Nuclear Waste in Canada | Backgrounder

Planning for Extended Storage

In the late 1950s, the U.S. was one of the first jurisdictions to declare its intention to "solve" the problem of nuclear waste by what was referred to at the time as "land disposal", with the preferred option being to place it in salt mines. The "runner up" options were solidifying the wastes and placing it in "sheds" on arid line, or injecting liquid radioactive wastes 5,000 feet below the surface. Canada followed two decades later, with a three-month study resulting in the identification of "geological disposal" as the preferred option, either in the Canadian Shield or salt formations.

Another four decades have passed, and numerous countries have spent considerable time and research effort developing programs to investigate or support deep geological repositories for the "disposal" of highly radioactive reactor fuel waste, but to date no country has actually implemented a nuclear waste burial program.

Increasingly, discussion both in North America and internationally is shifting to an examination of options related to extending on-site storage of nuclear fuel waste into the long or very long term, for periods ranging from 100 to 300 years. There are three primary motivations for this shift:

- After several decades and a number of failed attempts, there is no geological repository on the near horizon
- Post 9/11 there are increased security concerns and – correspondingly – increased security benefits to moving the fuel wastes into more robust conditions
- Following the Fukushima crisis commencing in March 2011, there is growing awareness of the vulnerability of the spent fuel while being maintained in the Irradiated Fuel Bays

> "*Disposal in cavities mined in salt beds and salt domes is suggested as the possibility promising the most practical immediate solution of the problem. Disposal could be greatly simplified if the waste could be gotten into solid form of relatively insoluble character. In the future the injection of large volumes of dilute liquid waste into porous rock strata at depths in excess of 5,000 feet may become feasible.*"
> National Academy of Sciences - National Research Council Division of Earth Sciences Committee On Waste Disposal, Report on Disposal of Radioactive Waste on Land, U.S.A., 1957

In addition, in some situations, particularly in the U.S., pools are reaching capacity, and action must be taken in the short term to keep the waste secure over the short, medium and long term.

In the U.S., reactors are generally single units, whereas in Canada – and particularly Ontario – the practice of having multi-unit reactor stations has *de facto* created centralized storage, with up to eight reactors operating on a single property. That said, the precise location of the waste management facility within the nuclear generating station boundaries may not be the most appropriate for extended storage that may reasonably be expected to be in place for 100 to 300 years. This will be particularly evident in light of the features of robust storage as described below.

Moving to a program of long term at-reactor-site storage will present both opportunities and challenges. Challenges include shifting program momentum after so many decades of focus on illusory repository programs, and responding to reactor communities' expectations that the waste will be moved off-site, after decades of having been told that this would be the case. Technical challenges include having to potentially manage newer fuels with higher burn-ups rates and maintaining technical capacity over the longer term in order to adequately maintain and - where necessary - upgrade or replace system components.

Notably, these technical challenges will be part of any management scenario. For Canada, an additional challenge is that there appears to have been very little attention given to CANDU spent-fuel management in the international programs, including research related to extended on-site storage. With 10% of reactors world-wide using the CANDU design, this is a gap that should be of concern to more than just Canada.

The opportunities include increased security benefits, avoiding the risk of off-site transfer and transportation, and receiving better returns on investment to make storage systems more robust.

A necessary first step in the evaluation of the extended on-site storage is the evaluation of how mature current technologies are in their ability to meet storage needs over a 200-300 year period. In addition, a review of the regulatory regime may assist by determining the degree to which it can accommodate an extended on-site storage program or the degree to which it would need to be supplemented in order to provide regulatory oversight. Again, this challenge will be part of any management scenario.

In Canada, very little work has been done in this area. A generalized report was prepared for Ontario Power Generation on behalf of Canadian nuclear fuel owners in 2003, discussing conceptual designs for reactor-site extended storage facility alternatives for used nuclear fuel. In comparison, there are numerous reports by U.S. agencies and organizations, some of which include very detailed technical discussions of aging of both fuel and storage system components, and others which provide detailed discussions of options to increase the robustness of a storage site or system. Unfortunately, the corollary work has not been done for the Canadian / CANDU context.

Three features make spent fuel storage more secure, in terms of potential security threats:

- Wastes are placed in a condition where it is passively safe, i.e. it does not rely on electrical power, cooling water or active ongoing maintenance
- The facility is "hardened", through layers of concrete, steel, gravel or other materials being placed – in various combinations – above and around the irradiated fuel waste
- The fuel wastes are dispersed, with the fuel spread more uniformly across the site rather than concentrated in a single area

The feature of passive safety is key in making the waste more secure from human or operational error or natural events. In some situations and designs, dispersal can also be advantageous in keeping the waste secure from human or operational error of natural events.

Inarguably, there are benefits to taking a planned approach to extending on site storage, rather than simply have "short term" or "interim" storage extend over the long term simply due to program failure.

Further Reading Related to Extended On-Site Storage

Alvarez, Robert, et al "Reducing the Hazards from Stored Spent Power-Reactor Fuel in the United States", *Science and Global Security, 11:1–51, 2003*

Alvarez, Robert "Improving Spent-Fuel Storage at Nuclear Reactors", Winter 2012

CANTech, "Conceptual Designs for Reactor-site Extended Storage Facility Alternatives for Used Nuclear Fuel Alternatives for the Pickering, Bruce and Darlington Reactor Sites Report of a Study carried out for Ontario Power Generation, New Brunswick Power, Hydro-Québec and Atomic Energy of Canada Limited, April 2003

Davied, Eric M., "Long-Term Interim Storage for Used Nuclear Fuel: Dry Cask Storage in Centralized Storage Facilities", 2011 WISE Intern, Sponsored by the American Nuclear Society

Electric Power Research Institute (EPRI), "Used Fuel and High-Level Radioactive Waste Extended Storage Collaboration Program", November 2009 Workshop Proceedings

Electric Power Research Institute (EPRI), "International Perspectives on Technical Data Gaps Associated With Extended Storage and Transportation of Used Nuclear Fuel", Extended Storage Collaboration Program, International Subcommittee Report, 2012 Technical Report

GAO, "*Commercial Spent Nuclear Fuel*. *Observations* on the Key Attributes and Challenges of Storage and Disposal Options". *GAO*-13-532T, Apr 11, 2013

GAO, "SPENT NUCLEAR FUEL: Options Exist to Further Enhance Security" Report to the Chairman, Subcommittee on Energy and Air Quality, Committee on Energy and Commerce, U.S. House of Representatives, July 2003

IAEA, "Further analysis of extended storage of spent fuel", Final report of a Co-ordinated Research Programme on the Behaviour of Spent Fuel Assemblies during Extended Storage (BEFAST-III) 1991-1996

IAEA, "International Atomic Energy Agency (IAEA) Technical Meeting On Extending Spent Fuel Storage Beyond The Long Term", 22–24 October 2012

Mcconnell1, Paul*, Brady Hanson2, Moo Lee3, And Ken Sorenson1 1Transportation Manager, "Extended Dry Storage Of Used Nuclear Fuel, Technical Issues: A Usa Perspective", US Department of Energy Fuel Cycle Technologies Program *Received September 28, 2011*

Nuclear Regulatory Commission, "Project Plan for The Regulatory Program Review to Support Extended Storage and Transportation of Spent Nuclear Fuel", June 2010

Rigby, Dr. Douglas B, "United States Nuclear Waste Technical Review Board Evaluation of the Technical Basis for Extended Dry Storage and ransportation of Used Nuclear Fuel" December 2010

Thompson, Gordon, "ROBUST STORAGE OF SPENT NUCLEAR FUEL: A Neglected Issue of Homeland Security" Institute for Resource and Security Studies, January 2003