

Nuclear Waste Facility Siting; 40 Years of Experience - 16521

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ABSTRACT

In this study, siting efforts for radioactive waste management facilities in democratic countries have been reviewed to identify common factors of success and failure. The study has considered facility siting efforts in the past 40 years. The study has considered storage and disposal facilities for low-level wastes (LLW), transuranic wastes (TRU), intermediate-level wastes (ILW), high-level wastes (HLW) and used nuclear fuel (UNF).

The study has reviewed thirty-nine facility siting efforts with the following results:

- 13 successes in Finland, Germany, Japan, Korea, Spain, Sweden and the US.
- 18 failures in Australia, Korea, the UK and the US.
- 8 ongoing efforts in Canada, France, Germany, Japan, Sweden, Switzerland, the UK and the US.

INTRODUCTION

The nuclear industry must provide for the management of the radioactive wastes that it generates. These include all forms of waste. Siting efforts are ongoing throughout the world.

Many siting efforts are being “reset” to embrace what has become labeled as “Consent Based Siting” or CBS [1]. The essence of the situation is that in the past, project proponents would decide the best place for a facility to be sited, this being driven by technical, economic or political factors. The proponents would then launch efforts to convince the affected communities that the facility should be sited.

In CBS, the approach is quite different. Communities are informed of a need for a facility, of economic or other incentives for the host community, and perhaps of the adequacy of sites or regions for such facilities. The affected communities then engage with the proponents to secure the siting “franchise”. The motivation of affected communities is left to them, with the proponents working hand-in-hand with community proponents to secure approvals through the political processes at hand.

In the United States, planning is underway for new siting efforts to manage both commercial UNF as well as defense related wastes. The authors are of the view that this planning needs to consider not only previous HLW and UNF efforts but also those related to ILW, TRU and especially LLW. This view is driven by the belief that

the public does not differentiate between the various types of radioactive wastes in siting discussions. Rather, the public reaction is driven by the fact that the wastes are radioactive. Hence, barriers to successfully siting a facility for HLW or UNF are affected by previous actions by all nuclear industry groups in siting and managing all types of wastes. Therefore, this study has considered the broader range of waste categories.

REVIEWS OF SITING EFFORTS¹

Australia: LLW Disposal South Australia

In 2003, the Federal government under its national low-level waste program selected a site in South Australia on Federal land at Woomera for construction of a LLW disposal facility. In July 2004, the government reversed its position and abandoned the selection. [2] The decision was a combination of political opposition in South Australia and judicial intervention in the process by the State of South Australia. Political failure. [3]

Australia: LLW Disposal Muckaty Station

In 2007 the Northern Land Council nominated Muckaty on behalf of the traditional owners, the Ngapa clan. The Northern Territory (where the site is located) objected, but this did not stop the project. At the time of its nomination, one small family of traditional owners resident in the area approved the nomination. Two issues unfolded – the remainder of the traditional owner group felt those who approved did not represent the wishes of the entire group. Also, when the land was returned to traditional owners, five clans were named, not just the Ngapa. Money was paid to the Council. Eventually, the issue went to court and the siting effort ended. [4] It was abandoned in 2011. Legal and political failure.

Canada: UNF/HLW Disposal National

Canada has an ongoing siting process for UNF disposal. This program is a strong consent based siting model. The effort is managed by the Nuclear Waste Management Organization. There is extensive involvement from all stakeholders, including the indigenous populations. The “Adaptive Phased Management” process has been developed over many years and has been in implementation for five years. [5]

Finland: UNF/HLW Disposal National

The government, in 1983, established a national policy on used fuel disposal. After a national screening, in 1999 an application was made for the facility to be sited at Eurojoki at Olkiluoto Island. The Parliament approved the decision. The Eurajoki

¹ Andrew Newman and Gerry Nagtzaam authored *Decision-making and Radioactive Waste Disposal*, to be published by Routledge in 2015. Much of the content of this paper relating to LLW siting comes from this book.

Council, which had the right to veto the decision, voted in favor. Construction is underway. Waste emplacement is scheduled for 2016. [6]

France: HLW Disposal National

A French HLW repository is being pursued by ANDRA. The Cigeo project has been the subject of extensive public debate. A construction license application is being prepared for the repository with a scheduled submission to the regulators in 2017. [7]

Germany: LLW Disposal Konrad

The Konrad facility was selected as a LLW repository in 1975. Numerous legal challenges were mounted but the facility is scheduled for operation for a limited portion of the country's LLW. [6,8]

Germany: LLW Storage Facility North

The North Interim Storage Facility (ZLN) was developed for storage of operational and decommissioning wastes of the Greifswald and Rheinsberg Nuclear Power Plants. The facility is fully operational. [9]²

Germany: UNF Storage Ahaus

UNF has been stored at Ahaus since 1993 following a license issuance in 1983. [10]

Germany: UNF Disposal Gorleben

Exploration work has been done at Gorleben since 1979. Work was stopped politically in 2000. The project remains on hold pending political resolution of a siting decision. [6,11]

Germany: UNF Storage Gorleben

UNF has been stored at Gorleben since 1995 following a license issuance in 1983. [10]

Japan: HLW Storage

In 1995, Japan's first high-level waste (HLW) interim storage facility opened in Rokkasho-mura – the Vitrified Waste Storage Centre. The first shipment of vitrified

² In addition to the LLW Storage Facility North, Germany has successfully sited and developed other LLW storage facilities. These include the Gorleben Waste Storage Facility, the Stadland Waste Storage Facility, the Waste Storage Facility of the Bavarian Utilities, the Central Interim Storage Facility Ahaus, and the Waste Storage Facility HDB Karlsruhe Baden-Wurtemberg. Germany has also developed numerous storage facilities associated with research institutions.

HLW from Europe (from the reprocessing of Japanese fuel) also arrived in that year. The last of twelve shipments from France was in 2007, making a total of 1310 canisters. Shipments from UK started in 2010, with 1850 canisters to go in about 11 shipments. These include an equivalent amount of HLW to avoid the need to transport greater amounts of low-level wastes (LLW). The first shipment from UK arrived in March 2010, the fourth in April 2014. [6]

Japan: HLW Disposal

While Japan has conducted investigations on HLW disposal since 1976, the current phase of work began in 2000 with the passage of the Final Disposal Law. This calls for HLW (and subsequently ILW) to be disposed of in a repository. NUMO is working with all municipalities in Japan to seek volunteers. This will be followed by evaluations of site adequacy. [6]

Korea: LLW Disposal North Gyeongsang Province

Between 1986 and 1989, the Government selected the North Gyeongsang Province to host a national LLW disposal facility. The local population held protest marches and disrupted local services. [12] The effort was cancelled. Political failure.

Korea: LLW Disposal Anmyeondo Island

In 1990, the Government selected Anmyeondo Island to host a LLW disposal facility. The Government offered to add a research complex to the proposal. The local population rejected the proposal and the effort was cancelled. Political failure. [13]

Korea: LLW Disposal Gyeongsang Provinces

In 1993, residents of the North and South Gyeongsang Provinces asked the Government to site a LLW disposal facility. The Government committed significant sums of money to the communities. Other residents rejected the proposition and the project was cancelled. Political failure. [14]

Korea: LLW Disposal Galup Island

In 1994, the Government selected Galup Island to host the LLW disposal facility. The small group of local residents were to be relocated from the tiny island. A fault was found nearby. At the same time, environmental groups began to protest the project. In 1995, the project was cancelled. Technical and political failure. [15]

Korea: LLW Disposal Gyeongju

The Government undertook a very deliberative CBS process. The Gyeongju city area was found to be suitable and nearly 90% of the voting residents approved the selection. In 2014, the facility was given regulatory approval to begin operation. [16]

Spain: UNF/HLW Storage Villar de Canas

In 2006, the Parliament approved the plan to construct an interim storage facility for UNF and HLW. A volunteer process was undertaken. In 2011, the government announced that Villar de Canas had been selected as the storage location. In mid 2015, the Consejo Seguridad Nuclear (CSN) approved the suitability of the site and construction of the facility began. [6]

Sweden: LLW/ILW Disposal Forsmark

The Swedish Nuclear Fuel and Waste Management Co (SKB) operates a repository for the disposal of LLW and ILW. The site is located in a granite formation under the Baltic Sea near the Forsmark Nuclear Power Plant. The facility was commissioned in 1988. [17]

Sweden: UNF Disposal National

SKB has been working to develop a repository since the mid-1970s. A consent based, volunteer process replaced a “selection” process leading to two communities agreeing to host a repository. The Forsmark site (see above, LLW/ILW Disposal Forsmark) was selected in 2009. The licensing review is expected to continue through 2015 and then be followed by various legal challenges assuming a positive outcome in licensing. [18]

Sweden: UNF Storage Oskarshamn CLAB

UNF has been stored in underground water basins at the Oskarshamn Nuclear Power Plant since 1985. [18]

Switzerland: UNF Disposal National

NAGRA is leading a very long, consent based siting program that is not expected to lead to a siting decision until 2027. [6]

UK: ILW Disposal NIREX National

The UK Nuclear Industry Radioactive Waste Executive (NIREX) was established in 1982 to construct and operate disposal facilities for LLW and ILW. NIREX attempted to establish disposal facilities at numerous locations in the UK, with all being terminated. The failures included technical weaknesses, but by and large were defeated politically. [15]

UK: UNF/HLW Disposal National

The UK is implementing an exhaustive process to find a qualified disposal site for its UNF/HLW, and where the host community has volunteered to have the facility constructed and operated. The process is ongoing. [19]

US: ILW Disposal WIPP New Mexico

The Waste Isolation Pilot Plant took many years to be approved. Through the process, the project had significant support from the local community. The site was selected by the Government and did not emerge from a volunteer process. However, the local community retained the right to withdraw their support at any time.

US: LLW Disposal Boyd County Nebraska

In 1982, Nebraska became a member of the Central Interstate Compact. One state government committed Nebraska to host a LLW disposal site, which was eventually selected to be in Boyd County. This became a State-wide election issue. The legal and political battlefield was extensive and is reported in reference 15. However, in 2005, Nebraska paid \$146 million to the Central Interstate Compact Commission for failing to perform on its obligation to host a LLW disposal site. [15]

US: LLW Disposal Envirocare Utah

The Envirocare facility began disposal operations in 1990 near Clive, Utah. The siting process for the facility in not a consent-based process but rather involved actions and payments that were subsequently prosecuted. [15]

US: LLW Disposal Fort Hancock Texas

In 1987, the state government's radioactive waste disposal authority selected a site near Fort Hancock in West Texas to host a LLW disposal facility for the state. Hudspeth County officials as well as officials from neighboring El Paso County opposed the decision and in 1991 a judge issued a permanent injunction against the site. Political failure. [15]

US: LLW Disposal Sierra Blanca Texas

In 1991, the state government's radioactive waste disposal authority selected a site near Sierra Blanca in West Texas to host a LLW disposal facility for the state. Officials in Mexico and local residents/environmental groups in Texas opposed the decision and in 1998 the Texas Natural Resources Conservation Commission denied the license application due in part to proximity to a potential fault and an aquifer. Technical and political failure. [15]

US: LLW Disposal Spofford Texas

In 1988, Texcor Industries proposed the construction of a disposal facility for naturally-occurring radioactive material (NORM) near Spofford in Kinney County, South Texas to local officials, business groups and civic organizations. Local residents and Mexican officials opposed the proposal and in 1993 the Texas Water

Commission rejected the license application due in part to the presence of an active fault line nearby. Technical and political failure. [15]

US: LLW Disposal Ward Valley California

The Ward Valley project included an initiative by the State of California in 1998, selecting the site and seeking developers. Over the subsequent years, the project was the source of technical and political issues, including failing to adequately address the concerns and rights of the Native Americans in the region. The project “failed” in 1998 with the Federal government halting all land transfer activities. [20]

US: LLW Disposal WCS Texas

In 2004, Waste Control Specialists submitted a license application to construct and operate two co-located near-surface LLW disposal facilities – one for federal waste and one for Texas Compact waste in Andrews County, West Texas. WCS makes annual payments to both the county and the state and provides employment in Texas and New Mexico. The license was granted in 2009 and disposal operations commenced in 2012. [15]

US: UNF Disposal Deaf Smith County Texas

Investigations for disposal of UNF in the Permian Basin in Texas by the US Government began in the 1970s. In 1982, the Nuclear Waste Policy Act (NWPA) named the Deaf Smith County Texas site as one of three candidate sites. In 1987, the NWPA was amended to eliminate the site as a candidate. Political failure.

US: UNF Disposal Hanford Washington

Investigations for disposal of UNF at Hanford by the US Government began in the 1970s. In 1982, the Nuclear Waste Policy Act (NWPA) named Hanford as one of three candidate sites. In 1987, the NWPA was amended to eliminate Hanford as a candidate. Political failure.

US: UNF Storage MRS Tennessee

Under the 1982 NWPA, the Government undertook studies for siting and constructing a Monitored Retrievable Storage (MRS) for the dry storage of UNF. In 1985, the Government undertook a national siting program that recommended the Clinch River Breeder Reactor Site as the favored location for an MRS. [21] Later that year, the State of Tennessee registered their objection to the siting. [22] The Government abandoned the effort. Political failure.

US: UNF Storage MRS National

After the termination of the Clinch River siting effort, MRS siting efforts, while not overtly active, were focused on the “consultation and concurrence” model wherein

the government would “consult” with a favored community and that community would eventually “concur” with a siting decision. The process, however, focused on Government designation of favored locations. The 1987 NWPA amendments created the MRS Review Commission. In 1989, that Commission reported back to Congress that the MRS, as outlined in the NWPA, “cannot be justified”. [23] All further efforts associated with MRS were terminated.

US: UNF Disposal Paradox Basin Utah

Work to investigate the Paradox Basin in Utah was initiated by the Government in the 1970s. Drilling to investigate the region was blocked by the State of Utah by denying the issuance of overweight permits from drilling equipment. Political failure. [24]

US: UNF Storage PSF Utah

The Private Fuel Storage company was established by several nuclear utilities and undertook to establish a UNF storage facility in Utah near Salt Lake City. PFS has an Indian tribe as a willing partner. Even though the facility was licensed by the NRC, it was ultimately cancelled due primarily to actions by the US Department of Interior that complicated or scuttled completely land and rail issues. [25,26]

US: UNF Disposal Yucca Mountain Nevada

The Yucca Mountain project was initiated in the 1970's. In 1982, the Nuclear Waste Policy Act (NWPA) established it as one of three primary candidate repository sites. In 1987, the NWPA amendments established it as the sole repository site for development pending licensing. With the election of President Obama, funding was withheld in Congress. The project remains in stalemate, partially through licensing. Political failure. [27,28]

SUMMARY

This paper summarizes efforts in democracies to site facilities for the storage and/or disposal of radioactive wastes undertaken in the last 40 years. The results of these many siting efforts are as follows:

Successes:

1. Finland: UNF/HLW Disposal. Selected site, local community having right to withdraw.
2. Germany: LLW Disposal Konrad.
3. Germany: LLW Storage Facility North.
4. Germany: UNF Storage Ahaus.
5. Germany: UNF Storage Gorleben.
6. Japan: HLW Storage.
7. Korea: LLW Disposal Gyeongju. Consent Based Siting Program.

8. Spain: UNF/HLW Storage Villar de Canas. Consent Based Siting Program.
9. Sweden: LLW/ILW Disposal Forsmark.
10. Sweden: UNF Storage Oskarshamn CLAB.
11. US ILW Disposal WIPP New Mexico.
12. US LLW Disposal Envirocare Utah.
13. US LLW Disposal WCS Texas.

Failures:

1. Australia: LLW Disposal South Australia.
2. Australia: LLW Disposal Muckaty Station.
3. Korea: LLW Disposal North Gyeongsang Province.
4. Korea: LLW Disposal Anmyeondo Island.
5. Korea: LLW Disposal Galup Island.
6. Korea: LLW Disposal Gyeongsang Provinces.
7. UK: ILW Disposal NIREX National.
8. US: LLW Disposal Boyd County Nebraska.
9. US: LLW Disposal Fort Hancock Texas.
10. US: LLW Disposal Sierra Blanca Texas.
11. US: LLW Disposal Spofford Texas.
12. US: LLW Disposal Ward Valley California.
13. US: UNF Disposal Deaf Smith County Texas.
14. US: UNF Disposal Hanford Washington.
15. US: UNF Storage MRS Tennessee.
16. US: UNF Storage MRS National.
17. US: UNF Disposal Paradox Basin Utah.
18. US: UNF Storage PSF Utah.

Pending Efforts:

1. Canada: UNF/HLW Disposal National.
2. France: HLW Disposal National.
3. Germany: UNF Disposal Gorleben.
4. Japan: HLW Disposal.
5. Sweden: UNF Disposal National.
6. Switzerland: UNF Disposal National.
7. UK: UNF/HLW Disposal National.
8. US: UNF Disposal Yucca Mountain Nevada.

REFERENCES

1. Report to the Secretary of Energy, Blue Ribbon Commission on America's Nuclear Future, Washington DC, January 2012.
2. Parliament of Australia, 'Radioactive waste and spent nuclear fuel management in Australia', Updated 21 July 2011.
3. *South Australia v Honourable Peter Slipper MP*, (2004), ALR, 473; David Bennett, 'The Constitutional Decisions of Justice Selway: (1) Nuclear Waste Dumps and Fire Brigades; (II) Low Flying Planes and (III) What is State

- Insurance?' 2007 *Adelaide Law Review*, p. 79-93, <http://www.austlii.edu.au/au/journals/AdelLawRw/2007/4.pdf>
4. Mark Lane Jangala v. The Commonwealth of Australia, The Northern Land Council & The Minister for Resources, Energy & Tourism, Statement of Claim, No. VID 433 of 2010, The Federal Court of Australia Victorian District Registry, 16. Aug. 2010, pp. 3 - 4.
 5. Web site of the Nuclear Waste Management Organization, www.nwmo.ca.
 6. Web site of the World Nuclear Association, www.world-nuclear.org.
 7. Alain Harman, Thibaud Labalette and Gerald Ouzounian, *Update on Cigeo, the French Geological Disposal Project*, published at WM'15, Phoenix, March 2015 and in the WMS Journal, Issue 1, 2015.
 8. Holger Volzke, Gregor Nieslony, Manel Ellouz, Volker Noack, Peter Hagenow, Oliver Kovacs, Tony Horning, *Container Approval for the Disposal of Radioactive Waste With Negligible Generation in the German Konrad Repository*, presented at WM'12, Phoenix, March 2012.
 9. Bundesamt für Strahlenschutz; Nuclear Waste Management, 2015, http://www.bfs.de/EN/topics/nwm/interim-storage/heat-generation/heat-generation_node.html
 10. Ulrich Alter, *Management of Radioactive Waste and Spent Fuel in Germany*, IAEA conference, May 31, 2010.
 11. Federal Ministry of Economics and Technology (BMWi), *Final Disposal of High-Level Radioactive Waste in Germany – The Gorleben Repository Project*, Berlin, 2008.
 12. Yean Hong Choi, "Nuclear Waste Management: Gaining Public Acceptance," *The Journal of East Asian Affairs*, Vol. XIX, No.2, Fall/Winter 2005, p.231-232. North Gyeongsang Province.
 13. Seong-won Park, Miles A. Pomper and Lawrence Scheinman, "The Domestic and International Politics of Spent Nuclear Fuel in South Korea: Are We Approaching Meltdown?" *Korea Economic Institute*, Academic Paper Series, Vol. 5, No.3, March 2010, p.2, <http://www.keia.org/sites/default/files/publications/APS-ParkPomparScheinman.pdf>
 14. Cho and Whang, "Status and Challenges of Nuclear Power Program and Reflections of Radioactive Waste Management Policy in Korea."
 15. Andrew Newman and Gerry Nagtzaam, *Decision-making and Radioactive Waste Disposal*, published by Routledge, 2015.
 16. World Nuclear News, *First Phase of Korean Waste Facility Opens*, December 12, 2014, <http://www.world-nuclear-news.org/WR-First-phase-of-Korean-waste-facility-opens-1212145.html>
 17. Borje Torstenfelt, Fredrik Vahlund and Peter Larsson, *Disposal of LLW/ILW: The Extension of the SFR-Repository for Handling and Disposal of Decommissioning Waste*, presented at WM2014, Phoenix, Arizona, March 2014.
 18. Johan Swahn, *Storage of Spent Nuclear Fuel in Sweden: The role in Management of Nuclear Waste and the Ongoing License Application for a Spent Fuel Repository*, The Swedish NGO Office for Nuclear Waste Review, MKG, 2014, <http://www.polsoz.fu->

berlin.de/polwiss/forschung/systeme/ffu/veranstaltungen/termine/downloads/14_salzburg/Swahn-2014.pdf

19. John Dalton, *Update on the Radioactive Waste Position in the UK*, presented at WM2014, Phoenix, Arizona, 2014.
20. University of Michigan, *Environmental Justice Case Study: The Ward Valley Struggle*, <http://www.umich.edu/~snre492/ward.html>.
21. 1985: Voss, J. et.al., "Monitored Retrievable Storage: Facility Siting and Evaluations", published by the US Department of Energy, Washington, DC.
22. Tennessee Department of Health and Environment, *The Public Response to MRS: An Interim Report*, October 22, 1985, DOE/OR/21555-T5.
23. Monitored Retrievable Storage Review Commission, *Nuclear Waste: Is there a Need for Federal Interim Storage?*, November 1, 1989, Washington DC.
24. George Raine, *Nuclear Waste Issue Splits State and US Officials*, New York Times, July 25, 1982.
25. Utah Department of Environmental Quality, "Private Fuel Storage LLC: May 17, 2006 Update for the Natural Resources, Agriculture & Environment Interim Committee", http://www.deq.utah.gov/Pollutants/H/highlevelnw/opposition/docs/2006/05May/LEG_PFS_051706.pdf
26. Judy Fahys, *Money, Politics Bury Plans for Utah Fuel-Rod Cemetery*, The Salt Lake Tribune, January 7, 2013.
27. Nuclear Waste Technical Review Board, *Survey of National Programs for Managing High-level Radioactive Waste and Spent Nuclear Fuel*, Report to Congress and the Secretary of Energy, Washington DC, October 2009.
28. Steve Tetreault, *Energy Chief Defends Yucca Mountain Determination*, Las Vegas Review-Journal, February 5, 2010.