Transport of Spent Nuclear Fuel From the High Flux Beam Reactor

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Introduction

The shipment of more than 1000 elements of spent nuclear fuel (SNF) from the Department of Energy's Brookhaven National Laboratory (BNL) High Flux Beam Reactor (HFBR) to the Department's Savannah River Site (SRS) for long term interim storage required overcoming several significant obstacles. The project management team was comprised of DOE, BNL and NAC International personnel. This achievement involved coordinating the efforts of numerous government and contractor organizations such as the U.S. Coast Guard, the U.S. Nuclear Regulatory Commission, state and local governments, marine and motor carriers, and carrier inspectors. Unique experience was gained during development and execution of the project in the following areas: dry transfer of SNF to shipping casks; inter-modal transfers; logistics; cask licensing by the Nuclear Regulatory Commission (NRC); compliance with environmental regulations; transportation plan development, and stakeholder outreach and coordination.

Shipment Preparations

In 1992, after a five year hiatus from shipping SNF from BNL's High Flux Beam Reactor on Long Island, the facility's spent fuel pool was nearing its full capacity. The last shipment of SNF had been completed in 1987 using trucks driven through New York City via the NRC defined preferred route and casks approved, but not licensed, by the DOE. These shipments were made despite a political controversy resulting from an attempt by the City to impose a requirement for a permit for the transportation of high level radioactive shipments through its borders. During the same timeframe, the DOE policy on spent fuel shipments was changed to require shipping casks that were licensed to NRC standards as well as adding requirements for transportation planning and stakeholder outreach. The licensing requirement suspended the ability to make SNF shipments. In 1993 the BMI-1 shipping cask was licensed by the NRC for HFBR fuel. However, use of this cask, which carried 20 SNF elements, limited transportation options to use of a single motor carrier passing through New York City. Full DOE headquarters support would be needed to reassert BNL's legal right to make the shipment under federal regulations and without the New York City permit. Since shipping options at that time were limited, the DOE Brookhaven Group began to solicit the support needed to make the shipment despite the political sensitivity. As a result of the ongoing development of a programmatic environmental impact statement (PEIS) for SNF management across the DOE complex, support for the shipment was withheld pending the outcome of the process.

It became apparent to the BNL and BHG team that a significant amount of planning would be needed to overcome the many obstacles to the planned shipping campaign. In 1994, the BNL and BHG team began work on a detailed transportation plan, as required by DOE Orders. A stakeholder outreach program was also initiated. During evaluation of alternative methods and routes of transportation, it was learned that NAC International had five shipping casks known as the NAC-LWT, that could be made available. In order to ensure utilization of these casks as a shipping option, the NRC license for the cask was amended and baskets for HFBR fuel were fabricated. These five casks would make it possible to ship 210 elements at one time. It gave an economy of scale to making a shipment from Long Island via a marine route on a barge

***Above**: The first shipment leaves Long Island in 1996*

which would eliminate the need to confront the political controversy surrounding the New York City permit requirement for radioactive material. Based on this new capability, the BNL, BHG, and NAC team began to actively plan for an inter-modal shipping campaign using motor and marine carriers. This included procurement of the services of NAC International, a naval architect, rigger, fuel characterization services, a marine carrier, and a motor carrier.

The final transportation and communications plan was intended to define a complete framework for execution of the shipments. It included sections on: equipment, routing, emergency preparedness, emergency responder training, points of contact, a marine operations plan prepared by a naval architect, a stakeholder list, and media contacts. The plan was distributed to stakeholders and their comments were incorporated. The HFBR SNF transportation plan has been used as a model by DOE for other plans being developed.

Throughout the PEIS development process, the team worked closely with the DOE program office to ensure that all shipping options available to BNL were included and evaluated. In 1995, the Record of Decision (ROD) for the PEIS was issued, clearing the way for DOE research reactor SNF shipments to resume. With the NAC-LWT cask licensed, procurement complete, and a transportation and communication plan in place, the first HFBR shipment of spent fuel in nearly ten years was completed in December 1996.

The NAC-LWT Cask and the Dry Transfer System

The NAC-LWT cask, owned by NAC International, was selected based on individual cask payload, as well as the number of NAC-LWT casks in the NAC fleet. NAC was the sole company with the capability to provide a large enough payload per shipment to achieve a satisfactory economy of scale.

Since the size and weight of the NAC-LWT cask exceeded the internal handling capability of the HFBR, a dry transfer system was designed and fabricated. The main components of the system were a transfer container and a spent fuel pool shield. The transfer container is a lead and stainless steel cylinder closed on top and fitted with a shielding gate valve on the bottom end. It is also fitted with a hoist and an air operated grapple. The spent fuel pool shield is a cylindrical tube open on both ends and is fabricated of stainless steel and lead. The shield sits on an I-beam structure that spans the spent fuel pool. Sitting on this structure, the shield extends several feet into the pool water. To load the transfer container, it is placed on top of a mating fixture on the shield. As a basket of six SNF elements is lifted out of the pool by the hoist and grapple, the lead shield provides the shielding as the basket moves out of the water and into the transfer container. Once the loaded basket is inside the transfer container, the gate valve is closed and the transfer container is placed on a specially designed cart supplied by NAC. The cart is then towed to the shipping cask which has been up-righted on a stand outside the HFBR building. The top of the shipping cask is fitted with a second gate valve and mating fixture. The transfer container is removed from the transfer cart and placed on the mating fixture on top of the shipping cask. Both gate valves, on the transfer container and on the shipping cask, are opened and the basket of fuel is lowered into the shipping cask. Then both valves are closed and the transfer container is returned to the cart and then the spent fuel pool for another loaded basket. A total of six baskets per cask are loaded in this manner.

Setup of the transfer system takes approximately one day. Once that is complete, a shipping cask can be set up, loaded, and broken down in less than eighteen hours with a crew of six technicians and a supervisor. Two health physics

Above: the LWT cask
Below: transfer container being lowered onto the LWT cask

technicians are required for adequate radiological coverage of the work activities.

Cask Licensing and Environmental Documentation

The NAC-LWT cask license did not initially permit the transport of material test reactor (MTR) type, aluminum clad plate fuel. In order for the casks to be used for SNF from the HFBR, the NRC license was amended. Structural, criticality, thermal heat capacity, and shielding were all analyzed to ensure that the fuel could be transported in the NAC-LWT cask within the safety envelope defined by the Safety Analysis Report (SAR) for the cask. The initial amendment to the license specified a SNF cooling time of three years in order to permit decay heat loads to diminish adequately. In order to meet an accelerated shipping schedule in 1997, a letter amendment was issued by the NRC to permit fuel with specific decay heat values to be shipped. This approach permits SNF to be shipped in the cask based on actual decay heat loads for a specific fuel element rather than placing the limit solely on cooling time.

The entire spent fuel shipping team:

Owner of SNF:	DOE
Shipper:	BNL
Prime Contractor:	NAC Intl
Cask Owner:	NAC Intl
Marine Carrier:	Moran Services
Motor Carrier:	Trism
Safeguards:	BNL Security
NYS Escort:	Suffolk County PD
Health Physics:	BNL Safety
VA Escort:	VA State Police
Barge slip:	Long Island Lighting
VA Transfer:	VA Intl. Terminal
Documentation:	WMG, Inc
Naval Architect:	2DM Assoc
Marine regulation:	USCG

The PEIS prepared under the National Environmental Protection Act (NEPA) also contained a provision for SNF cooling time. In 1997, in order to support an accelerated shipping schedule, it became necessary for the PEIS to be revisited. The PEIS required HFBR SNF to be cooled out of the reactor for at least one year. At the time of the scheduled HFBR shipments, a small number of HFBR SNF elements had been cooled for nine to eleven months. The DOE headquarters program office performed a supplement analysis to ensure that the HFBR SNF was bounded by the fuel type used for the PEIS analysis. This precluded the need for modifications to the PEIS, or the development of additional environmental documentation to cover these few HFBR SNF elements.

Stakeholder Outreach

The BNL and BHG planners literally learned on the job what was required for stakeholder outreach. The outreach program evolved over the period of more than two years that the shipping campaign was being planned. Initial efforts were focused on local stakeholders that were required to support the shipping campaign, such as the local county police and emergency responders, and the local Long Island utility that owned an appropriate barge slip. The outreach efforts grew to include New York state emergency responders and state and county elected officials, town representatives, and civic groups.

Through the DOE Headquarters Program Office, contacts were then made with representatives from transit states between New York and South Carolina. Several presentations were made to organizations such as the Southern States Energy Board, and the Council of State Governments. Relationships were developed with representatives from the transit state's offices of emergency response, environmental protection, state police, port authorities, and fire departments. At the time of each individual shipment, these contacts were informed not only by the required by law written notifications to their governor's office, but also by way of courtesy telephone calls and individual letters.

The BNL and BHG planners learned that the outreach process must be continuous in order to be successful in such a sensitive operation. The process must be sincere, and must address stakeholder concerns to the extent possible.

Inter-modal Transfers and Logistics

Once the five casks are loaded, they are transported to SRS by motor carrier and marine carrier. This involves significant coordination and logistics.

Before the casks can be moved from BNL onto public roads, the trucks are inspected by the New York State Department of Transportation. The inspection is a thorough safety check of all tractor and trailer equipment including measurement of axle weights. Once this inspection is complete, permits are issued for movement of the trucks over public roads. At the same time these inspections are underway, a barge is delivered to a local barge slip by a marine carrier. By this time, the cask tie-downs and overall barge stability have been analyzed by

a naval architect and reviewed by the Coast Guard to ensure their integrity. At the barge slip, the barge is inspected by the Coast Guard and a marine surveyor. The inspections ensure that safety equipment and cask tie-downs are in compliance with the design specified in the marine operations plan. During early morning hours when public traffic is at a minimum, the five motor carriers are moved to the barge slip under local police and BNL security escort. At the barge slip, a rigging contractor utilizes a barge mounted crane to rig the casks from the motor carrier to the barge. After ensuring a satisfactory weather forecast, the barge is towed by ocean going tug to Portsmouth Marine Terminal (PMT) in Virginia. Throughout the shipment, its position is monitored using a satellite tracking system known as Transcom. Once at the PMT, the casks are loaded back onto the motor carriers by PMT stevedores. The motor carriers are then inspected by Virginia State Police to enhanced Commercial Vehicle Safety Alliance (CVSA) inspection criteria and then proceed directly to SRS. The total transit time was approximately 55 hours without any weather delays.

Offloading the barge at PMT.

Loading trucks at PMT

Conclusion

Shipment of spent nuclear fuel from the HFBR at Brookhaven National Laboratory was vital to the continued operation of the reactor and to prudent management of DOE spent fuel inventories across the DOE complex. The process for planning and executing such a shipment is lengthy and complex. It involves cask licensing, innovative fuel handling approaches, procurement, logistics, and extensive stakeholder involvement. Despite the seemingly impossible nature of such an endeavor, with enough perseverance, the spent fuel can be shipped safely and successfully.