The UNIVERSITY of VERMONT

Vermont Legislative Research Shop

Nuclear Waste

Nuclear power has recently been receiving much attention as an emissions-free alternative energy source. This is in part due to the acknowledgement of the global warming crisis by the government and the general public of the United States. However, despite its environmentally friendly appearance, nuclear power raises several important concerns including high overhead costs and safety issues related to the transportation and disposal of nuclear waste.[1] Nuclear waste is of particular importance because it poses a danger to human health and because facilities for its disposal are limited or non-existent. This report introduces the different types of nuclear waste, explores the waste policies of several states, and looks at how some states have attempted to control the production of nuclear waste.

Types of Nuclear Waste

Nuclear waste consists of the leftovers and by-products of radioactive materials used to generate electricity, carry out certain healthcare procedures, perform a variety of commercial processes and conduct university research. Because different types of nuclear waste have varying levels of radioactivity, waste is divided into two main categories: high-level waste and low-level waste.

High-level waste (HLW) consists of spent fuels rods used in the generation of fission power. HLW is exceedingly radioactive; simply being close to spent fuel without protection could result in death.[2] Additionally, fuel rods are composed of many elements whose radioactivity can take thousands or hundreds of thousands of years to dissipate or 'decay,' so it must be safely stored and controlled for that entire time.[3] HLW is currently stored on-site at the plant where it is used, as a national site has not yet been officially authorized and developed (see discussion below).[4]

In contrast, low-level waste (LLW) is a much broader category as it covers everything radioactive that is not spent fuel. This means it contains all objects that have been

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[1] For an overview of nuclear power issues, see VLRS Nuclear Power report at http://www.uvm.edu/~vlrs/Energy/energy.html.
[2] U.S. Nuclear Regulatory Commission, "Radioactive Waste: Production, Storage, Disposal," May 2002.
[3] U.S. Nuclear Regulatory Commission, May 2002.
[4] See the Office of Civilian Radioactive Waste Management for a discussion of the proposed site at Yucca Mountain, Nevada, retrieved 9 February 2009 from http://www.ocrwm.doe.gov/.

contaminated by radiation such as: protective clothing and covers, rags and mops, filters, and other objects. LLW is divided into three levels—Class A, Class B, and Class C—that represent from lowest to highest the degree of radioactivity of the waste. In general, LLW is much less radioactive than HLW, meaning that it decays in tens or hundreds of years rather than hundreds of thousands; however, it still represents a danger and so must be safely controlled and stored until the radioactivity has dissipated. Some LLW is stored on-site at the place it is produced, but official policy prefers that it be disposed of in an official disposal location off-site.[5] Throughout the U.S., about 4 million cubic feet of LLW was disposed of in 2005.[6] That is enough to fill the volume of about 16 large hot air balloons.[7]

Regulations Affecting Disposal

The U.S. Nuclear Regulatory Commission (NRC) is responsible for the licensing and regulation of all commercially produced radioactive waste.[8] The NRC in turn can negotiate agreements with state governments to allow them to license and regulate the storage and disposal of LLW within their boundaries. Thirty-two states, called "Agreement States", have arranged this type of agreement with the NRC. As of 2002 there were more than 20,000 licenses for the possession of radioactive materials.[9]

The Nuclear Waste Policy Act of 1980 specified that it is the responsibility of the Federal Government to provide a safe storage location for HLW, while states were given the responsibility for disposing of LLW. The law also specifies that until the Federal Government has created a permanent storage location, the producers of HLW are responsible for the safe storage of their HLW. Establishing a permanent storage location has, however, proved very difficult for the US government. [10] And, the US is not alone in facing such difficulties—no disposal site for HLW exists anywhere in the world today, despite the fact that there are more than 440 nuclear reactors in 30 countries.[11]

The Low-Level Radioactive Waste Policy Act of 1980 confirmed the responsibility of each state for the disposal of its LLW and further suggested that states create regional agreements, or compacts, in order to establish a regional LLW disposal center. As a result, 10 compacts were created with all but eight states in a compact. For example, a compact known as the Southwestern Low-Level Radioactive Waste Disposal Compact exists between the states of

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[5] U.S. Nuclear Regulatory Commission, May 2002.
[6] U.S. Nuclear Regulatory Commission, "Low-level Waste Disposal Statistics," 21 March 2007. Retrieved 3 February 2009 from http://www.nrc.gov/waste/llw-disposal/statistics.html
[7] Large hot air balloons have a volume of approximately 240,000 cubic feet.
[8] As distinct from government waste associated with military research and operations.
[9] U.S. Nuclear Regulatory Commission, May 2002.
[10] For further information, see Yucca Mountain section and the Office of Civilian Radioactive Waste Management on storage of high-level nuclear waste. http://www.ocrwm.doe.gov
[11] World Nuclear Association, "Nuclear Power in the World Today," June 2007. Retrieved 3 February 2009 from http://www.world-nuclear.org/info/inf01.html.

Arizona, California, North Dakota and South Dakota. [12] California was the designated "host state," but the construction of a disposal site was stopped in 1999.[13] Frequently, states in a compact have trouble reaching an agreement about where to locate the disposal site. For example, Nebraska dropped out of the Central Compact (including Arkansas, Kansas, Louisiana and Oklahoma) after being designated as the "host state."[14] As a result, despite the compacts, many states still completely lack the facilities for disposing of their LLW. There were 122 temporary storage sites in 39 different states in February of 2008.[15]

Currently there are only three sites for disposing of low-level nuclear waste. The site in Clive, Utah receives a majority of the Class A waste. Until July of 2008 the site in Barnwell, South Carolina took in most of the country's Class B and Class C waste, but now they only take waste from the two other states in the Atlantic Compact—Connecticut and New Jersey. The last site, located in Richland, Washington takes in all three classes of LLW from two separate compacts—the Rocky Mountain Compact and the Northwest LLRW Compact. These compacts are comprised of 11 states located in the northwestern United States, including Hawaii and Alaska.[16]

Nuclear Waste in Vermont

Vermont is part of a compact with Texas, and a license for a disposal site in Texas is still in the process of being approved. Most radioactive waste produced in Vermont is generated by Vermont Yankee, the nuclear power plant in Vernon which is owned and operated by Entergy Nuclear, and a small amount comes from hospitals. Until July of 2008, LLW from Vermont Yankee was shipped to the Barnwell, SC disposal site, which has since been closed to all states outside of the Atlantic Compact. As a result, LLW is now being stored on-site at the plant. Vermont Yankee reports that they have a 10-year storage capacity for LLW, and anticipates that the proposed storage site in Texas will be approved within that time frame.[17] High-level waste from the Vermont Yankee plant is currently stored onsite in a cooling pool, which is nearing capacity. In the future, Entergy anticipates the opening of the Yucca Mountain storage site but

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[12] Southwestern Low-Level Radioactive Waste Commission. Retrieved 10 February 2009 from http://www.swllrwcc.org/.

[13] American Geological Institute, "Low-Level Waste Disposal Update," 4 October 2002. Retrieved 10 February 2009 from http://www.agiweb.org/gap/legis107/lowlevel_waste.html.

[14] Nancy Zacha, "Low-Level Radioactive Waste Disposal: Are We Having a Crisis Yet?" *Radwaste Solutions*, American Nuclear Society, May/June 2007, pp. 10-16, retrieved 11 February 2009 from http://www.ans.org/pubs/magazines/rs/docs/2007-5-6-4.pdf.

[15] Matthew Wald, "As Nuclear Waste Languishes, Expense to U.S. Rises," New York Times Online, 17 february 2008. Retrieved 10 February 2009 from http://www.nytimes.com/2008/02/17/us/17nuke.html?ei=5124&en=b6ca1a453a9698f6&ex=1360990800&adxnnl=1&partner=permalink&exprod=permalink&adxnnlx=1203445154-+r7NYc0YYRsAM/CdkKY1lA.

[16] See the United States Regulatory Commission and its report on low-level waste compacts http://www.nrc.gov/waste/llw-disposal/compacts.html.

[17] Susan Smallheer, "Vermont Yankee to store radioactive waste on-site," *The Rutland Herald Online*, 4 June 2008. Retrieved 26 January 2009 from http://www.timesargus.com/article/20080604/NEWS02/806040330/1003

is also prepared to construct dry fuel storage facilities if necessary.[18] Dry storage facilities are used only after waste has been stored in a cooling pool for at least one year, and they consist of steel containers, called casks, filled with inert gas. The casks are further shielded by concrete or steel to protect from radiation and stored in a concrete vault.[19] Dry storage facilities are above ground and used for temporary storage; they do not constitute disposal of nuclear waste.

Yucca Mountain and Transportation of Nuclear Waste

Yucca Mountain, in Nevada, has been identified by the federal government as the site for the construction of a deep geologic repository for HLW. There are numerous issues surrounding the proposed site at Yucca Mountain, the most important of which is that the federal government has failed thus far to obtain local consent and move forward with actually constructing the facility.

Transportation of nuclear waste is also of great concern because of the vulnerability of the radioactive material and the increased chance of accidents during transportation. Trains are essential to the current plan for safe transportation of waste to the Yucca Mountain site, because they have a greater capacity for each trip and can avoid main roads. Trucks would have to pass through metropolitan Las Vegas to reach Yucca Mountain. There is, however, no rail access to Yucca Mountain yet.[20] In the past some states have been greatly opposed to railcars carrying nuclear waste passing through their state. In the 1980's Idaho's State Police actually blocked a rail shipment of low-level nuclear waste from entering the state. The Department of Transportation and the Nuclear Regulatory Commission have arranged procedures for the safe transportation of nuclear waste, including police protection, mapped routes, and durable casks to contain the waste.[21]

Recycling Nuclear Waste

Current U.S. policy favors disposing of HLW rather than recycling, or reprocessing, it, because producing new fuel is cheaper than recycling used fuel rods.[22] Many other countries, however, reprocess their spent nuclear fuel to extract additional plutonium and uranium that can be used to generate more power in the future. Currently the recycling process is much more expensive than newly produced fuel, but it significantly cuts down on the amount of radioactive waste that must be disposed of. Additionally, recycling can be used to extract and reuse elements with particularly long half-lives from waste, so that the storage period will ultimately be much

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[18] Vermont Yankee "Frequently Asked Questions," retrieved 3 February 2009 from http://www.safecleanreliable.com/faq.htm#q7.
[19] US NRC, retrieved 5 February 2009 from http://www.nrc.gov/waste/spent-fuel-storage/dry-cask-storage.html.
[20] Bob Halstead, "Yucca Mountain Rail Transportation Environmental Issues," 10 November 2008. Retrieved 10 February 2009 from http://www.state.nv.us/nucwaste/news2008/pdf/atlp081110halstead.pdf.
[21] Tom Hallenbeck, "Briefing on Low-level Radioactive Waste Transportation through California," 14 January 2000. Retrieved 10 February 2009 from http://www.energy.ca.gov/nuclear/yucca/documents/AG-155-2007-002998.pdf .
[22] Linda Sikkema & Melissa Savage, "Nuclear Renaissance?" *State Legislatures Magazine,* March 2007. Retrieved 3 February 2009 from http://www.ncsl.org/magazine/articles/2007/07SLMar07_Nuclear.htm.

shorter.[23] Research is also being conducted in several countries to improve the efficiency and efficacy of reprocessing technologies. The United States abandoned efforts to reprocess nuclear fuel under President Carter due to fear that recycling would result in proliferation of materials for nuclear weapons.[24]

State Policies Restricting the Expansion of Nuclear Power

In the wake of the partial meltdown at the Three Mile Island nuclear power plant in Pennsylvania in 1979, many states passed laws limiting the construction of new nuclear power facilities. In fact, no new nuclear plants have been built in the United States since 1979. To date, twenty different states have created nuclear moratoriums or statutes banning the building of new nuclear power sites.

States have created these policies in a variety of different ways. For example, California, Illinois, Kentucky, and Connecticut require that the federal government has means, or has approved the means to dispose of high-level nuclear waste. Both Maine and Massachusetts require that a HLW facility already exists before they lift their moratorium. Other states, such as West Virginia, are even more specific and state that the HLW disposal site must have been successfully operated for 2 years. Both Montana and New Jersey aim for the standard that disposal of nuclear waste will be not a threat to human life. In California the process for building a nuclear power plant requires the California Utilities Commission to bring a report to the California legislature regarding nuclear waste disposal technology. The legislature is then given 100 days to act upon the report; if the legislature does not approach a decision within that time period, the Commission may move forward with construction. [25]

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[23] J. Lake, R. Bennet, and J. Kotek, "Next Generation Nuclear Power." *Scientific American Online,* 26 January 2009. Retrieved 4 February 2009 from http://www.sciam.com/article.cfm?id=next-generation-nuclear.
[24] A. Andrews, "Nuclear Fuel Reprocessing: U.S. Policy Development." CRS Report for Congress, 27 March 2008.
[25] David Lovell, "Memo to the member of the Special Committee on Nuclear Power, RE: State Laws Limiting the Construction of Nuclear Power Plants," 29 November 2006. Retrieved 10 February 2009 from http://www.legis.state.wi.us/lc/committees/study/2006/npowr/files/memo2_npowr.pdf

About the sources:

The Office of Civilian Radioactive Waste Management:
"OCRWM's purpose is to safely manage and dispose of America's spent nuclear fuel and high-level radioactive waste. The Office of Civilian Radioactive Waste Management was established in 1982 under the Nuclear Waste Policy Act. OCRWM Acting Program Director Christopher Kouts reports to the Secretary of Energy." from http://www.ocrwm.doe.gov/about/index.shtml

The American Nuclear Society:
"The American Nuclear Society is a not-for-profit, international, scientific and educational organization. It was established by a group of individuals who recognized the need to unify the professional activities within the diverse fields of nuclear science and technology. December 11, 1954, marks the Society's historic beginning at the National Academy of Sciences in Washington, D.C. ANS has since developed a multifarious membership composed of approximately 11,000 engineers, scientists, administrators, and educators representing 1,600 plus corporations, educational institutions, and government agencies. It is governed by four officers and a board of directors elected by the membership." from http://www.ans.org/about/

The World Nuclear Association:
"The World Nuclear Association is the global private-sector organization that seeks to promote the peaceful worldwide use of nuclear power as a sustainable energy resource for the coming centuries. Specifically, the WNA is concerned with nuclear power generation and all aspects of the nuclear fuel cycle, including mining, conversion, enrichment, fuel fabrication, plant manufacture, transport, and the safe disposition of spent fuel" from http://www.world-nuclear.org/about/objectives.html.