Proceedings of the 18th International Symposium on the Packaging and Transportation of Radioactive Materials
PATRAM 2016
September 18-23, 2016, Kobe, Japan

Paper No. 5011

The Road to a Successful Used Nuclear Fuel Permanent Disposal Solution Runs through Consolidated Interim Storage

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Abstract

Background

Consolidated Interim Storage (CIS) is an integral part of a country's successful Used Nuclear Fuel (UNF) management system, which includes operating reactors, a robust UNF transportation network, and a final geological disposal solution for either UNF or ultimate waste. The examples of Waste Control Specialists' (WCS) proposed CIS facility in Andrews County, Texas and the Yucca Mountain geological repository in the U.S. are used to show how CIS supports and complements a repository program.

Discussions

International experience has shown that development of a permanent geological repository can be a multiyear-long process, especially in the face of public acceptance challenges. While permanent disposal moves forward on a time scale measured in decades, operating nuclear reactors continue to "produce" and discharge UNF every 18 to 24 months. With nowhere to ship the fuel, it continues to accumulate at the reactor sites, either in spent fuel pools or in dry storage systems when pools are filled to capacity.

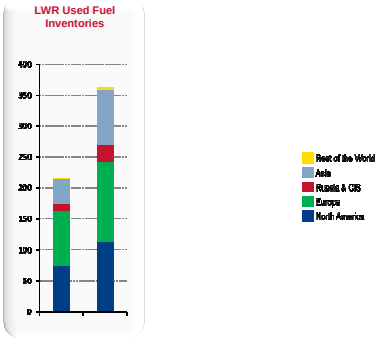
A CIS facility acts as a "surge volume" for a country's used fuel management system that allows UNF to be shipped off-site and consolidated into a single location in the near-term for more effective and efficient management. Implementation of CIS can also provide significant economic benefit, especially for so-called "stranded" sites which no longer have operating reactors and which have been completely decommissioned except for UNF sitting in a stand-alone Independent Spent Fuel storage Installation (ISFSI). Once all UNF has been removed and shipped to a CIS facility, owners of "stranded" sites would see immediate savings through the elimination of licensing and operating costs, plus the ability to repurpose sites for more economically productive uses.

The specific benefits of a CISF to a repository program include providing an early demonstration of the transportation infrastructure needed to support a repository and providing a robust facility at which Aging Management Programs can be implemented and at which any waste repacking or conditioning required for final disposal can be performed.

CIS does not compete with geological disposal and instead provides numerous complementary UNF management benefits to aid the successful implementation of a repository program.

Introduction

Demonstrating our capability to manage UNF is one of main challenges of the nuclear industry. It is critical for our industry to have a consent-based, practical, credible, and sustainable roadmap for managing the back-end of the nuclear cycle. World-wide UNF inventories are about 200,000 tons as of today and estimated to be more than 350,000 tons by 2030.



Two optional scenarios can be implemented for UNF management:

- Closed cycle: Transferring UNF from a pool to a recycling facility for reuse of materials, except a small percentage of ultimate waste to be disposed at a geological repository, or
- Open cycle: Directly transferring UNF from a pool to a geological repository for disposal.

While the closed cycle has been implemented successfully in a few countries, final disposal of

ultimate wastes and UNF at geological repositories has been delayed by decades mainly because public acceptance efforts have been under-estimated and also a lack of political commitments to expedite a final solution.

As a result, industrial stakeholders had to find practical interim UNF storage solutions to continue operating their reactors. Among those interim solutions, cask or canister based dry storage systems have drastically increased in the last 10 years as they provide flexibility for expansion with a low up-front investment.

Dry storage systems are stored either at reactor sites or at CIS facilities. While a large number of the systems are stored at reactor sites, a few consolidated storage facilities are already in operations or being developed (Switzerland, Spain, Japan, USA).

USA Background

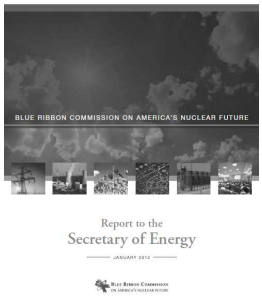
In the United States, the Department of Energy has responsibility of UNF disposal per the Nuclear Waste Policy Act of 1982 (NWPA). The NWPA established a broad policy framework for the permanent disposal of UNF and high-level radioactive waste derived from nuclear power generation. The NWPA authorized the government to enter into contracts with reactor operators – the generators and current owners of UNF – providing that, in exchange for the payment of fees, the government would assume responsibility for permanent disposal. The fees were to ensure that the UNF and High-Level Radioactive Waste generators pay the full cost of the disposal of their UNF and high-level radioactive waste.

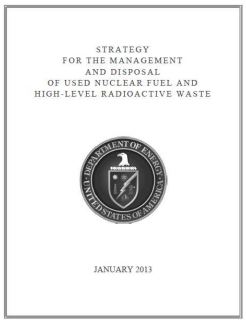
However, the plan to open the first geological repository in 1996 failed and today, there is not a definitive path, mainly due to political issues. As a result, the federal government did not meet its contractual obligation to begin accepting UNF by 1998 per NWPA and is now liable for damages to some utilities to cover the costs of on-site, at-reactor storage. Meanwhile, utilities pushed to find a solution, are purchasing dry casks for on-site storage.

It should be also noted that due to lack of integrated approach, as a result of utilities requesting lower interim storage costs, cask vendors have increased capacity that will result in heavier and most likely more complex routing and higher costs to transport later-on.

In 2011, at the request of the President of United States, a Blue Ribbon Commission was established to conduct a comprehensive review of policies for managing the back end of the nuclear fuel cycle and recommend a new strategy. These recommendations published early 2012 were endorsed by the Department of Energy in a Document entitled “Strategy for the Management and Disposal of UNF and High Level Radioactive Waste” issued in January 2013. This Strategy includes a phased,

adaptive, and consent-based approach to siting and implementing a comprehensive management and disposal system. At its core, this Strategy endorses a waste management system containing a pilot interim storage facility; a larger, full-scale interim storage facility; and a geologic repository.





Benefits of CIS facility

As described in the Strategy document referenced above, the US Administration foresee CIS facility as a critical element in the waste management system with several benefits, including flexibility in system planning and execution and also the opportunity to move expeditiously to fulfill government contractual responsibilities:

Near-term Path for DOE to Fulfill its Obligations and Remove Spent Fuel from Stranded Sites

Developing CIS facility would allow the federal government to begin the orderly transfer of UNF from reactor sites to safe and secure centralized facilities independent of the schedule for operating a permanent repository. The arguments in favor of CIS are strongest for stranded UNF from shutdown plant sites. Stranded UNF should be first in line for transfer to a CIS facility so that these plant sites can be completely decommissioned and put to other beneficial uses.

Economic, Security and Safety Benefits

Looking beyond the issue of today's stranded fuel, the availability of CIS facility will provide valuable flexibility in the nuclear waste management system that could achieve meaningful cost savings for both ratepayers and taxpayers when a significant number of plants are shut down in the future, can provide back-up storage in the event that UNF needs to be moved quickly from a reactor site, and would provide an excellent platform for ongoing R&D to better understand how the storage systems currently in use at both commercial and DOE sites perform over time.

With extended storage, UNF will be stored on site for periods beyond the original license of 20 years. As a result there is a need to develop aging management plans to mitigate:

- Aging and degradation of the storage systems: The main functions of the storage system are radiation protection and containment. Aging management programs must ensure that all the functions of the storage systems remain intact. Integrity of the canister /cask is particularity of importance especially with respect to potential Chloride Induced Stress Corrosion Cracking (CISCC)
- Evolution of fuel mechanical characteristics over time resulting in a change of licensed content. A dry storage system is licensed for a specified content. There are more uncertainties for high burn-up fuel assemblies degradation over time (US regulation define High Burn Fuel when more than 45 GWd/THM). Consequently, risk of deterioration of the cladding making fuel retrievability more complex needs to be further evaluated as authorized content could be altered.

Some component aging mechanisms are known and a great deal of information is available from power plant experience. However for some aging mechanisms while well understood from scientific perspectives, there is limited operating data to predict their occurrence. Overtime, it is expected that aging management activities and related costs will increase. Consequently, consolidation of storage systems will provide savings as the costs related to managing individual sites, such as licensing and operating costs, will be reduced by regrouping systems at a CIS facility.

In addition, infrastructure around those stranded and more recently shutdown sites is also aging with need to refurbish the transport infrastructure that will add costs too. It will be more cost effective to maintain infrastructure around one or a limited number of CIS facilities.

Once all UNF has been removed and shipped to a CIS facilities, owners of stranded sites would see immediate savings through the elimination of licensing and operating costs, plus the ability to repurpose sites for more economically productive uses.

Enhancements of Nuclear Industry Credibility by Proactively Addressing UNF Management

Polls show that the unresolved UNF management issue remains a vulnerability for the nuclear industry. Availability of a CIS offers a practicable near-term path to demonstrate the capability of our industry to implement phased-approach solutions to manage UNF. Development of a CIS provides a unique opportunity to build and demonstrate the capability to safely transport and store used nuclear fuel, and therefore to make progress on demonstrating the industry commitment to addressing the UNF issue.

Remove Barriers to Geological Repository Implementation

Implementation of CIS allows a phased approach that will benefit the implementation of a geological repository:

- Provides an early demonstration of UNF transportation infrastructure that will be essential for repository operations:

- Potential to address public concerns, particularly regarding transportation related matters, well before the actual need date
- Reduces the risk of further degradation of on-site infrastructure at permanently shutdown reactor sites
- Waiting to resolve transportation issues until a repository is built increases risk of further delay in successful repository operations

- Creates a robust facility which could be expanded to develop and deploy the repackaging technology to prepare the UNF currently in dry storage for final disposal in a repository
  - Repackaging may be needed before the over 70,000 MTU of UNF currently in the USA can move to repository
  - Standardization of repackaging at CIS would smooth transportation as well as operations at the repository and expedite schedule to start repository operations.

Overview of WCS CIS facility

AREVA TN is partnering with WCS to start operations of the first US CIS facility. NAC International is also associated to this effort with AREVA TN as technical integrator.

The WCS site is currently operating a low-level radioactive waste (LLRW) disposal facility licensed by Texas as an US Nuclear Regulatory Commission (NRC) Agreement State. The future plan is to accommodate UNF for interim storage in additional to LLRW disposal.

Arial picture of WCS LLRW disposal facility

The license application for CIS facility was submitted to the NRC in April, 2016. It covers an initial 40-year license for the CIS facility, which is designed to store 40,000 metric tons of UNF. The NRC is reviewing the application for completeness. Once NRC deems it complete, they will docket it for technical review and begin public meetings.

In line with the Blue Ribbon Commission, the first phase of the facility includes space for more 300 units comprised of 17 different systems (12 sites, 7 Stranded). We expect to receive NRC license for the WCS CIS facility in 2019 for systems already loaded and start construction in 2019 and begin operations in 2021.

In parallel, AREVA is developing a transportation plan for DOE to provide necessary infrastructure,

assets and expertise to safely deliver the UNF from the reactor sites to WCS's CIS facility.

Local and State representatives are welcoming this project that will create jobs and provide a safe and practical solution to the Nation while DOE continue its efforts on the geological repository.

WCS future CIS facility

Ribbon cutting WCS facility

Conclusions

Efforts to develop consolidated storage must not hamper efforts to move forward with the development of disposal capacity as CIS cannot become a de facto disposal site. CIS gives an opportunity to make discernible progress in the short term in the eyes of key stakeholders and the public while a geological repository is actively developed in parallel. In the United States with large inventories of used fuel and an increasing number of shutdown sites, CIS will be a valuable element of a sustainable spent fuel management program.

AREVA TN and its partners, WCS and subcontractor NAC are committed to develop and operate the first CIS in the United States with a necessary transportation program. The CIS is an economically viable interim solution for used fuel management that will remove burden from utility customers and demonstrate the capability of our industry to assume its responsibilities in a phased approach.

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