Proceedings of the 17th International Symposium on the Packaging and Transportation of Radioactive Materials
PATRAM 2013
August 18-23, 2013, San Francisco, CA, USA

Options for transportation of used fuel from dry storage at decommissioned reactor sites in the United States

Jeff Hays, Vice President Back End Fuel Cycle Solutions
Mike Valenzano, Director Transportation.
Catherine Shelton, Director Strategic Business Development
AREVA TN 7135 Minstrel Way Suite 300, Columbia MD 21045, USA
Emails: Jeffrey.Hays@areva.com; michael.valenzano@areva.com;
catherine.shelton@areva.com

ABSTRACT

The current inventory of used nuclear fuel assemblies (UNFAs) from commercial reactor operations in the United States totals approximately 65,000 metric tons or approximately 232,000 UNFAs primarily stored at the 104 operational reactors in the US and a number of decommissioned reactors. This inventory is growing at a rate of roughly 2,000 to 2,400 metric tons each year, (Approx. 7,000 UNFAs) as a result of ongoing commercial reactor operations.

In January 2010, The Blue Ribbon Commission (BRC) was directed to conduct a comprehensive review of policies for managing the back end of the nuclear fuel cycle and recommend a new plan. The BRC issued their final recommendations in January 2012. One of the main recommendations is for the United States to proceed promptly to develop one or more consolidated storage facilities (CSF) as part of an integrated, comprehensive plan for safely managing the back end of the nuclear fuel cycle. Another key recommendation is to remove in priority the used fuel at the decommissioned reactors where used fuel and greater than class C (GTCC) waste are currently stored on 9 different sites with 258 canisters. At least two more plants will be in decommissioning by the time that a centralized storage facility could start to receive fuel: Oyster Creek and Kewaunee. These will both have fuel in dry storage, also with a licensed transport cask (MP-197HB), but also fuel in pools. That fuel remaining in pools may be the real first priority.

This paper will describe the different package and transportation challenges and describe alternate options to transfer the used fuel from the decommissioned reactors to a consolidated storage facility.

INTRODUCTION

The Blue Ribbon Commission on America's Nuclear Future identified removal of stranded used nuclear fuel at shutdown sites as a priority so that these sites may be completely decommissioned. The shutdown sites included Maine Yankee, Yankee Rowe, Connecticut Yankee, Humboldt Bay, Big Rock Point, Rancho Seco, Trojan, La Crosse, and Zion. At these sites a total of 7649 used nuclear fuel assemblies and a total of 2813 metric tons heavy metal (MTHM) of used nuclear fuel are contained in 248 storage canisters. In addition, 11 canisters containing greater-than-Class C (GTCC) low- level radioactive waste are stored at these sites.

2013 has been a challenging year for the nuclear industry in the United States, with additional three (3) reactors shutting down, including San Onofre in California. A few more reactors are expected to cease operation in the coming years.

Removal of used fuel at shutdown reactors will be a challenging task due to

- The nine (9) shutdown reactors listed above use seven (7) different storage systems (canister/dual purpose cask types)
- Transportation infrastructure at these sites require maintenance/ refurbishment
- Five (5) sites have a rail spur while others will require heavy-haul truck or barge access
- Eight (8) of the sites have decommissioned their pools
- The licensing status of the storage canister/dual purpose casks varies from site to site

Since California is hosting the PATRAM, this paper will focus on the Rancho Seco shutdown plant owned by Sacramento Municipal Utility District (SMUD).

OVERVIEW OF RANCHO SECO

Background

The Rancho Seco Nuclear Station was built on 2,100 acres in Herald, California located in southeastern Sacramento County.

The 913 megawatt pressurized water reactor began operation in September 1974, and entered commercial operation in April 1975. In accordance with the results of a public referendum on June 7, 1989, SMUD decided to permanently shut down the Rancho Seco Nuclear Generating Station. The nuclear reactor was defueled later that year and decommissioning began in early 1997. A total of four hundred and ninety three (493) spent fuel assemblies were placed in three (3) types of canisters (Fuel Only, Fuel Control Components, Fuel Failed) at the Independent Spent Fuel Storage Installation (ISFSI). In August 2002, Rancho Seco had placed all 493 spent

fuel assemblies in dry storage at the ISFSI, licensed under 10 CFR Part 72. SMUD was the first utility in the world to load damaged fuel assemblies in dry storage containers. In addition, in August 2006, a canister containing Greater than Class C waste (GTCC) -- irradiated steel removed from the reactor vessel -- was loaded into a canister and transferred to the Rancho Seco ISFSI. Decommissioning was completed in December 2008 and in October 2009 the Nuclear Regulatory Commission released the majority of the site for unrestricted public use. Approximately 11 acres (4.5 ha) of land, including a storage building for low-level radioactive waste and a dry-cask spent fuel storage facility, remain under NRC licenses.

Description of the ISFSI, spent fuel assemblies and the Dry Storage systems

The ISFSI consists of a single concrete pad (about 130 feet by 200 feet) approximately 900 feet west of the cooling towers and enclosed by two security fences.

Four hundred and ninety three (493) fuel assemblies are Zircaloy-clad. The oldest fuel was discharged in 1977 and the last was discharged in 1989. The highest burnup is 38.2 GWd/MTHM, thus no high burnup fuel is stored at Rancho Seco (greater than 45,000 GWd/MTHM). Also, there are six (6) damaged fuel assemblies stored in sealed canisters.

The spent fuel assemblies (228 metric tons) are stored in 21 Dry Shielded Canisters (DSCs) within Horizontal Storage Modules (HSMs), all designed by AREVA TN. The NUHOMS® storage system, designed and built by AREVA TN is a storage and transport system which provides confinement, radiation shielding, structural integrity, criticality control and heat removal for spent nuclear fuel. The system, based upon the Multi-Purpose Canister (MPC) concept, is comprised of the following components:

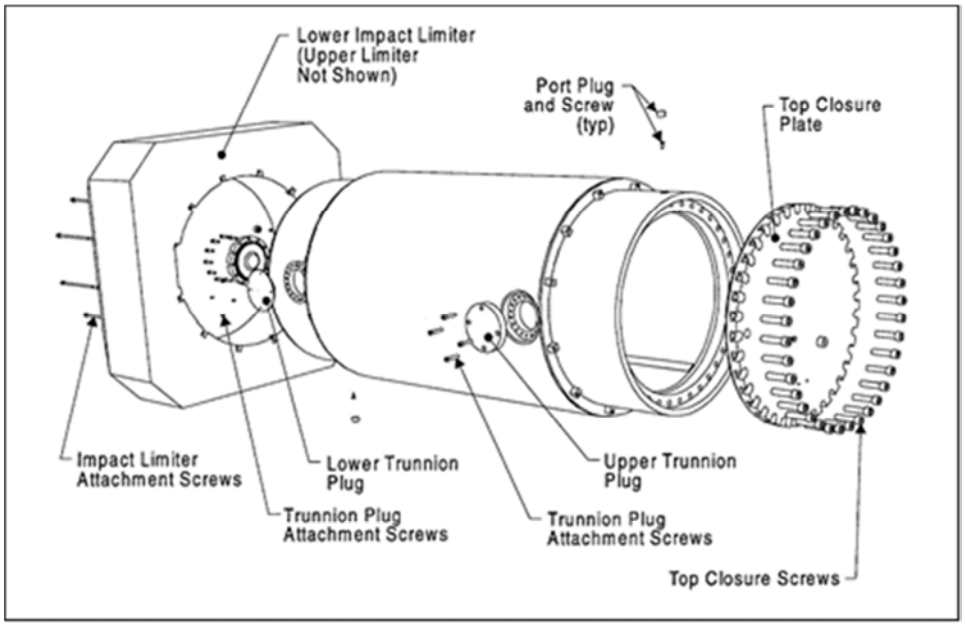
- Dry Shielded Canisters (DSC)
- Transfer Cask
- Horizontal Storage Module (HSM)
- Transportation Cask

The DSC consists of a cylindrical stainless steel shell with welded top and bottom cover plates forming a confinement boundary. Within the DSCs are baskets that provide heat transfer paths, criticality control and structural support. One DSC is loaded per concrete module. At Rancho Seco, each DSC holds twenty four (24) pressurized water reactor (PWR) used fuel assemblies.

The HSM is a reinforced concrete unit that stores the DSC horizontally with penetrations through the concrete at the top and bottom for airflow. The DSC Support Structure, a structural steel frame with rails, is installed in the HSM to support the DSC within the HSM and to easily slide the DSC in and out of the module.

The transfer cask is used for transfer operations within the Spent Fuel Pool Building and for transfer operations to and from the HSM. In the case of Rancho Seco, AREVA TN's MP 187 transportation cask was used as the transfer cask.

In the United States, AREVA TN has designed and licensed two (2) transport casks for the off-site transport of loaded DSCs originating from either the spent fuel pool or from storage pad. The MP187 and the MP197HB casks are similar in design and consist of concentric stainless steel-lead-stainless steel cylindrical shells with neutron shielding provided by borated polyester resin. As described above for Rancho Seco, the MP187 transport cask can be used for off-site shipment.



Overview of MP187 Transport Cask

REMOVAL PLAN

As previously noted, the reactor building equipment and spent nuclear fuel pool have been decommissioned and removed, but the cooling towers, reactor containment building and other associated structures remain onsite. Low-level radioactive waste is also stored onsite. Electrical power is available at the Rancho Seco ISFSI. However, handling equipment is not available.

Agreements will be put in place between the US DOE and the shutdown sites but, in general, shutdown site organizations should be responsible for removing their transportable dry storage canisters containing used nuclear fuel or GTCC low-level radioactive waste from onsite storage systems -- loading the canisters into transportation casks that will be provided by DOE (unless

the canister is already loaded in a dual purpose cask), preparing the loaded casks for shipment and loading the prepared casks onto transport vehicles.

The site operator will then prepare the transportation cask for shipment, including the assembly of all components, and conduct of tests to verify proper assembly for shipment specified by the cask's certificate of compliance. Last, the operator will place the transportation cask on a shipping skid/cradle, load the cask-on-cradle unit onto the transport vehicle provided by DOE, and provide DOE with the documentation required to verify that the shipment has been properly packaged for offsite transportation.

The primary activities that will precede shipments to a consolidated interim storage are comprised of two main components: Transportation Cask and Canister Preparation and Transportation Logistics Preparation.

Transport Casks and Canister Preparation

These activities will include:

- Licensing work
- Procurement of hardware
- Transfer of the canisters into the transport cask

In terms of licensing, the MP187 transportation cask is currently certified for transportation of spent fuel assemblies until November 2013. An application for renewal has recently been submitted to the NRC. Minor licensing work is needed to include the GTCC low-level radioactive waste. Also additional thermal, shielding and criticality analysis will have to be completed to address minimal fuel damage that was identified by SMUD after loading. Evaluation to demonstrate safety in accordance with transport regulations is expected to be straightforward. Extension of the certificate until transportation activities will also be required.

Regarding hardware procurement, one MP187 has been fabricated for Rancho Seco use in transferring the DSCs to the ISFSI. The impact limiters and transport skid and ancillary equipment still have to be fabricated.

For the transfer of the DSCs from the HSM into the Transportation Cask, mobile handling equipment and other auxiliary equipment will be necessary.

Procedures to move the DSCs into the transportation casks and to prepare the cask in accordance with its certificate of compliance will also have to be established.

Transportation Logistics Preparation

This includes preparation of the logistics infrastructure to transport the cask to the consolidated interim storage. This paper is only describing the logistics infrastructure at the Rancho Seco reactor as the final destination is still unknown.

A mile long rail spur owned by Rancho Seco connects from the site to the Union Pacific railroad mainline. The rail spur has not been maintained since the shutdown in 1989 but was refurbished to support the decommissioning in the early 2000s. It was last maintained and certified in 2008. Past restoration of the rail spur was relatively inexpensive and is expected to be straightforward at the time of the removal. A back-up option is to use a heavy-haul tractor trailer. Railcars will be provided by DOE.

Finally, AREVA TN will offer its extensive and unique proven expertise transporting used fuel in multiples countries. With 50 years of experience, AREVA TN has accumulated lessons learned for continuous improvement in the following areas:

- Design and licensing of transport casks, transport equipments and auxiliary components
- Fabrication
- Scheduling, fleet management and maintenance
- Road, rail and sea transports
- Management of rail and sea terminals
- Emergency response
- Public acceptance
- Risk management.

CONCLUSION

The DOE plans to perform a pilot shipment from one of the nine shutdown reactors in 2021. Rancho Seco meets different criteria to be selected as the pilot:

- SMUD has expressed interest in being the first,
- The site cask related and transportation related activities will be straightforward:
    - Operations at the site will be simplified using directly the MP187 cask to load the DSCs from the HSMs. Minimum additional equipment will be needed to complete the transfer.
    - Minor licensing work to update CoC 9255, GTCC not licensed
    - Fabrication of impact limiters