Radioactive Waste Disposal: A Policy Change on the Horizon

Waste disposal done the French way

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Executive Summary

Nuclear power provides sustainable electricity for the U.S. with many benefits. These benefits, however, come with weighty political baggage, the most prominent of which is the disposal of high-level radioactive waste and spent nuclear fuel. The legislation that currently governs waste disposal in the U.S. names one site as the legal location for a geological repository: Yucca Mountain. A great deal of controversy surrounds the location as a potential site. The Nuclear Regulatory Commission (NRC) completed the safety review of the license application for the site and ruled it as safe for a repository. Despite this conclusion, the NRC has not yet approved or denied the license application identifying Yucca Mountain as a repository, suspending the nuclear waste disposal situation in limbo.

The Nuclear Waste Policy Act, as amended in 1987, bans monitored retrievable storage and limits centralized interim storage capacity until a license has been issued for a geological repository. As a result, the U.S. currently stores spent nuclear fuel on reactor sites in spent fuel pools and dry casks. While this is a safe management strategy, it is not a permanent solution. Consolidated interim storage sites are needed to house spent nuclear fuel until a repository is developed. Given the current situation, the U.S. government is vulnerable to litigation involving the deadline set by the Nuclear Waste Policy Act of 1982 because the act has been cited in all contracts with nuclear power utilities. Since that deadline through 2012, the U.S. government paid over $2 billion in damages to utilities as a result of not being able to take title of the waste. To remove itself from this potential liability, the government should take title to the spent fuel either by taking it to consolidated interim storage or disposing of it in a permanent repository.

The U.S. government needs to pass new legislation that governs the management of spent nuclear fuel in addition to amending the current laws, which restrict progress on waste storage and disposal. To guide this path forward, the U.S. should look to other nations with successful radioactive waste disposal programs, such as France. France’s nuclear power industry produces about 80% of the nation’s electricity. French high-level waste management strategies are governed by two laws. These laws created a framework for several organizations to coordinate and oversee the research and implementation of geological repositories for waste disposal. These organizations conduct a consent-based search for sites to study and install underground laboratories. Local councils are established at the research sites to include community representatives in progress and obtain informed consent from local residents. Currently, the French waste management organization, Agence Nationale pour la gestion des Déchets Radioactifs (ANDRA), is preparing to submit an application for a license to construct the repository at Bure.

While distinct differences exist between the French government, the U.S. government, and their respective industry practices, France’s successes in finding a consenting host site may be applicable to the U.S. The national plan in France works to anticipate future waste disposal needs and reduce the burden on future generations. Regardless of Yucca Mountain, new legislation in the U.S. is needed to deal with the short-term management of radioactive waste and to establish a consent-based system for long-term management.
Foreword

About the Author
Suzanna Hinkle is a rising senior at the University of Pittsburgh. She is pursuing a B.S. in Chemical Engineering and a certificate in Nuclear Engineering in the Stephen R. Tritch Program. Suzanna serves as the president of the American Nuclear Society student chapter and the president of the Campus Women’s Organization at Pitt. Additionally, she is a member of the Allocations Committee of the Student Government Association, a committee that deliberates over distribution of the student activities funds to student organizations on campus. Suzanna was selected by the American Nuclear Society to participate in the WISE summer 2015 program.

About WISE
The Washington Internships for Students of Engineering (WISE) program was founded in 1980 through the collaborative efforts of several professional engineering societies to encourage engineering students to contribute to issues at the intersection of science, technology, and public policy. The nine-week program allows students to spend the summer in Washington, D.C. to gain exposure to the legislative and regulatory policy-making process through meetings with leaders in the Administration, federal agencies, Congress, and advocacy groups. In addition, each student is responsible for independently researching, writing, and presenting a paper on a topical engineering-related public policy issue that is important to the sponsoring society. For more information about the WISE program, visit www.wise-intern.org.

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Introduction

Nuclear Energy and Waste

Nuclear power is a valuable energy resource in the U.S. as it generates 19% of the nation’s electricity.\(^1\) It is also a major source of clean energy because power plants have near-zero carbon dioxide (CO\(_2\)) emissions. Nuclear power provides a consistent base load of electricity needed throughout the day while other sources are mostly used at times of peak demand or intermittent by nature, like many renewable sources of energy.

The nuclear industry in the U.S. is very complex because of the nature of the energy generation and the political atmosphere in the states. Despite the nuclear power industry’s excellent safety record, nuclear power is often perceived as dangerous and threatening to the well-being of our communities.\(^2\) Due to this perception, and in addition to many other negative connotations with nuclear power, the industry is highly regulated; the government is more involved in nuclear power than in any other industry in the U.S.\(^3\) This high level of regulation has created a great deal of political tension with the issue of the disposal of spent nuclear fuel (SNF), the fuel that has been permanently removed from a nuclear reactor, fueling constituents’ negative opinion on storing nuclear waste. The U.S. has yet to develop a long-term solution for SNF disposal. SNF is currently stored in spent fuel pools and dry cask storage at reactor sites, where it will remain until consolidated interim storage is developed or until a permanent waste disposal facility is sited, designed, licensed, built, and operating.

SNF is a uniquely complex issue because the fuel does not immediately cool down after the reactor is ‘turned off’ and continues to produce heat and release radioactivity after it is removed from the reactor. The waste must be isolated in order to protect public health and safety because of the harmful effects of radioactivity.

Evidence suggests that dry cask storage is viable for more than 100 years, a relatively short period of time considering the tens of thousands of years it takes for radioactivity to diminish to safe levels. Because of that, spent fuel pools on reactor sites are a useful means of interim storage in the short-term as long as space is not an issue, and the Nuclear Regulatory Commission (NRC) has certified dry cask storage for up to a minimum of 60 years.\(^4\) These options extend the time available to find a permanent storage option for spent nuclear fuel, a pressing issue in the nuclear industry. That said, if the U.S. is unable to find a safe disposal site for SNF, the nuclear industry may face an eventual end due to unsustainable disposal practices.

The Nuclear Waste Policy Act (NWPA) of 1982 was the first piece of legislation in the U.S. on high-level waste (HLW) and SNF disposal. The act authorized the Department of Energy (DOE) to study several potential sites and suggest three sites for selection as a geological repository, a site for deep underground disposal of HLW and SNF. The Nuclear Waste Policy Amendments Act

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(NWPAA) was enacted in 1987 and named Yucca Mountain (YM) to be the sole site for characterization as a potential repository site. Since then, the YM project has not resulted in a geological repository and there is no long-term solution for nuclear waste. The current situation demands legislative action to facilitate finding a new solution as spent nuclear fuel continues to be produced and requires long-term storage.

The breadth of this situation affects many different contingents, including nuclear power utilities, federal government agencies, Congress, and U.S. citizens. The nuclear power utility companies must handle the increasing buildup of SNF while the issues of long-term storage and disposal are handled on a policy level and while any solutions are implemented. The companies are currently facing the need to create more space at reactor sites for storage and, all the while, bear the burden of the cost of storage of SNF.

The federal government agencies directly involved with nuclear waste management are the NRC, the DOE, the Environmental Protection Agency (EPA), the Department of Transportation (DOT), and the Nuclear Waste Technical Review Board (NWTRB). It is the NRC’s responsibility to license facilities for waste disposal and storage, while the DOE develops these facilities. The NWTRB supervises and evaluates the validity of the DOE’s research and development, the EPA establishes facility safety standards, and the DOT must develop routes and methods of transportation for the waste to arrive at disposal and storage facilities. In order to manage the current SNF waste levels, these organizations should seek additional temporary solutions for SNF storage until a permanent solution is reached. They also should coordinate the development of a long-term repository.

Congressional representatives, in the meantime, should worry about the current waste situation on a legislative level. Congress has been unable to reach solutions on SNF disposal because of the political issues surrounding YM and each political party’s unwillingness to compromise in order to find a viable solution for long-term disposal. In order to facilitate a resolution to the current problem, Congressional representatives need to find a legislative solution.

Finally, U.S. citizens are affected. These are the constituents represented by members of Congress when it creates the much needed legislation on developing a repository. The citizens of the U.S. have the right to voice their opinions on nuclear waste disposal and one very clear opinion has thus far emerged from the general population: A SNF repository is fine but “not in my back yard” (NIMBY). In spite of the NRC’s extensive safeguard requirements, many U.S. citizens are concerned with their safety if radioactive waste is disposed of in close proximity to populations, especially if disaster should strike or accidents occur. These fears pose an extreme social challenge when searching for a site to house the solution to SNF disposal.

With the various contingents working on the current U.S. conversation regarding long-term storage of SNF, the U.S. should look to other countries who have successfully implemented waste disposal programs, such as France.

A Study of Alternate Waste Management Practices
France provides a case where policy has fostered a successful system for HLW disposal. In France, nuclear power provides nearly 80% of the electricity generated. L’Agence Nationale pour la gestion des Déchets Radioactifs (ANDRA) [the National Agency for the Management of
Radioactive Waste] is an agency that was given its independence of its parent agency by France’s 1991 Waste Management Act. ANDRA is responsible for properly disposing of all radioactive waste generated in France. The law provides ANDRA with a framework for developing permanent disposal facilities in addition to imposing guidelines for these facilities.

France reprocesses its SNF and has done so since 1958 in order to recover viable uranium and plutonium for re-use in mixed-oxide (MOX) fuel and to reduce the volume of HLW for disposal. The reprocessed waste is separated into three categories; each category requires a separate radioactive waste disposal facility. SNF differs from HLW because it is the entire fuel assembly whereas HLW is the highly radioactive fission products and transuranic actinides created as a result of nuclear reactions in the reactor core. In France, HLW is encased in glass which provides the first barrier of containment. Currently, there is a laboratory conducting studies on the geology of Bure, located in the northeast of France, in support of a HLW repository in that area.

The legislation that created this system is meant to enable future generations to change storage and disposal strategies if necessary. The majority of the legislation governing nuclear power in France was written within 20 years of the French commitment to energy independence after the 1973 oil crisis. This strategy fostered industry growth, turning it into an electricity exporter with an annual revenue of $3.3 billion (€3 billion). Additionally the strategy benefits the nation’s waste disposal practices, evident in the pending repository and the welcoming community response.

The purpose of this paper is to examine if an approach similar to the HLW disposal policy in France might work in the U.S. The intent of this discussion is to take into account the differences in governments, economies, nuclear power industries, and industry practices while looking for lessons to be learned.

**Background**

**The Technical Side**

In order to make an informed decision there are several concepts and practices that must be explained before a comprehensive policy reform can be discussed.

There are several waste disposal options for HLW and SNF, which depend on the reprocessing practices of that nation. If spent fuel is not reprocessed, direct disposal is the only option; however this results in a higher volume of waste to be disposed of in a repository. Direct disposal entails placing the used fuel in a designated repository. These are typically deep underground in isolated locations. This method’s simple approach has economic benefits because additional money is not necessary for the cost of reprocessing, further transport of SNF, and different disposal methods.

If spent fuel is reprocessed, there are more options available. For example, plutonium and uranium can be extracted and recycled for use in MOX fuel. This allows for more protective measures to be used for the HLW as needed since it accounts for approximately 3% of SNF. HLW is encased in glass to contain and shield the radioactive material and is buried in a protected repository. It should be noted that reprocessing SNF dramatically increases the volume of low-level waste.

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(LLW) produced by the nuclear power industry but decreases the volume of HLW to be disposed. This approach has the benefit of reducing the volume of the long-lived HLW and provides another fuel source because of the use of remaining uranium and plutonium in MOX fuel, which extracts significantly more energy than a once-through fuel cycle.  

The U.S. does not practice reprocessing for many reasons. A major product of reprocessing is the extraction of plutonium, which has raised fears of proliferation in the past. While there are methods that do not extract pure plutonium, these have never been practiced on an industrial scale. Economics also restrict reprocessing because studies have shown that reprocessing SNF is more expensive than direct disposal given the stability of the market value of mined uranium. Across the U.S. industry, there are several independent initiatives to start reprocessing SNF for a variety of reasons. These initiatives argue the benefits of reprocessing such as extracting more energy from uranium and reduction of HLW volume for disposal. While there are benefits associated with reprocessing, the U.S. has often maintained a position against the practice for a variety of reasons. A large case against reprocessing SNF is economics. Considering the comparatively low costs of mined uranium and the stability of its market value, it is not economical to reprocess SNF especially with a lack of pre-existing infrastructure. While three reprocessing plants were previously built in the U.S., they are no longer active facilities and only one actually operated. The costs of reviving them would be $5 to $7 billion while building new facilities would be on the order of $20 billion.

Regardless of reprocessing practices, the disposal of HLW is not excessively different from SNF disposal. While HLW may require less space in a repository, it may require additional spacing to avoid overheating of these wastes and result in a similar volume needed in a repository. The heat generation of HLW, however, can be controlled by volume of HLW placed in glass logs and how many logs are placed in canisters; this allows more control in heat generation for disposal practices. Regardless, the legislative framework to enable this scientific research and implementation would not differ.

Thus in the context of this document, there is not a significant difference between a HLW repository and a SNF repository. Additionally, the U.S. must develop a repository for defense wastes (HLW) which were originally planned for disposal in the same repository as SNF. The DOE has stated that the same process for siting a SNF repository will be used for a defense waste repository.

The Legislative Side
The development of policies governing the nuclear industry is crucial to understanding the current situation. The government has always been heavily involved in the U.S. nuclear power industry by funding research and development, regulating the industry, encouraging civilian development, and most importantly, writing legislation to set standards and protocols. The process for creating

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a long-term radioactive waste disposal facility was established by the NWPA. It was then streamlined by the NWPAA, which named YM as the sole site to be characterized as a repository.

The original act outlined a framework for the development of a geological repository. Five sites were to be studied by the DOE; after the investigation of these sites, three were to be recommended by January 1, 1985. It also included a deadline for the DOE to begin the disposal of SNF and HLW, which was January 31, 1998. This deadline was included in all contracts with nuclear utilities.

The Office of Civilian Radioactive Waste Management (OCRWM) was created within the DOE to implement the program, as well as develop centralized interim storage, monitored retrievable storage (MRS), and dry cask storage at reactor sites. These provisions acknowledged that additional storage space would be needed while the repository was being developed.

The NWPAA was enacted in 1987, which named YM as the only site to be characterized and officially terminated the second repository program. These amendments prohibited construction of a MRS facility until the NRC authorized construction of a repository. The NWTRB was established by these amendments to evaluate the technical and scientific validity of the DOE’s work on disposing nuclear waste. These amendments were intended to focus resources on the development of a repository and accelerate the process but the 1998 deadline passed without an operational repository. There were no successful efforts to change the deadline and no successful efforts to change the system of development.

In 2002, the Yucca Mountain Development Resolution was passed which confirmed YM as the location for a repository. Nevada exercised its power to veto the site selection but Congress overrode the veto and continued to the next step of licensing YM as a repository. When Congress moved forward without the consent of the host community, resistance intensified. The state of Nevada has put up a strong resistance on this issue and has not backed off.

By 2008, the DOE completed and submitted the YM license application to the NRC. In 2010, the OCRWM was disbanded by the Obama Administration, its functions were transferred to the DOE Office of Nuclear Energy, and the DOE was told to withdraw the application. The NRC proceeded with the application review based on a court ruling that the DOE did not have that authority. As of 2015, the review has been completed and the NRC has stated the site is safe to serve as a repository, however, a license has yet to be issued or denied. For a more in-depth discussion of the YM project and how it developed, refer to Appendix A.1 on page 24.

In 2010, the Secretary of Energy formed the Blue Ribbon Commission on America’s Nuclear Future (BRC). The BRC was tasked with conducting an intensive review of the policies governing the back end of the nuclear fuel cycle and recommending a new strategy. The Commission was

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to avoid acting as a siting body, thus all recommendations are in the spirit of reforming a failed system. The BRC conducted this review for about two years and developed eight recommendations to better handle the back end of the fuel cycle with new legislation. Some of these recommendations are reflected in current legislation moving through the House and Senate, however, no legislation with these recommendations has been enacted.

Dry cask storage at reactor sites was established out of necessity to avoid overfilling spent fuel pools at reactor sites because there are no facilities to accept SNF. This method of storage has been incredibly successful with almost no incidents of radioactive release. However, according to Dr. Peter Lyons, former DOE Assistant Secretary for Nuclear Energy, there is not a thorough understanding of how SNF behaves in a dry cask over long periods; it is currently being studied by DOE-funded projects. The DOE plans to encourage this method of interim storage due to the slim chances of having an operating repository in the next 20 to 30 years.

Dry cask storage is not a perfect solution to the lack of repository. A significant issue with dry cask storage is that some casks in use are not licensed for transport, which could restrict the transport of SNF to consolidated interim storage if such facilities existed. This continues to be an additional financial burden that falls upon the utility companies. These companies paid fees to the Nuclear Waste Fund, which funds the creation of a repository; these fees have since been suspended. The DOE has been subject to more than 70 lawsuits for not meeting the 1998 deadline for operation of a repository, coming to a total of approximately $2 billion in damages. As long as the SNF remains uncollected by the DOE, the U.S. government is at risk for litigation unless the NWPA is amended.

Clearly, the intended system is not working and requires a change.

The French System

The French nuclear industry has a high level of success in their radioactive waste disposal program. France’s system for creating a repository has been extremely successful thus far, however, it has yet to produce an operating HLW facility. The long-term repository is scheduled to be operational in 2025. This success stems from its laws, which formed organizations that are creating and implementing disposal methods for HLW and created a framework for these organizations to work together.

After the 1973 oil crisis, French President Messmer issued a decree which created a large nuclear power program that would liberate the nation from its dependency on oil. In the following 15 years, 56 reactors were built and brought online. The Messmer plan ambitiously envisioned 170 total reactors in the nation by the year 2000. Today, 58 reactors operate to generate approximately 80% of the electricity used in France while the remaining energy is sold to neighboring countries which generates approximately $3.3 billion (€3 billion) of revenue annually. This industry is a great source of national pride for the French government and its citizens.

14 Cummings, Kristopher. Personal interview. 8 July 2015.
15 Lyons, Dr. Peter. Personal interview. 18 June 2015.
There are aspects of the nuclear power industry that distinguish France from the U.S. industry. For instance, the two largest companies that contribute to nuclear power are majorly government owned. The dominant electric utility company is Électricité de France (EDF), of which 85% of the shares are in government hands.\(^\text{17}\) Areva, a major vendor in France for nuclear reactors, is approximately 90% government owned.\(^\text{17}\) While the U.S. government is heavily involved in the nuclear power industry via regulation, R&D funding and national energy standards, most of the utilities are publicly owned companies and nearly all of the businesses involved in the U.S. nuclear industry are non-governmental as well. However, both nations have their respective governments involved in waste disposal and have extensive legislation on the development of HLW and SNF disposal in underground repositories.

Another difference between the two industries is how they are run. France has an industry that is standardized across the nation. While the U.S. has standards that all utility companies must follow in their practices, it is regulated in a regional approach. The U.S. nuclear fleet is divided into four regions, each of which have their own regional offices and is headed by a single NRC Commissioner. The NRC regulates all reactors in the U.S. but this trickles down the hierarchy in a regional manner. In France, all reactors are regulated by l’Autorité de Sûreté Nucléaire [Nuclear Safety Authority] (ASN). Considering the 58 reactors that require regulation and the size of France in comparison to the U.S., a national approach is used because it is more efficient.

The legislation on radioactive waste reflects three principles: sustainable management with regard to health, safety, and environment; averting the burden borne by future generations; and the responsibility for radioactive waste is assigned to its producers.\(^\text{7}\) These laws will be discussed to examine the elements of their success. While legislation in France is named for the date it is enacted, they will be referred to using the year and what they govern in this document for the sake of clarity.

The 1991 Waste Management Act established a protocol for storage and disposal of radioactive waste and set the direction for research regarding HLW disposal. Several organizations coordinate the development of disposal, including:

- Comité Local d'Information et de Suivi du Laboratoire souterrain de recherché sur la gestion des déchets radioactifs de Bure [Local Information Committee and Underground Laboratory Monitoring on the management of radioactive waste in Bure] (CLIS)
- ANDRA.

This act made ANDRA an independent entity to serve as a waste management organization; it was originally formed in 1979 within the Commissariat à l'Énergie Atomique et aux Énergies Alternatives [Office of Atomic Energy and Alternative Energies] (CEA), a government-funded research organization. The American analog of CEA is the DOE while the analog of ANDRA would be the OCRWM.

The 1991 Waste Management Act assigned ANDRA several responsibilities, the most relevant of which include locating a repository site, studying the site as necessary, and designing, installing,

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and managing disposal facilities for radioactive materials and waste. As required by the Act, ANDRA reports to Parliament and CNE; the operating budget derives from a tax on the utility companies.

It is relevant to note that France reprocesses its SNF and has done so since 1958. The 1991 Waste Management Act was crafted under the assumption that the practice of reprocessing would continue throughout the lifespan of the nuclear power industry and indeed it has endured. This practice affects the design of disposal of HLW. Instead of disposing of entire fuel assemblies, the volume of waste to be disposed is approximately 3% of SNF.

CNE was created to assess research and development concerning deep geological disposal of nuclear wastes. It is not a formal regulator as it cannot issue licenses and it is not an implementation organization as it only reviews research. Its role is to assess the research as an outside organization and to peer review the research conducted because there is no standard against which research can be compared. CNE has been essential to monitoring the progress of R&D regarding HLW management. Its analog in the U.S. is the NWTRB.

CNE publishes an annual report on French and international research in these areas. These reports explore reversible disposal in deep geological formations and long-term surface storage of the waste, as well as other related topics. The reports are based on meetings conducted with each organization that is carrying out research on radioactive waste management, both in France and abroad. CNE determines if the French research is consistent with goals set by the 1991 Waste Management Act and 2006 Planning Act and reports to Parliament as an independent entity.

The mission of the CLIS, the local monitoring council of the Bure laboratory, is to obtain as much information as possible in the field of storage, obtain as much data for references in the future, communicate this information to the public, and ensure that there is proper consultation and debate regarding the laboratory at Bure. The members of CLIS include representatives of the regions of Lorraine and Champagne-Ardenne, representatives of the departments (equivalent to a county in the U.S.) of Haute-Marne and Meuse, and technical experts. CLIS works closely with ANDRA and CNE.

In addition to defining the responsibilities of these organizations, the 1991 Waste Management Act outlined standards that waste disposal must meet. The first is recoverability, defined as the ability to extract any waste package from storage. This stipulation ensures safety in case of a material breach of boundary. The second standard is flexibility, defined as consideration of technical and scientific advances as well as storage adaptation to the changing nature of waste. These criteria must be met for a minimum of 100 years.

ANDRA located several departments in France that had suitable geology to pursue as possible areas to host a laboratory to conduct studies in support of a repository. The pre-existing general councils in these departments voted on the nomination of their departments for a laboratory site, and four sites accepted this nomination. In 1994, three sites were selected for study and such characterization was carried out through 1997. After characterization, each of these sites were

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19 Law no 06-590 15 June 2006.
20 Law no 91-1381 30 December 1991.
surveyed for public opinion of hosting an underground laboratory and all had a positive response to the survey.

In 1999, a decree authorized ANDRA to establish an underground laboratory in Bure; the other sites were deemed less favorable due to geology.21 Shortly after, CLIS was established. Scientific and technological tests were carried out to demonstrate feasibility of deep disposal, continuing through 2005.22 Once construction of the laboratory was completed, additional demonstrations of feasibility and research activities were carried out according to the schedule laid out by the 1991 Waste Management Act.

The 2006 Planning Act reevaluated the state of research on waste management and reaffirmed the research occurring at the Bure laboratory. During the same year, the 2006 Transparency and Nuclear Safety Law was enacted, which mandated transparency for the national nuclear industry. This law created ASN, a regulatory body that evaluates the safety of all nuclear matters and publishes reports on the status of all aspects of the industry.22 All organizations involved in waste disposal now report to ASN in addition to the hierarchy established by the 1991 act.

The 2006 Planning Act established a schedule beyond 2006 for the repository development to follow. From 2006 to 2009, technical development brought proposals for zoning the repository and implementation scenarios. The zoning proposals were studied and approved by the government in 2012, followed by a public debate and selection of implementation strategy.22 In 2017, ANDRA plans to submit the application for the repository license to ASN. Construction will begin in 2020 provided that the license is granted and operation should begin in 2025.22 France has met all of the deadlines that have been set in its governing policies for radioactive waste management. For a more in depth discussion of the activities in France that have led to the confirmation of Bure as a repository, see Appendix A.2 on page 25.

Key Conflicts and Concerns

Resistance to Resolution in the U.S.
There has been a great deal of disagreement in the U.S. over the solution to SNF and HLW disposal. The obstacles faced in the process of establishing a repository are time, political, economic, site selection, and licensing.

While the NWPA established a plan to produce a solution and set a deadline for that solution, it became very clear that a repository would not be developed in time to meet the deadline. The deadlines created by the NWPA included provisions to ensure that serious consequences would follow a missed deadline instead of provisions to reassess and adjust the national policy if a deadline could not reasonably be met. After the NWPAA, there was a great deal of resentment and opposition from the residents and Congressional representatives of Nevada because the state’s government is staunchly against hosting a repository.13 This also resulted in a serious lack of trust of the DOE and Congress to handle SNF disposal.

Economics is a strong deterrent to making progress on a repository. This was a large factor in the impetus to select one site instead of continuing to study the three sites selected in 1984 by the DOE. This played a large role in the enactment of the NWPAA, which limited the sites to YM. Since then, approximately $15 billion have been poured into the characterization of YM.\textsuperscript{23} Much of this money is perceived as “wasted dollars” because of the suspension of the YM project. Error! Reference source not found. Whether YM will become a repository or not remains a mystery, however, the scientific work done in the characterization of the site will be useful in the development of alternative sites, as a second repository will certainly be required for separate disposal of defense wastes.

Time is another obstacle faced in the process of developing a repository and has a significant impact on the legislation regarding waste disposal. When site characterization was failing to meet the deadlines set in the NWPA, it was an indicator that the other deadlines set would be near impossible to meet. This was another factor in the creation of the NWPAA, which attempted to streamline the selection process. Unfortunately, it has taken more than 30 years to develop a repository only to result in the suspension of the only legal option.

There are two initiatives currently present in Congress. The first wants to abandon the YM project and invest U.S. capital in a project that has the consent of the host community. The second initiative pushes to continue completion of the YM project against the consent of the community in order to have an immediate solution.

A significant issue that the first initiative acknowledges is the acceptance of the American people and finding a willing host community. It can be difficult to find host communities that want to house a repository. The French experienced this before enacting the 1991 Waste Management Act in order to have government backing in the search for a host. The NIMBY stance has been very popular with the American people. While much of the American public benefits from electricity generated by nuclear power, it seems that many have safety concerns about living near radioactive waste.

A major facet of the debate surrounding YM is that Nevada largely does not benefit from nuclear power. There are no nuclear power plants in the state of Nevada; nuclear power is concentrated primarily on the eastern coast and in the mid-west of the U.S., while there are comparatively few nuclear power plants in the west. The U.S. is at a stalemate and neither side is willing to compromise. Indeed it is difficult to reach a solution where both sides will be satisfied, though there is not a lack of effort in this area.

\textsuperscript{23} Ostendorff, William. Personal interview. 19 June 2015.
The second initiative acknowledges the need for a repository in the near future and the consequences of failing to develop such a facility. The costs of storing SNF on reactor sites in dry cask storage is accumulating at the expense of utilities. The government remains a risk for litigation at the expense of the taxpayers while there are no temporary or permanent facilities for SNF.

From 2010 to 2012, the BRC searched for solutions to this impasse. It conducted a nearly two-year review of policies managing the back end of the nuclear fuel cycle in order to recommend a new strategy. The Commission met with experts, stakeholders, organizations, and interest groups to develop a final report with recommendations on a new strategy. The most pertinent suggestions from the final report are using a consent-based siting approach, creating an organization to implement a waste disposal program, and prompt development of geological disposal facilities and consolidated interim storage facilities. While the report was released in 2012, no new legislation reflecting these recommendations has been enacted.

In a surprising turn of events, in 2015 two communities have volunteered to host a consolidated interim storage facility and have sent letters of intent to the NRC for consideration.\(^{24,25}\) This provides options for the management of SNF while a repository is developed. A major obstruction to the development of consolidated interim storage is the NWPAA. It has effectively stopped any action to create a MRS facility because it cannot be constructed before there is a license to construct a repository according to the NWPAA and the limitations imposed on consolidated interim storage are far too restrictive to act significantly as a short-term solution.

Additionally, the NWPAA dictates YM is the only legal site for a geological repository. If YM is not pursued to completion, the law will need to be changed so that an alternate repository may legally be developed. Legislation will be required to amend or repeal the law. It is likely that amending the NWPA will be the best option so that the initial framework does not need to be completely recreated.

\(^{24}\) “Valhi’s WCS Subsidiary to Apply for License to Store Used Nuclear Fuel.” Waste Control Specialists, LLC. 7 Feb. 2015.
The science of developing a repository is not a key concern for this issue. According to Dr. Everett Redmond of the Nuclear Energy Institute (NEI), a variety of geologies can be engineered to be a suitable deep-geological repository and the U.S. has many eligible geologies. This is evident in the variety of geologies that will host repositories in Europe. France’s repository will be in shale, Finland is using granite, and Switzerland is researching the use of claystone. Technical solutions should not restrict the progress of achieving policy solutions.

A major facet of the French system was the use of local councils in communities studied as possible hosts for a laboratory conducting studies in support of a repository. This unique implementation of consent-based siting has included the community in all progress made. Before major decisions, public debates mandated by law take place in order to promote a general understanding of the impact that decision has on the nation and the local communities. If general public opinion concerning hosting a research facility or a repository in a location was negative, the government did not pursue those locations. A single person, however, cannot block the development of a laboratory or a repository. This approach alternates between using science and public consent to select a repository site, which is likely to result in less community resistance.

The U.S. could benefit from this strategy because it would ensure that many perspectives are heard while also guaranteeing that communities would understand their impact. In the U.S., a great deal of misinformation is spread about nuclear power by organizations that oppose nuclear and how waste affects surrounding areas. Providing free education to the public before major decisions are made can prevent community rejection. Additionally it allows the community to learn about the benefits a consolidated interim storage facility, laboratory, or geological repository bring to surrounding areas, such as economic stimulation and growth. If community and state resistance disappears, then Congressional representatives have no reason to continue to resist progress.

If new legislation is enacted, political resistance should be mitigated to a degree. Every party can agree on several concepts that are reflected in the French laws. An independent waste organization and consent-based siting are the highest priorities of politicians as illustrated by the proposed legislations today like the Nuclear Waste Administration Act (NWAA) and the Nuclear Waste Informed Consent Act (NWICA), both of which are bipartisan bills. The creation of a separate organization to handle waste management is the main goal of the NWAA. The focus of the NWICA is to create provisions for consent-based siting. Both of these concepts are part of the recommendations made by the BRC and are widely accepted, however, neither of these bills have enough traction to pass through Congress.

Obtaining informed consent as siting progresses has the potential to save a great deal of economic stress. A community’s early acceptance or rejection of a site’s nomination could prevent spending money on characterizing a site that may be rejected. This can allow for the project to be stopped if community education does not have an effect. An open dialogue between the entity nominating a site and the community of that site is crucial to public understanding and acceptance.

Another facet of the French system is the oversight organization which collects research on waste disposal methods and ensures that the research reflects the national goals set by the law. While a

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26 Redmond, Dr. Everett. Personal interview. 23 June 2015.
27 Capdevila, Jean-Marc. Personal interview. 29 July 2015.
similar organization exists in the U.S., there is little work for the NWTRB to complete because YM has been suspended. Once a repository project is in motion, the NWTRB will continue to evaluate the validity of the research in addition to the other aspects of waste disposal, such as consolidated interim storage and transport of waste. The NWTRB should follow the lead of CNE of assessing the progress of research with the national plan and deadlines set by legislation. This can avoid having deadlines pass without re-opening the conversation on nuclear waste.

Potential Disadvantages to a Legislative Change
If YM is pursued to completion, there will be an incredibly resentful local community in Nevada. Already there are problems from the YM host state that would hold up progress on a repository. As previously mentioned, the DOE does not have water rights to the YM site and the state is withholding these rights. The majority of residents of the state and its administration have firmly opposed the project despite support from Nye County – the actual host – and neighboring counties.

Another problem posed by the local and state resistance is the necessary ground transportation across the state in order to deliver the SNF to the site. Rail transportation has been stated to be the preferred method in order to transport waste across the country. This development is opposed because of the potential transportation of radioactive material through highly populated areas. Residents and county officials are dissatisfied with the lack of research on the transportation casks despite the DOE’s statement that these casks would be acceptable for travel. While more hazardous materials are transported in the U.S. with less attention, radioactive materials frequently have a spotlight on them because of the high-profile power plant accidents that have occurred in history despite the industry’s excellent safety record.

If YM is abandoned in favor of alternative sites due to a legislative change, more research money will be needed for site characterization. The variety of geologies creates a plethora of options for an appropriate site. The high number of potential repository sites can be perceived as a drawback because more sites will have to be studied. More research money will be needed to start fresh at a new site. An additional conflict is finding a willing host site. While select communities have volunteered for consideration as a site for a permanent repository, there has been considerable resistance from the American people regarding the storage and disposal of SNF which is not expected to disappear with a legislative resolution.

Policy Alternatives

The French Alternative
In general, the French policies on HLW and SNF management focus on maintaining integrity of public health, safety, and environment, much like the NRC’s mission statement. All of the policies emphasize the value of minimizing the burden of radioactive waste for future generations which has led to a definitive method of implementation in order to accomplish this. The attitude towards nuclear waste reflects the ideology of shared responsibility. Those who create the waste bear financial responsibility for its disposal and thus pay taxes that flow into select funds within ANDRA dedicated to research and/or implementation. While these philosophies may not differ

from those of the U.S. policies, the implementation is quite different considering the organizations created to carry out the management.

Policy in France dictates that several areas of waste treatment and disposal must be pursued with research and implementation. One of these areas is separation, which CEA was charged with the pursuit of studying. Additional areas are reversible disposal and storage, which ANDRA has been charged with managing. In addition to maintaining existing waste disposal and storage sites, ANDRA was charged with developing disposal solutions for HLW and defense wastes.

The 1991 Waste Management Act and 2006 Planning Act in France created a nationally-geared plan for the management of radioactive waste and materials. This plan creates assessments for existing modes of management in order to best store and dispose of waste. It also identifies foreseeable needs for storage and disposal to create a more informed landscape for future solutions. The plan in these policies states compulsory capacities and timeframes to create parameters to adhere to in the development of new modes. Finally, the plan is meant to create goals for waste that has no disposal method yet. With all of this information, the national plan organizes the implementation of research and studies by setting milestone dates.

The national plan also sets guidelines and timeframes for the industry and relevant organizations to follow in waste management. Several concepts are emphasized as stipulations to be met, such as reversibility and retrievability. Any radioactive waste disposal program must enable its retrieval for a period of time that must not be less than 100 years. This reflects safety principles in case there is a breach of boundary and trust in future generations to find alternative methods of waste disposal. Storage facilities must also be sufficiently robust to last a minimum of 100 years in order to facilitate waste disposal and to allow for time to construct additional facilities.

The policies also created an oversight organization to keep research activities on track for waste disposal and provide outside evaluation of the research conducted. The power given to this organization via policy allows it to compile French and international. An annual report is published that compiles a review of the French research and studies on similar issues abroad. This is also a factor in the transparency that France has mandated in the nuclear industry.

While France does not yet have an operational repository for HLW, the nation is well on its way to having one. The concepts that are emphasized in French waste policy reflect an alternate legislative strategy that the U.S. could benefit from. Progress on one waste project is not contingent upon another project regarding waste. The current policy in the U.S. restricts short-term solutions until a long-term repository is licensed for construction.

While the French are praised for meeting the deadlines set by its national plan, this also raises questions about their practices. How exhaustive is the research? How impartial are the results and conclusions? There is no evidence to suggest that the research and regulatory practices are not sound, however, these are valid questions to ask when the timelines of repository studies in the U.S. and in France diverge so distinctly.

Another aspect is the lack of separate facilities that serve the purpose of interim storage. This is not unique to France, but this is intentional because the national industry does not produce as much waste as the U.S. industry. The SNF is either stored on reactor sites in spent fuel pools or on sites
of reprocessing plants until it is reprocessed, thus these sites act informal interim storage facilities. It is also more economical to transport waste directly to a reprocessing plant rather than to a storage facility and then to a plant. There is currently a backlog of SNF that is stored at La Hague, France’s reprocessing plant, until it is reprocessed. La Hague’s average annual throughput is 1100 tonnes, which restricts how much waste can be produced. The HLW is stored at the reprocessing site in a separate facility until a repository is operational.

While France may not require an interim storage facility, the U.S. will require consolidated interim storage in order to remove governmental liability and to relieve utilities of the costs of storing excess SNF on reactor sites. Unless the law is changed to relieve the DOE of its responsibility to take title to nuclear waste, consolidated interim storage is an option that will remove this aspect of the DOE’s liability.

Criteria for Evaluation
The highest priority of nuclear power has always been safety. Without the strict safety regulations in the U.S., the safety record would be significantly worse. The government should continue to be involved in the development of a repository using performance-based regulation. Any geological repository must sufficiently contain and isolate radioactive materials from humans and the environment for a great deal of time. Legislation should specify criteria to ensure this safety but should refrain from specifying criteria such as an individual geology or sites to allow for flexibility of selection. The focus should be on the creation and robustness of the facility rather than a checklist of geological attributes. That is not to say that criteria for selection should not be specified. For example, geological stability is necessary for assurance of structural integrity of the facility.

Implementation for a geological repository is part of the criteria for evaluation. Many solutions to nuclear waste disposal have the potential to incorporate very unreasonable provisions. These can cause the implementation schedule to become unreasonably lengthy and inflate the cost of such a facility. While safety is a high priority, there are a variety of solutions with reasonable provisions to maintain the integrity of a geological repository. The time necessary for the creation of a solution can stretch so long that the amount of SNF that requires disposal can double, creating a need for an additional repository. The legislative plan for implementation must have a timeline that solves the disposal problem but should allow for deadline changes if unforeseeable circumstances arise.

Another criterion is the funding required to construct such a facility. A great deal of funding is needed for the characterization and construction of sites so the U.S. must be careful in spending the money of the Nuclear Waste Fund (NWF). A matter that deserves major consideration is whether or not the money being spent on a repository will result in a repository. Seeing as the YM project has been suspended and considering the political controversy surrounding the project, it is unlikely that YM will be completed and operational. Much of the research conducted to characterize YM will be helpful for future repository work. While the NWF contains

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approximately $36 billion it is not an infinite resource.\textsuperscript{30} Once a repository project has been established, the operator fees can once again be collected to sustain the fund.

The final criterion is licensing. While the EPA establishes performance criteria for the NRC to implement via licensing, the requirements must be evaluated to ensure safety. Robustness of the facility must meet a certain threshold for a period of time. The period of time should be on a large scale such as tens of thousands of years. New legislation needs to foster the development of a repository that follows this criterion.

**Policy Recommendations**

**Policy Revitalization**

Based on the lack of success in the U.S. in developing a long-term repository, I believe a new policy to change the structure of development can revitalize and provide a new direction for this process. I propose to create a system similar to that of France, where policy has provided a strong momentum for HLW disposal. New legislation to govern SNF disposal is needed to achieve a solution for disposal because the legal options have been limited by the law. My recommendations are elaborated below.

- **Amend the NWPA**

  The NWPA must be amended to make it possible to expand options for a repository and a new law must be enacted to create organizations that are equipped to better coordinate the development of a repository and consolidated interim storage facilities. These amendments should also remove restrictions on MRS and consolidated interim storage.

- **Create a waste management organization**

  A waste management organization is needed for the development and implementation of a SNF disposal facility. While this is not a novel concept as it was a major component of the BRC’s recommendations, a waste management organization has yet to be created for these purposes. This organization would be authorized to create geological repositories and interim storage facilities. Its responsibilities would include locating sites for characterization, characterizing the sites until suitable candidates are found, recommending sites for selection to the President, applying to the NRC for a license to construct, developing the site, and operating the site. This organization would be responsible for submitting a plan of action to Congress for approval by a deadline within a certain timeframe of the creation of this organization.

- **Reinstate the nuclear waste fee**

  As soon as the waste management organization has commenced the search for repository sites, the nuclear waste fee should be reinstated to proceed with funding as originally planned. The organization should have access to the NWF via appropriations. In order to reopen a dialogue on nuclear waste, appropriations should be available until a certain date to create a research period, after which the research and progress will be evaluated by the NRC and NWTRB to assess and change the national plan as needed. This should require the input of both the NRC and NWTRB

to Congress so that a resolution may be passed to continue according to the recommendations of the NRC and NWTRB in addition to the national plan as developed by the waste organization.

- Expand the advisory board

A separate advisory body to oversee the research used in the development of a facility is necessary. The NWTRB is currently responsible for monitoring the progress of all research on the subject of waste management. In addition to its existing responsibilities, the NWTRB should expand its role in actively communicating the developments of waste disposal to the public. The NWTRB should pursue open communication with communities of potential sites and the waste management organization in order to facilitate consent of all relevant governmental bodies, Native American tribes, and community members. In addition to research hearing, the NWTRB should hold meetings for the sake of proactively educating the public on nuclear waste disposal and the impact of a repository.

- Include the communities in all major decisions

Local councils should be created in areas being researched to oversee the work done by the waste management organization and obtain community consent. These councils should be funded by the NWF and would be formed once research commences at their community. Members would include representatives of relevant governmental bodies, Native American tribes, and community members. To promote informed consent and understanding of the impact on the community of a potential waste site, technical experts would sit on these councils. This would ensure the communities are informed and aware of developments in the plans. Communication with the waste management organization would be mediated by the NWTRB. These councils would communicate the information about the research being conducted and about the impacts of hosting a repository.

- Government funded public education on nuclear energy and waste disposal

Once the sites for characterization are selected, there should be a form of education for the communities that have these sites. The government should fund classes on nuclear energy that are open to the public in these communities. Once progress reaches formal selection as a repository, mandated public debates should occur. These debates should be on a national level to implement mass education and fight the stigma that is associated with nuclear power.

Conclusions

Above all, new legislation is needed to enable flexibility for the management of HLW and SNF. The NWPA must be amended to allow other sites as legal options for repositories and to enable effective consolidated interim storage. A waste management organization is needed to develop and implement these facilities. Consent-based siting should be implemented via local councils to involve host communities in selection and to enhance community understanding of what it means to have a repository or storage facility in close proximity. Finally, a decision must be reached on the license for the YM Repository. In order to move forward with the permanent disposal of HLW and SNF, the government must move forward with the YM Project or pursue a new repository project. The U.S. must act on waste disposal policy in order to lessen the burden for future generations and to ensure the continued success of the nuclear power industry.
References

15. Lyons, Dr. Peter. Personal interview. 18 June 2015.
26. Redmond, Dr. Everett. Personal interview. 23 June 2015.
Glossary

ANDRA .................................................. Agence Nationale pour la gestion des Déchets Radioactifs
BRC .......................................................... Blue Ribbon Commission on America’s Nuclear Future
CEA .......................................................... Commissariat à l’Énergie Atomique et aux Énergies
 Alternatives
CLIS .......................................................... Comité Local d’Information et de Suivi du Laboratoire souterrain de recherché sur la gestion des déchets radioactifs de Bure
DOE .......................................................... Department of Energy
DOT .......................................................... Department of Transportation
EDF .......................................................... Électricité de France
EPA .......................................................... Environmental Protection Agency
HLW .......................................................... High-level waste
LLW .......................................................... Low-level waste
MOX .......................................................... Mixed oxide fuel
MRS .......................................................... Monitored Retrievable Storage
NIMBY ...................................................... Not In My Backyard
NRC .......................................................... Nuclear Regulatory Commission
NWAA ....................................................... Nuclear Waste Administration Act
NWF .......................................................... Nuclear Waste Fund
NWICA ..................................................... Nuclear Waste Informed Consent Act
NWPA ......................................................... Nuclear Waste Policy Act
NWPAA ..................................................... Nuclear Waste Policy Amendments Act
NWTRB ....................................................... Nuclear Waste Technical Review Board
OCRWM .................................................... Office of Civilian Radioactive Waste Management
OPCST ...................................................... l’Office Parlementaire d’évaluation des Choix Scientifiques et Technologiques
SNF .......................................................... Spent Nuclear Fuel
YM .......................................................... Yucca Mountain
Appendix A

Appendix A.1 – Legislation and Yucca Mountain

The process for creating a long-term radioactive waste disposal facility was set up by the NWPA.

The original act outlined a framework for the development of a geological repository. Five sites were to be studied by the DOE; after the sufficient investigation of these sites, three were to be recommended by January 1, 1985. Procedures were created for characterizing and recommending a site, selecting a site, licensing a site, and funding the site. Capacity limits of the repository were set in this policy document to create incentives for the development of a second repository. It also included a deadline for the DOE to begin the disposal of spent fuel and HLW in order to have a tangible beginning for the management of spent fuel, which was January 31, 1998. This deadline was included in all contracts with nuclear utilities.

The law created the OCRWM within the DOE to implement the program, as well as provisions for centralized interim storage, MRS, and the development of dry cask storage at reactor sites. These additional provisions were meant to enable the DOE to develop temporary storage methods and to ensure there would be sufficient on-site interim storage at reactor sites until the repository commenced operation. These provisions also acknowledged that the process of developing a long-term repository would take a long enough period of time to require additional storage space.

In 1986, Congress considered the amount of funding being poured into the analysis of these sites and that the original deadline for three site recommendations was not met. The NWPAA was enacted in 1987, which named YM as the only site to be characterized and terminated the second repository program. These amendments prohibited the DOE from beginning construction of a MRS facility until the NRC authorized construction of a repository. Additionally, it imposed a limit of 1,900 tonnes of waste storage at any interim storage site which is miniscule in comparison to the 70,000 tonnes of spent fuel currently amassed in the U.S. The NWTRB was established by these amendments to evaluate the technical and scientific validity of the DOE’s work on disposing nuclear waste. While these amendments were intended to focus resources on the development of a repository and accelerate the process, it inhibited the possible development of alternate sites. The 1998 deadline passed and there were no successful efforts to change the deadline and no successful efforts to reassess the system of development.

The Secretary of Energy recommended YM to the President as a repository site and the 2002 Yucca Mountain Development Resolution was passed. Nevada exercised its power to veto the site selection but Congress overrode the veto and continued to the next step of the procedures. When Congress moved forward on this policy without the consent of the host community, resistance intensified. While the DOE owned the land that YM sat on, many obstacles were about to become clear. Several state-level policies must be put in place before YM can serve as a repository, such as granting water rights to the site and land rights for a railroad to transport SNF. The state has put up a strong resistance on this issue and has not backed off.

By 2008, the DOE completed and submitted the license application for the YM repository to the NRC for review. In 2010, the OCRWM was disbanded by President Obama and its functions were transferred to the DOE Office of Nuclear Energy. In the same year, the DOE was ordered by the Obama Administration to withdraw the application. The NRC proceeded with the application
review based on a court ruling that the DOE did not have that authority. In 2011, the NRC halted the proceedings for licensing the site on the basis of insufficient funding to continue. The NRC was ordered by the U.S. Court of Appeals in 2013 to continue the application review with whatever funding was available.\footnote{10} As of 2015, the review has been completed and the NRC has stated the site is safe to serve as a repository, however, the NRC has yet to issue a license.\footnote{12} The most significant factor in this failure to issue a license is the opposition at the state level for YM, such as permanent land removal and water rights for the site.

In 2010, President Obama authorized the Secretary of Energy to create a Blue Ribbon Commission on America’s Nuclear Future (BRC). The BRC was tasked with conducting an intensive review of the policies governing the back end of the nuclear fuel cycle and recommending a new strategy. The Commission was to avoid acting as a siting body, thus all recommendations are in the spirit of reforming a failed system.\footnote{13} The BRC conducted this review for about two years, meeting with thousands of individuals and organizations who provided insight into the current situation and how the existing laws affect it. The commission developed eight recommendations to change the system in order to better handle the back end of the fuel cycle.\footnote{13} Some of these recommendations are reflected in current legislation moving through the House and Senate, however, none have been enacted.

Dry cask storage continues to be an additional financial burden that falls upon the utility companies. These companies had paid fees to the Nuclear Waste Fund, which will fund the creation of a repository when it is licensed. These fees have since been suspended because the DOE is not currently working on a disposal solution. Additionally, the DOE has been subject to more than 70 lawsuits for not meeting the deadline of January 29, 1998 for operation of a repository, coming to a total of approximately $2 billion in damages. As long as the SNF remains uncollected by the DOE, the U.S. government is at risk for litigation.

\textbf{Appendix A.2 – Legislation in France}

The legislation on radioactive waste reflects three principles: sustainable management with regard to health, safety, and environment; averting the burden borne by future generations; and assigning the responsibility for radioactive waste to its producers.\footnote{7} These laws will be discussed to examine the elements of their success. While legislation in France is named for the date it is enacted, they will be referred to using the year and what they govern in this document for the sake of clarity.

The 1991 Waste Management Act established a protocol for storage and disposal of radioactive waste and set the direction for research regarding HLW disposal.\footnote{20} Several organizations coordinate the development of disposal, including:
Comité Local d’Information et de Suivi du Laboratoire souterrain de recherché sur la gestion des déchets radioactifs de Bure [Local Information Committee and Underground Laboratory Monitoring on the management of radioactive waste in Bure] (CLIS)
ANDRA

This act made ANDRA an independent entity to serve as a waste management organization; it was originally formed in 1979 within the Commissariat à l’Énergie Atomique et aux Énergies Alternatives [Office of Atomic Energy and Alternative Energies] (CEA), a government-funded research organization that focuses on the areas of energy, defense, security, information technology, and health technologies. The American analog of CEA is the DOE while the analog of ANDRA would be the OCRWM, dissolved by the Obama administration in 2010 as previously mentioned.  

The 1991 Waste Management Act was introduced because of the troubles that ANDRA faced locating a site during the 1980s for an underground laboratory to pursue research on geological disposal. This act assigned ANDRA several responsibilities, the most relevant of which include steering research on storage and deep geological disposal, producing and publishing inventory of radioactive materials and waste, and radioactive waste management. It is responsible for locating a repository site, studying the site as necessary, and designing, installing, and managing disposal facilities for radioactive materials and waste.  

With regards to a long-term solution to HLW, it is important to note that France reprocesses its SNF and has done so since 1958. The 1991 Waste Management Act was crafted under the assumption that the practice of reprocessing would continue throughout the lifespan of the nuclear power industry and indeed it has endured. This practice affects the disposal design of HLW. Instead of disposing of entire fuel assemblies, the volume of waste to be handled is reduced because HLW is approximately 3% of SNF and contains up 95% of the total radioactivity. When this is separated, it greatly reduces the volume of waste that requires disposal in a repository and affects how the repository is designed. All research carried out in support of a repository assumes that all HLW requiring disposal will be reprocessed SNF.

CNE was created to assess research and development concerning deep geological disposal, separation, and interim storage of nuclear wastes. The commission consists of twelve members, each of whom is selected based on recommendations from:

- l’Académie des Sciences [Academy of Sciences]
- l’Académie des Sciences Morales et Politiques [Academy of Moral and Political Sciences]
- l’Office Parlementaire d’évaluation des Choix Scientifiques et Technologiques [Parliamentary Office for the Evaluation of Scientific and Technological Choices] (OPECST)

CNE is not a formal regulator as it cannot issue licenses and it is not an implementation organization as it only reviews research. However, CNE has been essential to monitoring the progress of research and development regarding HLW management. It has also acted as a technical
resource in related area and can be called upon by the government or OPECST. The American analog of CNE is the NWTRB.

CNE publishes an annual report on French research in these areas in addition to international research. These reports examine the proposed solutions for the separation of long-lived radioactive elements in the waste, explore reversible disposal in deep geological formations, and study conditioning processes and long-term surface storage of the waste. The reports are based on meetings conducted with each organization that is carrying out research on radioactive waste management. Additionally, CNE travels to international research sites and meets with the organizations coordinating the research and implementation at these sites. CNE determines if the French research is consistent with the goals set by the 1991 Waste Management Act and 2006 Planning Act and reports back to Parliament as an independent entity.

CNE also reports to the local monitoring council of the Bure laboratory, CLIS. The mission of the CLIS is to obtain as much information as possible in the field of storage, obtain as much data for references in the future, communicate this information to the public, and ensure that there is proper consultation and debate regarding the laboratory at Bure. The members of CLIS include representatives of the regions of Lorraine and Champagne-Ardenne, representatives of the departments (equivalent to a county in the U.S.) of Haute-Marne and Meuse, and technical experts.20

In addition to defining the responsibilities of these organizations, the 1991 Waste Management Act outlined standards that waste disposal must meet. The first is recoverability, defined as the ability to extract any package waste from storage. This stipulation ensures safety in case of a material breach of boundary and allows for future generations to have the ability to change management strategies. The second standard is flexibility, defined as consideration of technical and scientific advances as well as storage adaptation to the changing nature of waste and packages.20 These criteria must be met for a minimum of 100 years.

ANDRA located several departments in France that had suitable geology to pursue as possible repository hosts. The pre-existing general councils in these departments voted on the nomination of their departments for a laboratory site, and four sites accepted this nomination. In 1994, three sites were selected for study and such characterization was carried out through 1997. By this time, a dossier on each of these sites was filed by ANDRA which started a public assessment of the general opinion of hosting a laboratory to support a repository in its corresponding department.21 Each of these sites had a positive response to the survey.

In 1999, a decree authorized ANDRA to establish an underground laboratory in Bure; the other sites were deemed less favorable due to geology.22 Shortly after this decree was issued, CLIS was established. During construction of the underground laboratory, scientific and technological tests were carried out to demonstrate feasibility of deep disposal, which continued through 2005. Error! Bookmark not defined. Once construction of the laboratory was completed, additional demonstrations of feasibility and research activities were carried out according to the schedule laid out by the 1991 Waste Management Act.

The 2006 Planning Act reevaluated the state of research on waste management and reaffirmed the research occurring at the Bure laboratory. During the same year, the 2006 Transparency and
Nuclear Safety Law was enacted, which mandated transparency for the national nuclear industry. This law created the Autorité de Sûreté Nucléaire [Nuclear Safety Authority] (ASN), a regulatory body that evaluates the safety of all nuclear matters. ASN must act as the main source of transparent and reliable public information. ASN publishes annual reports on the status of all aspects of the industry. All organizations involved in waste disposal now report to ASN in addition to the established hierarchy.

The 2006 Planning Act established a schedule beyond 2006 for the repository process to follow. From 2006 to 2009, additional technical development occurred. Proposals were made for the zoning of the repository, implementation scenarios, and technical choices for safety, design, and reversibility. These proposals were studied and approved by the government by 2012. A public debate followed the approval and then the selection of implementation strategy occurred. In 2015, ANDRA plans to submit the application for the repository license to ASN. Construction is scheduled to begin in 2017 provided that the license is granted; operation should begin in 2025. France has met all of the deadlines that have been set in its governing policies for radioactive waste management.