Overview of the Government of Canada Nuclear Legacy Liabilities Program – 13551

D. Metcalfe*, D. McCauley*, J. Miller** and S. Brooks**
* Natural Resources Canada, Ottawa, Ontario, Canada K1A 0E4, Doug.Metcalfe@nrcan-rncan.gc.ca
** Atomic Energy of Canada Limited, Chalk River, Ontario, Canada K0J 1J0

ABSTRACT

Nuclear legacy liabilities have resulted from more than 60 years of nuclear research and development carried out on behalf of Canada. The liabilities are located at Atomic Energy of Canada Limited's (AECL) Chalk River Laboratories in Ontario and Whiteshell Laboratories in Manitoba, as well as three shutdown prototype reactors in Ontario and Quebec that are being maintained in a safe storage state. Estimated at about $7.4 billion (current day dollars), these liabilities consist of disused nuclear facilities and associated infrastructure, a wide variety of buried and stored waste, and contaminated lands. In 2006, the Government of Canada adopted a long-term strategy to deal with the nuclear legacy liabilities and initiated a five-year, $520 million start-up phase, thereby creating the Nuclear Legacy Liabilities Program (NLLP). The Government of Canada renewed the NLLP in 2011 with a $439-million three-year second phase that ends March 31, 2014. The projects and activities carried out under the Program focus on infrastructure decommissioning, environmental restoration, improving the management of legacy radioactive waste, and advancing the long-term strategy. The NLLP is being implemented through a Memorandum of Understanding between Natural Resources Canada (NRCan) and AECL whereby NRCan is responsible for policy direction and oversight, including control of funding, and AECL is responsible for implementing the program of work and holding and administering all licences, facilities and lands.

INTRODUCTION

Nuclear legacy liabilities have resulted from more than 60 years of nuclear research and development (R&D) carried out on behalf of Canada by the National Research Council and Atomic Energy of Canada Limited (AECL). About 70% of the liabilities (in terms of cost) are located at AECL's Chalk River Laboratories (CRL) in Ontario, and a further 20% are located at AECL's Whiteshell Laboratories (WL) in Manitoba, which is undergoing decommissioning. Most of the remaining 10% relate to three shutdown prototype reactors in Ontario and Quebec that are being maintained in a safe storage state. Estimated at about $7.4 billion (current day dollars), these liabilities consist of disused nuclear facilities and associated infrastructure, a wide variety of buried and stored waste, and contaminated lands. The inventory of legacy waste includes used fuel, intermediate-level and low-level solid and liquid radioactive waste, and waste (largely contaminated soils) from site clean up work across Canada. Most of the waste is in an unconditioned form, and limited characterization information is available for the waste generated in past decades. More than half of the liabilities are the result of Cold War activities during the 1940s, 50s and early 60s. The remaining liabilities stem from research and development for nuclear reactor technology, the production of medical isotopes and national science programs.

In 2006, the Government of Canada adopted a long-term strategy to deal with the nuclear legacy liabilities and initiated a five-year, $520 million start-up phase, thereby creating the Nuclear Legacy Liabilities Program (NLLP). The objective of the long-term strategy is to safely and cost-effectively reduce risks and liabilities based on sound waste management and environmental principles in the best interests of Canadians. Under the strategy, disused infrastructure will be safely decommissioned, contaminated lands will be restored to meet federal regulatory requirements, and long-term solutions will be developed and implemented for managing the waste. The Government of Canada renewed the NLLP in 2011 with a $439-million, three-year second phase that ends March 31, 2014. The NLLP is now in its seventh year of implementation. The projects and activities carried out under the Program focus on

infrastructure decommissioning, environmental restoration, improving the management of legacy radioactive waste, and advancing the long-term strategy.

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STATUS OF PROGRAM IMPLEMENTATION

The long-term strategy adopted by the Government of Canada in 2006 was conceptual in nature, and designed to be completed over a 70-year period. The time frame reflected the fact that the site with the majority of the legacy liabilities, CRL, is an operational, multi-mission research laboratory, and recognized that a range of waste management facilities will need to be established to fully implement the strategy. The implementation of the strategy at CRL needs to be coordinated with ongoing site operations, and deal with operational facilities and other infrastructure over time as they are shutdown and taken out of service. Further, waste conditioning, treatment, packaging, storage and long-term management facilities will need to be designed and constructed to effectively deal with the existing legacy waste inventory, as well as the waste that will be generated by decommissioning and clean up activities.

Over the first seven years of Program implementation, the approach taken has been to reduce risks and liabilities by addressing health, safety and environmental priorities, improving waste management practices, and conducting infrastructure decommissioning and environmental restoration projects while advancing and refining the long-term strategy. Further, necessary care and maintenance activities continue to maintain the liabilities in a safe state until they can be fully addressed in subsequent phases of the Program. Progress and achievements to date are summarized below under the following four broad areas of work:

- Waste management;
- Infrastructure decommissioning;
- Environmental restoration; and
- Advancing the long-term strategy

Waste Management

A number of waste management projects and initiatives have been completed to date, and others are underway to establish waste management facilities and capabilities, and to improve the storage conditions of certain legacy wastes. Regarding waste management facilities, waste clearance facilities have been established at CRL and WL to confirm that "likely clean" waste is indeed suitable for recycling or disposal with conventional waste. During fiscal year 2011-12, about 7000 m^3 of waste was cleared through these two facilities, thereby providing cost effective routes to reduce legacy waste inventories. Further, a waste handling and characterization facility consisting of two compactors and an automated gamma waste assay system has been established at WL, and mobile waste characterization capabilities have been established at CRL to support infrastructure decommissioning and environmental restoration projects. Also, a shielded above-ground storage building with a capacity of 4000 m^3 and a contaminated soil storage compound have been constructed at WL to manage the waste that will be generated in decommissioning the WL site.

In terms of projects aimed at improving the storage conditions of legacy waste, the CRL Fuel Packaging and Storage (FPS) Project is addressing older, experimental fuels from approximately 100 tile holes (in-

ground vertical structures used to store all used research reactor fuel at CRL) with problematic and degraded fuel and storage conditions. The FPS Project involves the design, licensing, construction and commissioning of the equipment, systems and facility required to retrieve, dry, repackage and store the fuel waste safely for up to 50 years. To date, the fuel retrieval system has been installed in the tile hole area, the drying and packaging equipment have been constructed, and the construction of the fuel handling and storage facility, which is located in close proximity to the tile holes, has been completed. AECL expects to complete the installation of the fuel drying and repackaging systems in the facility in early 2013, and cold commissioning and licensing are scheduled to be completed by the end of 2013. Legacy fuel recovery operations will then commence in mid 2014. Related, ongoing activities include investigations and studies to prepare for fuel recovery and sludge removal, drainage of the tile holes that have become flooded over time, and treatment of the water recovered. The FPS facility is shown in Figure 1.

Fig. 1. Fuel drying, repackaging and storage facility at CRL

Opportunities to ship legacy waste to off-site facilities for treatment or management are also being pursued. Most importantly, Canada and the United States (U.S.) are cooperating to repatriate U.S.-origin, highly enriched uranium (HEU) currently stored at CRL. The Prime Minister of Canada announced in April 2010 at the Nuclear Security Summit held in Washington, D.C. that spent HEU fuel would be repatriated between 2010 and 2018. At the March 2012 Nuclear Security Summit in Seoul, South Korea, the Prime Minister announced that the repatriation initiative had been expanded to include other HEU-bearing materials. Good progress has been achieved to date, with both initiatives proceeding according to schedule.

In addition, radioactively-contaminated polychlorinated biphenyl (PCB) liquids have been processed off-site to remove the radioactive constituents, and the PCB liquids were shipped to the Swan Hills Treatment Facility in Alberta, Canada for incineration. Also, CRL's inventory of radioactively-contaminated oils and solvents has been largely incinerated at commercial facilities in the U.S., and metal melt facilities have been used to recycle waste metals for reuse in the nuclear industry.

Infrastructure Decommissioning

Disused, unoccupied research facilities and associated buildings, particularly the older contaminated wood-framed buildings at CRL, can present risks. Also, the costs to monitor, maintain and repair such infrastructure to ensure that it remains in a safe and compliant state until it is demolished can be substantial. An objective of the NLLP is to accelerate building decommissioning and reduce the current inventory of disused buildings.

To date, the following decommissioning projects have been completed at CRL:

- A large radioisotope laboratory was decommissioned and removed (3800 m^2 footprint);
- A pool test reactor was decommissioned and the room it occupied was returned for reuse;
- A fire break was created between the National Research Experimental (NRX) reactor and its former spent fuel handling facility by draining a spent fuel trench and removing a 30-m section of a highly-contaminated wood-framed building; and
- Several non-nuclear buildings and structures have been removed.

Regarding the WL site, R&D activities have largely ceased, and a site-wide decommissioning plan is being implemented. To date, the following progress has been achieved in decommissioning the WL site:

- All redundant, non-nuclear buildings have been cleared;
- Approximately 120 laboratories in the main R&D complex, which comprises an area of about 17,000 m^2, have been removed, with the remaining 50 laboratories scheduled for removal by early 2013. Further, all active drain lines have been removed from the complex, and the removal of the active ventilation system is targeted for completion by mid 2013;
- Certain areas of the Shielded Facilities have been decommissioned, including the 1300 m^2 Immobilized Fuel Test Facility (IFTF), and its five Warm Cells. Figure 2 shows the Warm Cells before decommissioning, and Figure 3 shows the area after the Warm Cells were removed and the decommissioning work was completed in mid-2012;
- The inventory of legacy radioactive liquid waste has been solidified and placed into safe storage; and
- The underground works of the Underground Research Laboratory near WL have been decommissioned, including the removal of all underground experiments, support services and shaft and ventilation raise furnishings. Concrete bulkheads were installed over the shaft and ventilation raise surface openings in October 2010.

Fig. 2. IFTF Warm Cells before decommissioning

Fig. 3. Area where IFTF Warm Cells were located after decommissioning was completed

The decommissioning of the WL site has included projects to reconfigure site utilities and services to consolidate the “nuclear operations” campus, and “right-size” required site infrastructure and supporting operations based on the reduced requirements for decommissioning. These projects are being implemented to reduce the site’s “nuclear footprint”, reduce utility costs, and permit building decommissioning to proceed more efficiently. For example, the WL Waste Handling and Characterization

Facility was installed in the Shielded Facilities on the floor space that was made available as a result of the decommissioning of the IFTF, and the Analytical Laboratory required to support site-wide decommissioning was established in another area of the Shielded Facilities. Further, stand-alone individual electrical heating systems will be installed in all non-redundant buildings on the site's main campus by mid 2013, so that these buildings can be disconnected from the existing centralized oil-fired hot-water heating system. This will allow for the decommissioning and demolition of individual buildings without requiring utility reconfiguration for adjacent buildings, and permit the shutdown of the oil-fired boiler prior to the fall 2013 heating season, which is projected to save about $1.2 million annually in heating costs, avoid $14 million to $18 million in boiler modification and refurbishment costs over the next 10 years, and reduce annual emissions of carbon dioxide.

At both CRL and WL, work continues to prepare for future infrastructure decommissioning, including radiological surveys and hazard assessments, the development of option studies, environmental assessments, detailed decommissioning work plans, storage with surveillance plans, and cost estimates, as well as cataloguing and archiving relevant records.

Environmental Restoration

In terms of environmental restoration, specific wastes have been recovered from a number of historic burial areas at CRL, and cleanup activities have been completed for selected affected lands. The waste recovery activities have targeted higher-hazard buried wastes, including used fuel rods, glass blocks containing mixed fission products, and structures containing liquid waste. Figure 4 shows the initiation of a project to recover containers of contaminated solvents and other radioactive liquid waste that were buried in three concrete bunkers in the 1950s and 1960s. Recovery operations were completed in 2010, including the recovery of a small quantity of fissile liquid waste that was solidified for safe storage, and the removal of the concrete structures.

Fig. 4. Recovery of CRL Solvent Bunkers

Regarding contaminated lands, the infrastructure at the Field Irradiation Gamma (FIG) and Zoological Environment Under Stress (ZEUS) outdoor experimental sites at WL has been removed and the lands restored. Further, several small areas at the CRL site have been remediated that were impacted by tracer test and waste burial experiments, as well as past site operations. In 2013, an engineered cover will be installed over a 50,000 m^2 area at CRL containing buried solid, low-level radioactive waste to reduce infiltration and thereby reduce the release of contaminants, primarily tritium, to the surrounding environment.

At present, there are three groundwater treatment systems operating at CRL to mitigate plumes of groundwater contamination, and a fourth groundwater treatment facility will be installed in 2013. The new facility will consist of a passive, permeable reactive barrier funnel-and-gate system to intercept and remove radioactive contamination that currently discharges to a wetland on site.

Field investigations and the preparation of risk and option assessments and remedial action plans continue to support future site restoration work.

Advancing the Long-term Strategy

As noted previously, the long-term strategy that provided the basis for the creation of the NLLP was conceptual in nature, and required further development and refinement. In fact, the advancement of the long-term strategy will be an ongoing, continuing process that takes into account:

- Increased understanding of the nature and extent of contamination through field investigations and characterization work;
- Improved definition of the waste inventory;
- Lessons learned from implementing the NLLP; and
- Evolving international best practice.

For fiscal year 2012-13, the focus for CRL has been the elaboration and refinement of an Integrated Waste Plan that provides an assessment of the viable options for the treatment and long-term management of the legacy waste inventory at CRL. The Integrated Waste Plan will include a consolidated and refined waste inventory, and an assessment of the waste management facilities needed to characterize and treat the waste generated by infrastructure decommissioning and environmental restoration activities, as well as the legacy waste that is currently in storage. The Plan will provide the necessary integrated information for evaluating options for long-term management of these wastes including in-place management of buried wastes and contaminated lands, requirements for long-term management facilities, and the potential to use offsite facilities for treatment or disposal.

Regarding WL, the Strategic Plan for decommissioning the site is being updated, with the objective of reducing the remaining time to complete the decommissioning of the main campus buildings, including the WR-1 reactor, to 10 to 15 years. The Plan will define a high-level schedule for completing the decommissioning, dismantling, environmental restoration and waste management projects that comprise the Strategic Plan, as well as identify the required infrastructure projects and support functions to implement the Plan. The Strategic Plan is scheduled to be completed in early 2013.

National and international experience points to the importance of involving stakeholders, including the general public, in the development of strategies for the decommissioning and clean up of nuclear sites and radioactive waste management. Efforts to date have focused on providing information on NLLP projects and activities and the high-level timeline for implementing the long-term strategy. In particular, public information sessions were held in three communities near the CRL site in May 2010. A variety of information materials were developed to explain the Program and highlight projects underway, and a dedicated NLLP website was created (http://www.nuclearlegacyprogram.ca/). While the information sessions were not heavily attended, feedback indicated that major stakeholders in the Chalk River area appear to be well informed about the NLLP.

In 2013, a formal NLLP Communications Project will be initiated with the goal of informing decision making and building understanding and trust through interactions with individuals, groups and organizations which have a stake in the NLLP to provide a basis for the Program to advance in an

effective and timely manner. Stakeholder feedback received as part of communications activities on on-going activities and planned projects will inform NRCan and AECL in advancing the long-term strategy and refining the near-term program of work, with the view of achieving the objective and planned outcomes for the NLLP.

PROGRAM IMPROVEMENT

NRCan and AECL identify and consider opportunities for improving the planning and delivery of the NLLP on an ongoing basis, recognizing the overall objective of the Program to safely and cost-effectively reduce risks and liabilities in the best interests of Canadians. These efforts to continuously improve the NLLP have been guided by three major Program reviews, the first being a Mid-Program Review that was conducted by AECL in fall 2008 at the mid-point of the five-year start-up phase. The Mid-Program Review identified a number of measures to improve performance and optimize program delivery, including the need for:

- More detailed, up-front planning;
- Making greater use of option and feasibility studies;
- Increased use of external expertise and enhanced learning from foreign decommissioning experience; and
- Improved work prioritization and program monitoring.

These measures have now been fully implemented. The second and third major reviews consisted of an internal NRCan Evaluation of the Program that was conducted between September 2009 and March 2010, and an internal NRCan Audit that was conducted between January and March 2010.

The feedback from the Evaluation and Audit expanded on the findings of the Mid-Program Review, and identified a number of additional recommendations to improve both AECL's implementation of the NLLP and NRCan's Program oversight. The Evaluation recommendations included enhancing NRCan's oversight of the Program, increasing NRCan's presence at CRL and WL, and making improvements to AECL's procurement processes and approaches to risk management and cost-effectiveness analysis. The Audit's recommendations included greater use of third-party reviews, streamlined reporting requirements under the Program to increase value and reduce reporting burden, and updating the NLLP risk and control assessment annually.

NRCan has fully addressed the Audit recommendations, and NRCan and AECL are on track to addressing the Evaluation recommendations by the end of March 2013.

PROGRAM ADMINISTRATION

The NLLP is being implemented through a Memorandum of Understanding between NRCan and AECL whereby NRCan is responsible for policy direction and oversight, including control of funding, and AECL is responsible for Program implementation.

A Joint NRCan-AECL Oversight Committee (JOC) chaired by NRCan makes decisions on the planning, delivery, reporting and administration of the Program. NRCan represents the interests of the Government of Canada and provides policy direction; oversees implementation; and ensures value for money, transparency and accountability. AECL implements the work; ensures safety and regulatory compliance with site licences granted by the Canadian Nuclear Safety Commission (CNSC); identifies priorities and develops annual plans; reports on approved activities; and holds and administers licences, facilities, lands, materials and other asset responsibilities related to the nuclear legacy liabilities.

The JOC takes a consensus approach to decision making, recognizing the Government's interests as ultimate owner of the liabilities and funder of the work, and AECL's need to protect health, safety and the environment and meet regulatory requirements.

A Performance Measurement Strategy is in place to assess program performance against the federal government's objectives and goals for the current three-year phase. It includes about 85 detailed milestones as well as planned outcomes, which provide for higher-level measures of the success of the Program and its overall value to Canadians. Outcomes include improved health, safety and environmental conditions, improved legacy waste management, increased understanding of the liabilities, and reductions in risks and liabilities.

CONCLUSION

The Government of Canada is implementing a program to deal with nuclear legacy liabilities dating back to the Cold War and the birth of nuclear technologies and medicine in Canada. The achievements to date and ongoing projects and activities are addressing health, safety and environmental priorities, reducing liabilities, and providing the studies, plans and facilities that will be needed to enable subsequent strategy phases. The long-term strategy continues to be advanced and refined with the input of a variety of stakeholders in order to achieve the Government's objective of safely and cost-effectively reducing risks and liabilities in the best interests of Canadians.