OVERVIEW OF THE SPENT NUCLEAR FUEL STORAGE FACILITIES AT THE SAVANNAH RIVER SITE

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ABSTRACT

The May 1996 Record of Decision (ref. 1) on a Proposed Nuclear Weapons Nonproliferation Policy concerning Foreign Research Reactor Spent Nuclear Fuel initiated a 13 year campaign renewing a policy to support the return of spent nuclear fuel containing uranium of U.S.-origin from foreign research reactors to the United States. As of July 1999, over 18% of the approximately 13,000 spent nuclear fuel assemblies from participating countries have been returned to the Savannah River Site (SRS). These 2400 assemblies are currently stored in two dedicated SRS wet storage facilities. One is the Receiving Basin for Off-site Fuels (RBOF) and the other as L-Basin.

RBOF, built in the early 60's to support the "Atoms for Peace" program, has been receiving off-site fuel for over 35 years. RBOF has received approximately 1950 casks since startup and has the capability of handling all of the casks currently used in the FRR program. However, RBOF is 90% filled to capacity and is not capable of storing all of the fuel to be received in the program. L-Basin was originally used as temporary storage for materials irradiated in SRS's L-Reactor. New storage racks and other modifications were completed in 1996 that improved water quality and allowed L-Basin to receive, handle and store spent nuclear fuel assemblies and components from off-site. The first foreign cask was received into L-Area in April 1997 and approximately 86 foreign and domestic casks have been received since that time.

This paper provides an overview of activities related to fuel receipt and storage in both the Receiving Basin for Off-site Fuels (RBOF) and L-Basin facilities. It will illustrate each step of the fuel receipt program from arrival of casks at SRS through cask unloading and decontamination. It will follow the fuel handling process, from fuel unloading, through the cropping and bundling stages, and final placement in the wet storage rack. Decontamination methods and equipment will be explained to show how the empty casks are prepared for shipment off-site. This paper provides a useful reference to foreign facilities, cask owners and shipping contractors on the cask and fuel handling capabilities of the Savannah River Site.

Receipt Preparation Activities

Prior to the receipt of any spent nuclear fuel from foreign research reactors, DOE and WSRC must complete a series of activities in parallel to ensure the safe and timely receipt and storage of the assemblies at the Savannah River Site and to ensure the fuel is within the SRS facilities' Authorization Bases (AB). As shown in Fig. 1, DOE-HQ and the Research Reactor Government initiate the program by reaching an agreement on the conditions and protocol for the return of the "U.S. origin" SNF. DOE-SR formalizes the scope, logistics, and terms of the contract and also coordinates the receipt activities which includes transportation and security plans. WSRC, with the assistance of the research reactor facilities, collects the fuel data and ensures it is accurately characterized in a fuel data sheet/Appendix A. The document referred to as the Appendix A contains geometric and isotopic data for each fuel assembly, and provides the data required to perform the SRS receipt and storage facility safety analyses. A Nuclear Criticality Safety Evaluation (NCSE) is performed for each cask/fuel combination to ensure the safety of the receipt and unloading process. Based upon the results of the NCSE, a Nuclear Safety Data Sheet (NSDS) is developed for each fuel type that specifies safe storage configurations in both RBOF and L-Basin. This safety documentation, together with an operations review of the ability to handle the cask, make up the bases for

WSRC to provide DOE-SR with a "Certification to Receive and Store". DOE-SR, with the receipt of this certification, authorizes release for the loading and shipment of the fuel to the Savannah River Site.

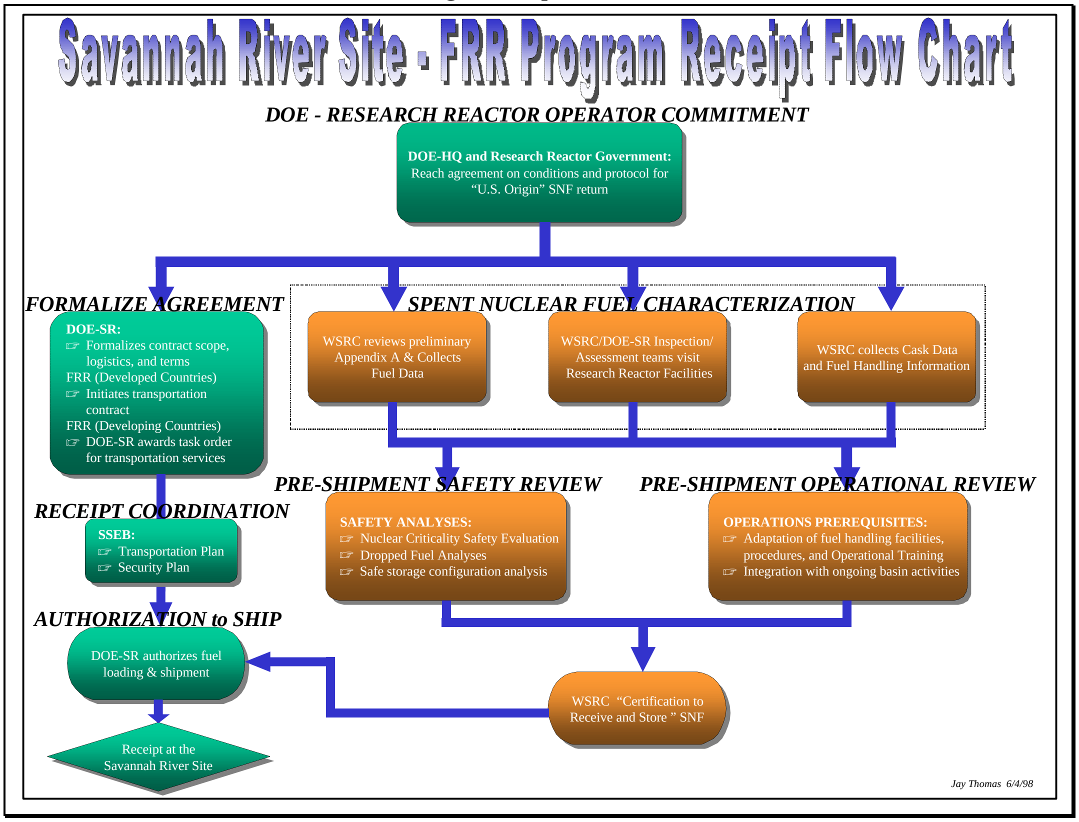

Fig. 1 - FRR Program Receipt Flow Chart

Receiving Basin for Off-site Fuels [RBOF]

The SRS Receiving Basin for Off-site Fuels (RBOF) is a 139 ft wide by 148 ft long structure that houses the primary facilities to unload, handle, and store spent nuclear fuel (Fig. 2). This includes a fuel receiving port, a cask wash pit, a cask unloading basin, two fuel storage racks, a fuel inspection basin, a fuel disassembly basin and a fuel repackaging basin. The basins vary in area and depth with an unloading basin depth from 29 to 45 ft. They are interconnected by underwater canals, and are monitored for a constantly controlled level of water. The permanent deionizer and the nearby resin regeneration cell are used to control the basin water chemistry to help minimize corrosion to the fuel assemblies.

Fig. 2 RBOF

RBOF Cask/Fuel Receipt and Storage:

Prior to the WSRC "approval for receipt and storage", all Appendix A documents are reviewed to ensure compatibility with the facility's Safety Analysis Report (SAR). The RBOF (SAR) serves as the governing Safety Authorization basis for the operation of the facility.

A cask containing spent fuel assemblies enters the RBOF in the receiving port by either truck, for off-site shipments, or by rail, for on-site transfers. After a radiological survey, the impact limiters are removed from the cask and the security seals are verified and recorded to verify package integrity. The cask is removed from the International Standards Organization (ISO) shipping container, if used during transportation, with an overhead 100-ton crane and placed on the bottom of a cask wash pit. The crane travels on a runway that permits access to the receiving port, cask wash pit, and cask basin. Dual 50-ton hoist trolleys and two 3-ton hoists are used to enhance efficiency.

Prior to immersion into the unloading basin, the cask is washed in the cask wash pit to remove any dirt acquired during transit. As a precaution to unloading, the cask is then vented, filled with water and subsequently sampled for radioactive contamination. The presence of contamination may reveal a potentially failed fuel assembly. This is unlikely to occur, as the Department of Energy requires a SIP test on all casks prior to departure. Lastly, the lid bolts are loosened or removed. The cask wash pit has a depth of 15 feet.

The cask is then hoisted over the cask unloading basin (Fig. 3) where the remaining lid bolts are removed and the cask is submerged to the bottom of the basin. The basin has a depth of 29 feet and contains a pit on one end, which increases the depth to 45 feet. This depth provides enough water over the exposed assemblies to adequately shield personnel from radiation. The lid is removed and remains in the basin.

Fig. 3 - RBOF Unloading Basin

SNF assemblies are removed from the cask using special handling tools one assembly at a time. The unloading process utilizes three buckets: the unloading bucket, an isolation bucket and a transfer bucket. An assembly is placed in the unloading bucket and set next to the isolation bucket. The isolation bucket maintains the separation between the unloading and transfer buckets. After the assembly number is identified and confirmed against the final loading diagram, the assembly is placed into the transfer bucket. The transfer bucket contains an insert that limits the number of assemblies to a predetermined safe number. When full, the bucket is transferred to the repackaging basin for bundling.

The repackaging basin (Fig. 4) varies in depth from 15 to 29 ft and also contains a pit that provides an additional 15-ft of depth. The basin contains an underwater saw and bundling station. The assemblies are transferred from the transfer bucket to an empty fuel bundle. The bundle is a round tube bundle that is designed to be stored in the L-Basin storage racks. All aluminum based fuel assemblies will be transferred to L-Basin for final wet storage. Many fuel assemblies require additional cropping (inert ends cut off) to fit in the bundle or to minimize wasted space inside the bundle. Operators remotely crop the assemblies with the use of the underwater saw and the assemblies are then bundled and transferred to the storage basin.

Fig. 4 - Repackaging Basin

The fuel bundles are guided through the canals with the aid of a manual hoist suspended from an overhead monorail system. A traveling bridge, a motorized platform that spans the cask unloading basin and fuel storage basins, supports up to three operators and can be positioned at precise locations over the basins. The traveling bridge contains a section of monorail that lines up with the rest of the system at many locations next to the basins. The canals are 3 ft wide by 29 ft deep. Seven stainless steel hollowed doors compartmentalize the canals into eight sections.

Fuel bundles are stored in rows of vertical racks made up of aluminum I-beams fastened to the bottom of the basins (Fig. 5). Gratings, guide plates and spacers (collectively referred to as 'hardware') are installed between the racks creating individual storage slots along the row. The RBOF SAR manages safe critical arrangements. Depending on the length of the fuel assemblies, a row can be fitted with up to four tiers of hardware. The large storage basin contains 42 rows of racks, 18 ft in length, that vary in width from 9 to 25.5 inches. The large basin also has special storage racks known as bucket and test tube storage. Special canned assemblies and confirmed or suspected failed assemblies can be stored in these racks.

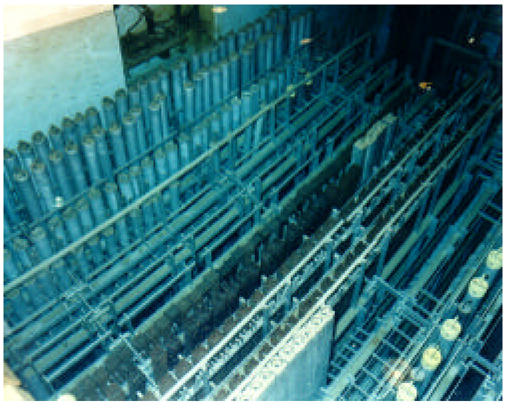
Fig. 5 RBOF Storage Racks

The disassembly basin is 14 ft deep and contains in the center of the floor a depression in the shape of an inverted pyramid. The end of which is piped to a pump that discharges to a waste tank. This basin is used to isolate fuel for special reasons.

Once the cask has been unloaded, the lid is placed back on the cask and the cask is removed from the basin and placed in the cask wash pit. A continuous supply of deionized water is sprayed on the cask throughout this process. Large area smears are taken to determine the level of decontamination that is required to ensure the cask is shipped off-site per Department of Transportation (DOT) regulations. Detergents, steam and a solution of alcohol can be used to decontaminate the externals of the cask to below DOT limits. The cask is then placed on its skid on the truck or railcar. Final surveys are taken of the ISO container (if used), truck and trailer prior to its release from the building. All casks are surveyed within 24 hours of the casks' departure from the site.

L-Basin


Fig. 6 L-Basin

L-Basin (Fig. 6) simultaneously utilizes two separate areas of the building to decrease the time to turnaround the casks and thus making the process more efficient. The stack area is used to prepare the cask for unloading and contains the decontamination facility for use after fuel unloading. The storage basin area contains a number of basins similar to the RBOF where fuel is unloaded, handled and stored. Water chemistry to inhibit corrosion is controlled by the use of a continuous deionizer system.

Prior to the receipt, all SNF Appendix A documents are reviewed to ensure compatibility with the L-Area Basis for Interim Operation (BIO). The BIO serves as the governing safety authorization basis for the facility's operation.

L-Basin Cask/Fuel Receipt and Storage:

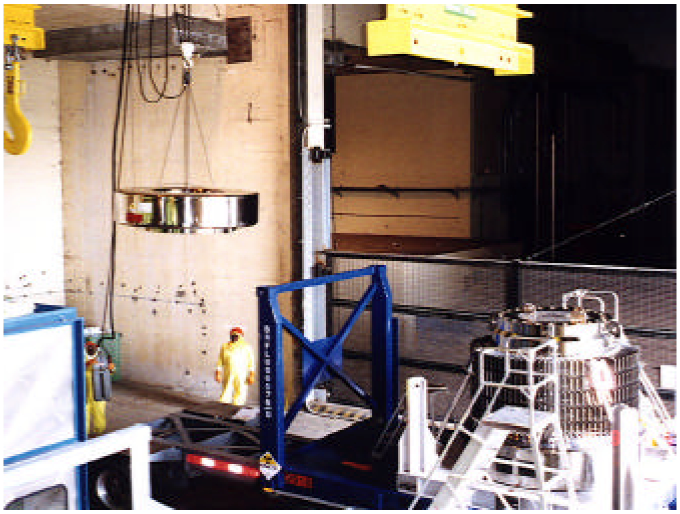

Fig. 7 Stack Area

Casks shipped in ISO containers and/or with impact limiters are received into the L-Stack Area via tractor- trailer. Casks received without an ISO container, like the domestically used BMI cask, are taken directly to the transfer bay for unloading. A complete set of receipt surveys is performed on the container externals prior to initiating any work. A 120-ton overhead crane is used to remove the cask from the ISO container and a 3-ton auxiliary hoist is used to remove the impact limiters before the cask is sent to the transfer bay (Fig. 7). The cask is placed on a different trailer for transport to the transfer bay. The crane is pendant controlled from the stack area floor and travels the length of the stack area. It utilizes two 60-ton trolleys with a maximum 24-ft span of horizontal travel. The ceiling extends to 72 feet to accommodate the crane's operation. Spreader beams and yokes are provided for each cask to be moved.

When the cask arrives at the transfer bay (Fig. 8), the cask contents are checked for integrity (security seals) and the cask is vented and filled with deionized water. The deionized water is sampled to determine the activity level of the internals of the cask. Should the preset limit of activity be exceeded, following reflushing activities, it is assumed that the fuel cladding has been breeched and preparations are made to containerize the fuel with an approved failed fuel canister. The cask lid bolts are loosened and the cask is submerged into the transfer pit via the 85-ton overhead crane. The lid is then removed and placed on the bay's floor. The depth of the transfer pit ranges from 17 to 20 ft. Due to the depth being shallower than RBOF's unloading basin, the longer TN-7/2 cask cannot be unloaded in L-Basin. A dry transfer system, white vertical tube in Fig. 5, was installed in 1998 and specifically allows for the unloading of the NAC-LWT and NLI casks.

Using the appropriate handling tools assemblies are removed from the cask one at a time, and placed in an unloading bucket (Fig. 9). The unloading bucket is the first of three buckets used in the unloading process. All three buckets are placed on the 17-ft ledge in the transfer pit. The unloading bucket is placed closest to the cask, then the isolation bucket followed by the transfer bucket. The transfer bucket has an insert that allows only a specified number of fuel assemblies to be placed into it. After positively identifying the assembly against the final cask loading diagram the assembly is placed in the transfer bucket. Once the

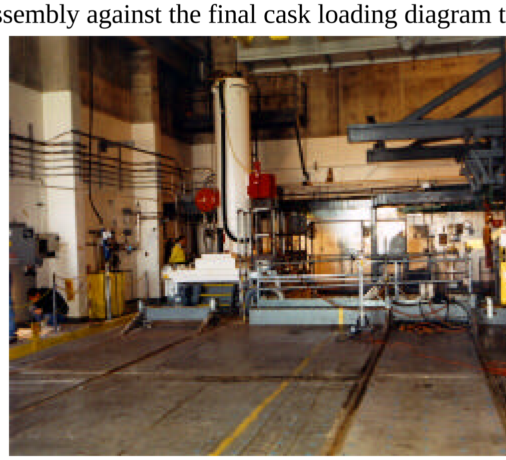

Fig. 8 SRS Reactor Transfer Bay

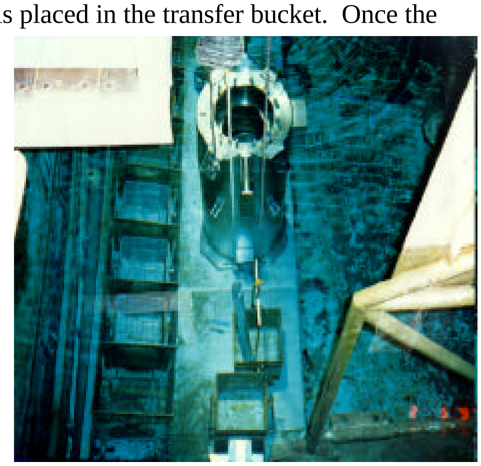

Fig. 9 Cask Unloading Basin

predetermined number of assemblies has been placed in the transfer bucket, a hoist is used to transfer the assemblies from the transfer pit to the other areas of the storage basin.

As in RBOF, the transfer pit connects to the other basin areas through a system of canals. Spent fuel assemblies and other irradiated components are supported, transferred, and stored using the overhead monorail system (Fig. 10). This system is composed of overhead rails traversed by wheeled trolleys. Specialized equipment is used to enhance the processing, handling, and storing of materials in the basins. Some of the components are: handling tools, hangers, trolleys, chain falls, bundles, electric and manual carriages, and twin hook and bucket hoists.

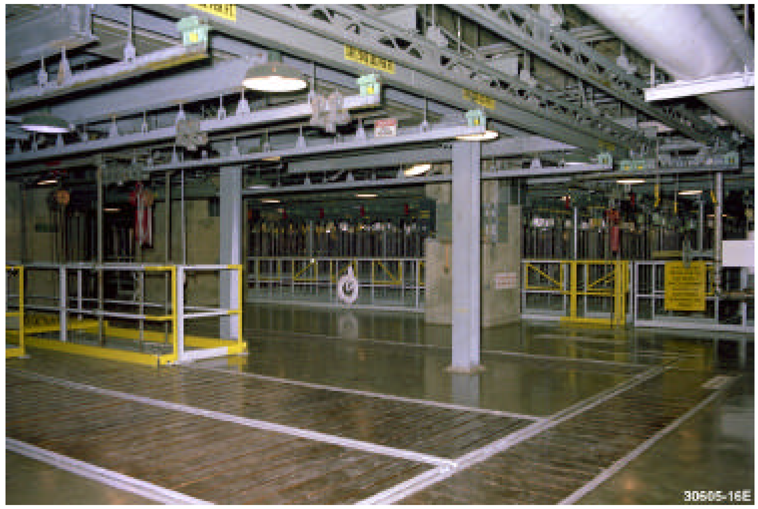

Fig. 10 Storage Basin Monorail System

One frequently used area in the storage basin contains the underwater equipment required for the inspection, disassembly, and bundling of fuel assemblies. This equipment is located within work areas called canal stations that range in depth from 17 to 30 ft deep. There are also three deep pits that are 51 ft in depth. Facility personnel on walkways above the basin water remotely operate the equipment. An empty fuel bundle is secured to the tilting table in the horizontal position. The assemblies are placed in the tube bundle and the table is slowly rotated to the vertical position after each assembly is inserted. After a designated number of assemblies have been placed into the bundle, the tilting table is lowered and a lid with a handling bail is secured to the bundle. The bundle is then transferred via a manual chain hoist to the vertical tube storage area.

If cropping of the fuel assemblies is required to fit in the bundle or for the maximizing of storage, the assemblies are first taken to the underwater saw which is located in the same area of the storage basin as the tilt table. The assembly is placed on the saw table and the non-fuel end pieces are removed. The cropped assembly is then taken to the tilting table and the bundling and storage sequence mentioned previously begins. The end pieces are transferred to scrap buckets for later disposal.

The vertical tube storage (VTS) area contains modular fuel storage racks (Fig. 11) in which fuel bundles are stored in the vertical position. The racks are a framework of welded aluminum construction and contain 30 storage spaces. A 2-ton transfer crane provides a bridge to move bundles between the VTS and other basin areas. Monorails allow for the movement of fuel bundles into and out of the VTS lanes. Eighteen lanes contain modular storage racks with a storage capacity of approximately 2040 spent fuel bundles. The basin depth is 30ft. The tube bundles in L-Basin are shorter than the bundles used in the RBOF. Accordingly, fuel handling in L-Basin differs from that in RBOF to the extent that operators are permitted to move fuel bundles over other loaded fuel racks. All positions are readily accessible without prerequisite fuel moves.

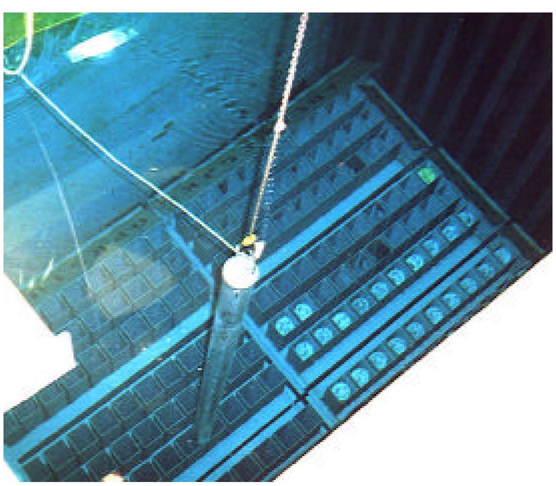
Fig. 11 VTS Rack

Another area of the basin is used for storage of underwater tools and scrap and has a floor that ranges in depth from 17 to 30 ft. There is also an area that is used to temporarily store sludge from basin vacuuming. It has a depth of 17 ft.

After unloading the fuel, the 85-ton crane is used to remove the cask from the transfer pit. The cask is rinsed with deionized water with minimal brushing. The cask is wrapped in a radcon bag, surveyed and transported by truck to the stack area where it is placed inside the decontamination facility (Fig. 12). Utilizing an all-electric hot/high pressure water cleaning system, the outside of the cask is decontaminated to below DOT shipping limits. The cask is then placed on the original trailer inside the ISO container where the impact limiters are reinstalled and the final surveys are taken.

Fig. 12 Decontamination Facility

REFERENCES

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