decommissioning activities.

2. ENVIRONMENTAL ASSESSMENT, PUBLIC CONSULTATION AND LICENSING

Prior to commencing decommissioning, AECL was required to obtain a decommissioning licence from the regulator, the CNSC. As part of the documentation provided in support of the licence submission, AECL completed a comprehensive environmental assessment (EA) in accordance with the Canadian Environmental Assessment Act (CEAA) [1]. In 2002 April, the Federal Minister of the Environment responded with a positive decision that the decommissioning of Whiteshell Laboratories 'is not likely to cause significant adverse environmental effects and that no further environmental assessment by a review panel or mediation is warranted'. As part of the EA, all sediments at the outfall to the Winnipeg River and nearly all entrenched low level wastes were shown to be acceptable for abandonment *in situ*. As well, more than 3000 ha of the site property were shown to be unaffected by nuclear operations and excluded from the scope of the project. Inventory estimates were used to assess the potential effects on humans and non-human biota in the river. It was determined that, even with extremely conservative dose estimation methods, the doses would be below accepted guidelines [3]. Therefore, it was confirmed the operation of the Whiteshell Laboratories had led to no significant impact in the river sediments and remediation of the sediments was not required as part of the WL decommissioning project.

Successful completion of the EA cleared the way for AECL's application to the CNSC for a decommissioning licence. In the licence application, the Commission considered written and oral submissions from AECL, CNSC staff and interveners, over the course of two public hearings. The WL decommissioning licence was issued 2002 December 31 and was valid until the end of 2008. Issuance of the WL decommissioning licence was a significant achievement. This was the first overall site decommissioning licence issued for a Nuclear Research and Test Establishment in Canada. It was also the longest licence term ever granted for a nuclear installation of this complexity. In 2008 the licence was renewed for a 10-year period, valid until the end of 2018.

Public consultation was proactively undertaken from the outset of the EA and has continued to the present time. The Project maintains two formal lines of public communications: 1) Public Liaison Committee, comprising Mayors and Reeves of local towns and municipalities, business leaders and provincial ministry officials, and 2) Sagkeeng First Nation Communication Protocol. In the WL experience, socio-economic issues of site closure (loss of jobs, disruption of communities, political implications) were of comparable importance to health, safety and environmental aspects. Interveners proposed the shortening of decommissioning timeframes to concentrate economic activity in the near term and to reduce the burden on future generations. Shortening of decommissioning timeframes, and avoiding lengthy deferment periods, was also shown by AECL to reduce total costs. The accelerated plan endorsed by the NLLP achieves this.

3. QUALITY ASSURANCE

AECL's Quality Assurance (QA) Program is based primarily on the Canadian Standards Association (CSA) N286 series of Standards for Nuclear Power Plants. The *Whiteshell Laboratories Decommissioning QA Plan* identifies the specific management responsibilities, procedures and operating instructions for decommissioning at the WL site. It addresses the requirements for decommissioning management, work planning, verification, records management, and interfaces to AECL's company-wide compliance programs. The CNSC independently audits performance to the QA Plan.

4. DECOMMISSIONING PROGRESS

4.1 Nuclear Facilities

4.1.1 Building 300 Radiochemical Laboratory

The B300 Radiochemical Laboratory was WL's primary research laboratory. Comprising an area of approximately 17,000 m^2, the B300 complex housed over 170 labs, including a variety of radiological and non-radiological laboratories, approximately 400 offices, mechanical rooms and storage offices, and a high bay for large-scale engineering experiments. B300 also includes the Shielded Facilities (SF) and RD-14M Thermalhydraulics Experimental Facility (see Figure 2). B300 was constructed in seven stages and the strategy is to demolish the building, similarly, in stages. The SF comprises two of the stages and while many areas have been partially or completely decommissioned (see next section), the SF area will remain in use for many years. RD-14M occupies one stage, and will remain operational for the foreseeable future. One other stage was occupied until just recently, and decommissioning of this stage has begun.

Decommissioning of the other three stages in B300 is well underway. Prior to the NLLP funding the Van de Graaff Accelerator and Neutron Generator in B300 were fully decommissioned. During the five-year initial NLLP funding, most of the equipment and services from the other areas in these three stages were removed, and the building is being decontaminated to an eventual free-release state, ready for demolition. The active drain lines, redundant furnishings, services, and active ventilation devices (e.g., fume hoods, glove boxes) from these areas have been removed (Figure 3). Nuclear research equipment has been removed and dismantled (e.g., Thorium-Nitric Acid Solution Storage tank and piping). With this work complete, the active ventilation system (e.g., ducting, fan system) is now being decommissioned. Work has started in one of the above three stages – this ventilation system is the least contaminated of all the B300 ventilation, and is

being used to gain experience prior to working on more contaminated systems. Planning and design is also in progress for the remediation of soils in the crawlspace.

This work focuses on the reduction of cost and liability at the WL site. In particular, removal of the active ventilation system eliminates a potentially mobile source of contamination and eliminates the majority of the site heating demand, thus enabling early decommissioning of the costly central oil-fired heating system. The remaining non-redundant buildings are being converted to less expensive and much cleaner electrical heating systems.

4.1.2 Shielded Facilities

The Shielded Facilities includes a 1200 m^2 Hot Cell Facility (HCF) (see Figure 4), and a 1300 m^2 Immobilized Fuel Test Facility (IFTF), together with associated systems and operating areas.

Six of the twelve Hot Cells (Cells 6-11) were previously partially decommissioned (Figure 4). The manipulators have been removed and services (air, distilled and process water, electrical) have been disconnected and the lines removed. Mechanical transfer elevators were dismantled and removed. Equipment such as shelves and brackets and other appurtenances were removed from the cells by mechanical means (cutting, grinding, etc.). The active ventilation system is still in operation. Hot Cells 6 to 11 have been decontaminated and are presently in a defined interim end-state as they share active drain and ventilation systems with operating Hot Cells 1-5. Associated experimental equipment such as a Scanning Electron Microscope and Hot Cell 12 (which contained a Metallographic Microscope) were dismantled and removed.

The HCF storage blocks, which were used to store irradiated samples of reactor fuel and other radioactive samples prior to, and following, post irradiation examinations in the HCF, have been decontaminated and are presently in a defined interim end-state. Final decommissioning of the hot cells will follow the final decommissioning of the WR-1 Reactor.

Seven canisters in the IFTF, constructed of reinforced concrete 2.06 m in diameter by 1.68 m high with an internal cavity of 0.65 m in diameter and 1.44 m deep that were previously used to conduct a wide range of experiments in support of the Canadian Nuclear Fuel Waste Management Program, were dismantled and removed. Decommissioning of the IFTF's Warm Cells[1] 14-18 is complete, and included dismantling of the Warm Cells (main floor), and removal of the active ventilation and drain lines in the crawlspace below the cells. Figure 5 shows the Warm Cells before decommissioning, during (in the final stages of demolition - the left-most cells have been debricked (lead brick shielding), with only the liner and table remaining), and after. The cells were decommissioned in stages, starting with all exterior services, then the manipulators, interior services and decontamination (including cutting the cell liner), p-trap removal, window removal, lead brick removal, liner removal, and finally the table frames. Thereafter, the active ventilation and drain lines beneath the Warm Cells, located in the crawlspace, were decommissioned. Cells 17 and 18 were the most contaminated, and lessons learned from Cells 14-16 were incorporated in their decommissioning.

Decommissioning activities in the SF, as with B300, has reduced the nuclear liabilities of the WL site, and provides valuable floor space for new waste handling and treatment facilities that are needed for decommissioning.

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[1] The Warm Cells are smaller and have less shielding than the Hot Cells. They were also used in support of the Canadian Nuclear Fuel Waste Management Program, where a wide range of experiments using radioactive materials was carried out.

4.1.3 Active liquid waste immobilization

Active Liquid Wastes (ALW) arising from reprocessing and fissile material separation experiments conducted in the 1970s and 1980s have been immobilized by cementation. The ALW consisted of: approximately 150 litres of solution, resulting from fuel processing experiments, 75 litres of waste from a Thorium Fuel Reprocessing Experiment (TFRE), and 600 litres of a non-irradiated Uranium-Thorium solution (UTS). The cemented irradiated wastes are in storage in a specially designed bunker in the WL Waste Management Area (WMA) until permanent disposal facilities are available.

4.1.4 Other nuclear buildings

Plans are underway for the decommissioning of two other nuclear buildings at WL – the active liquid waste treatment centre (ALWTC - B200) and the laundry and decontamination centre (B411). The functions of these two buildings are being reconfigured and consolidated in the SF and B300.

The ALWTC began operation in 1963, receiving Low-Level Liquid Waste (LLLW) effluent from site operating nuclear facilities. The liquid effluents are transferred via underground lines connecting operational facilities to the ALWTC for temporary storage in holding tanks prior to sampling, treatment and controlled release. The facility includes an Intermediate-Level Liquid Waste (ILLW) processing system, taken out of service in 2001, that concentrated liquid waste originating from the SF and the WMA. The concentrate was solidified and then transferred to the WMA for storage.

The laundry and decontamination centre has been in operation since 1966 providing laundry service for radioactively contaminated clothing, and decontamination services for maintaining research and development rigs, equipment and tools in a safe useable state.

4.2 Non-nuclear buildings

The WL Site has many buildings and structures that were not used for nuclear activities. Redundant non-nuclear buildings are being fully decommissioned. In 2008 the two largest non-nuclear buildings were decommissioned. B400 (former Engineering and Administration building) and B406 (former Cafeteria) was a complex structure comprising two large reinforced concrete buildings and a connecting passageway, having a total floor area of 5326 m^2, and a footprint area of 2166 m^2. The main waste forms generated were concrete rubble and structural steel. The steel was recycled and the concrete rubble was crushed and has been used for road base material at the WL site. Figure 6 is a view of the facilities just before demolition commenced and after demolition and remediation were complete.

Several other smaller buildings have also been decommissioned (some were removed for reuse, others were demolished while maximizing material that could be recycled). These buildings were the Internal Friction Laboratory buildings (B500 and B530), the Gas Dynamics Facilities (B307 trailer and grain bin, B312), the Drill Site Office trailer (B515), the Meteorology Trailer #2 trailer (B525), and the Engineering Development and Civil Storage buildings (B504, B509, B526). The total floor and footprint area removed was 1369 m^2 (all were single-story structures).

4.3 Waste management strategy

Decommissioning wastes are radiologically screened and segregated at the source into "Likely Clean" and "Presumed Active" (contaminated) categories and routed to the Waste Clearance

Facility (WCF) and Waste Handling Facility (WHF), respectively. 'Likely Clean' waste is monitored for clearance at the WCF (and may also be monitored at the source). Cleared materials are segregated and dispositioned as either reusable, recyclable, landfill or hazardous materials, following final confirmation monitoring with a bulk material vehicle monitor at the material handling building. Materials identified as contaminated during clearance monitoring are returned to the waste generator for processing as active waste.

'Presumed Active' materials are inventoried and packaged or sent for decontamination. The waste containers are sent to the WHF for processing. Decontaminated materials are sent to the WCF for clearance monitoring. Contaminated materials are sent to the WMA for storage.

5. ACKNOWLEDGEMENTS

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6. REFERENCES

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[2.] Miller, J. et al, "Implementation of a comprehensive program to deal with Canada's Nuclear Legacy Liabilities: a progress report", Sustainable Development through Nuclear Technology, 29th Annual Conference of the Canadian Nuclear Society and 32nd CNS/CNA Student Conference, Toronto, Ontario, June 1-4, 2008.

[3.] Rhodes, M., "Radiological surveys of lands and river sediments to support defining the scope of the Whiteshell Laboratories Decommissioning Project", Canadian Nuclear Society Conference on Waste Management, Decommissioning and Environmental Restoration for Canada's Nuclear Activities: Current Practices and Future Needs, Ottawa, Ontario, May 8-11, 2005.

Figure 1. Aerial photograph of AECL Whiteshell Laboratories (2010 October).

Figure 2. Aerial photograph of Building 300 and the Shielded Facilities.

Figure 3. Decommissioning of a typical radiochemical laboratory in B300 (before and after).

Figure 4. Decommissioning of Hot Cells 6-10 in the WL Shielded Facilities (before and after).

Figure 5. Decommissioning of Warm Cells 14-18 in the WL Shielded Facilities (before, during and after).

Figure 6. B400 (background) and B406 (foreground) prior to and after decommissioning.