TRANSPORT OPERATIONAL EXPERIENCE WITH SHIPMENTS OF FOREIGN RESEARCH REACTOR SPENT NUCLEAR FUEL

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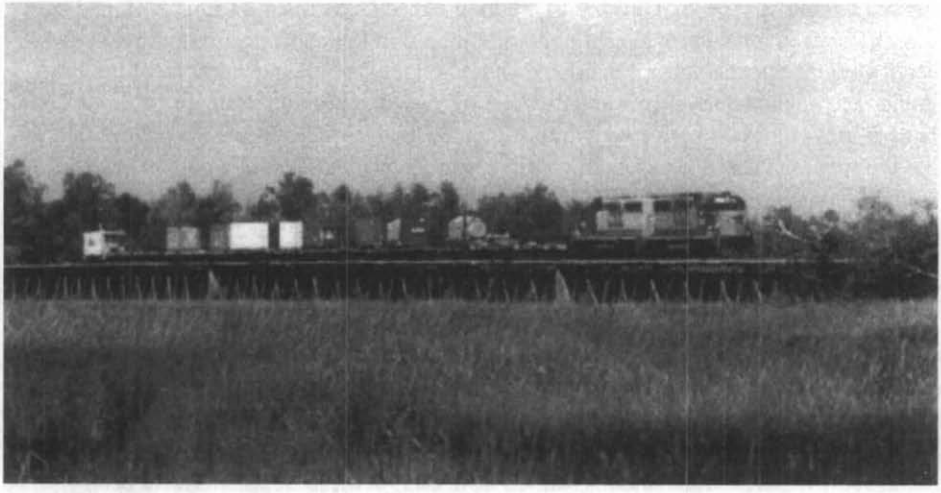
SUMMARY

As the implementation of the foreign research reactor spent fuel acceptance program approaches its second year and U.S. Department of Energy (DOE) receives more shipments, the transport of spent nuclear fuel becomes more routine. However, each shipment always amplifies a new set of issues creating a unique experience for each shipment. Some reactor operators or storage facilities have completed multiple shipments while other reactor operators and facilities are initiating their first shipment. Each reactor operator as well as each country operates by somewhat different requirements and regulations.

This paper will review several of the recent shipments to the Savannah River Site (SRS) in Aiken, South Carolina and highlight some of the lessons learned that could be helpful to reactor operators and shippers involved with future shipments.



INTRODUCTION

Beginning in the 1950's, as part of the "Atoms for Peace" program, the United States provided nuclear technology to foreign nations for peaceful applications in exchange for their promise to forego development of nuclear weapons. A major element of this program was the provision of research reactor technology and the highly enriched uranium (HEU) needed in the early years to fuel the research reactors. Research reactors play a vital role in important medical, agricultural, and industrial applications. Nevertheless, the HEU initially used in the fuel elements for these reactors can also be used in nuclear weapons. In the past, after irradiation in the research reactor, the spent nuclear fuel was returned to the United States so that the United States maintained control over disposition of the HEU that it provided to other nations.

To further reduce the danger of nuclear weapons proliferation, the United States in 1978 initiated the Reduced Enrichment for Research and Test Reactors (RERTR) program, which was aimed at reducing the use of HEU in civilian programs by promoting the conversion of research reactors from HEU fuel to low enriched uranium (LEU) fuel. From the beginning of the RERTR program, foreign research reactor operators made it clear that their willingness to convert their research reactors to LEU fuel was contingent upon the continued acceptance by DOE of their spent nuclear fuel for disposition in the United States. The United States accepted foreign research reactor spent nuclear fuel until the "Off-Site Fuels Policy" expired in 1988 for HEU fuel and 1992 for LEU fuel.

In an anticipation to resume the spent nuclear fuel acceptance policy in the united States, an environmental impact study was performed and an Environmental Impact Statement (EIS) was issued in February 1996. On May 13, 1996, the U.S. Department of Energy issued a Record of Decision on Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel (ROD) based on the bounding conditions of the EIS. An implementation strategy plan was subsequently issued to provide strategic guidance and major activities required to effectively implement the nuclear fuel acceptance policy. The goal of the spent nuclear fuel acceptance policy is to recover enriched uranium exported from the United States, while giving foreign research reactor operators sufficient time to develop their own long-term solutions for storage and disposal of spent nuclear fuel. The spent nuclear fuel accepted by DOE under the policy must be discharged from the research reactors by May 13, 2006 and returned to the U.S. by May 13, 2009.

Since resuming the foreign research reactor spent fuel acceptance program in 1996, DOE has successfully accepted shipments of spent fuel from European and South American countries, Canada, and Japan. For these shipments, trucks, trains, ships, and, in one case, an aircraft have been used to transport these transportation packages. Each shipment has proved to be unique in some aspect and the lessons learned from each of these shipments have been incorporated to make future shipments go more smoothly. The implementation of these shipments has required a concerted and coordinated effort between DOE, the foreign research reactor operators, and the various shippers.

OPERATIONAL EXPERIENCE WITH SPENT FUEL SHIPMENTS

These experiences and lessons learned have been categorized into the following groups.

- Scheduling
- Transportation Logistics
- Contract Issues
- Security
- Technical Issues
- Public Relations
- Other Lessons Learned

Scheduling

Establishing and maintaining a schedule involving international shipments from several countries using different transport package types is very difficult. The DOE can not control many of the variables associated with establishing a fixed schedule. However, through cooperation between all participants, costly schedule changes and delays can be minimized to ensure that all eligible reactor operators desiring to participate can return the spent fuel eligible under the program. Good scheduling is especially important in order to maximize shipments early in the program to ensure all material can be returned within the policy period. It is to the advantage of all participants to ship eligible material as early as possible.

The largest limiting factor is the availability of transportation packages or casks. There are a limited number of casks available to conduct these shipments. Additionally, the cask and its associated equipment must be compatible with a specific facility for loading. Casks must also be certified within the originating country, the United States, and transient countries. The DOE does not control cask utilization or certification, but does conduct advance planning based on a prospective cask availability. Westinghouse Savannah River Company (WSRC) personnel at the receiving facilities at Savannah River Site (SRS) are trained and equipped to unload each cask as quickly as possible so that the cask can be made available for future shipments. The DOE commits to unload casks at the rate of four per month, but frequently surpasses this expectation in the absence of facility equipment difficulty.

The DOE maintains basic information regarding eligible reactor operators and facilities, but does not maintain detailed information about the fuel or facility until a facility is targeted for shipment. Shipments of material may be better coordinated when detailed information is promptly provided to include a comprehensive Appendix A, Spent Nuclear Fuel Acceptance Criteria. An Appendix A is an appendix to the contract between the reactor operator and DOE-Savannah River Operations Office (DOE-SR) in which the reactor operator provides detailed information regarding their spent nuclear fuel. (See definition under Contract Issues.)

DOE must also understand the reactor operator's shipping needs or desires. The DOE will work with any eligible reactor operator to meet special needs within the authorization of the EIS and ROD. Additionally, advance understanding of the reactor operator's shipping desires such as time of year, cask preferences, shipper preferences, plans for combining

shipments, and other special considerations will assist in effective and efficient scheduling for the benefit of all participants.

Transportation Logistics

Transportation requirements are designed to minimize cost to participants, meet applicable transportation regulations, and mitigate concerns by regulators and other interested parties.

Within the United States, transportation planning is conducted in an open forum with interested organizations. These parties provide significant input into recommendations for needed actions and resolution of identified issues. These planning sessions are coordinated by the Southern States Energy Board (SSEB) to ensure proper communication with all identified organizations. For example, the SSEB was essential in assisting in the resolution of a major concern by the state of South Carolina regarding the planned truck route for shipments from the terminal in Charleston to SRS.

The EIS analyzed the shipment of eight transportation packages on one ocean going vessel. The reactor operators and shippers working together with other reactor operators in the same geographic area can maximize the eight-cask-per-ship limit and therefore minimize the shipping cost by each participating reactor operator. Some ships transporting spent fuel from countries with high income economies have carried as few as four packages. Each reactor operator with packages on board paid 1/4 of the shipping cost per package for that vessel, twice as much as 1/8 of the cost per package if the vessel was fully loaded. In order to minimize these costs, early identification of shipping participants within a geographic region to include the number of transportation packages from each reactor or facility is necessary to allow proper authorizations within each country. When making a port of call, packages on board as well as the package being shipped from the country's facility must be certified in that country and appropriate permits must be obtained.

During a multi-vessel shipment, the first vessel to arrive at the entrance to the Charleston, South Carolina harbor must wait until the second vessel arrives. This can lead to demurrage charges as well as other logistical and scheduling problems if ship arrivals are not closely coordinated. During one shipment, one vessel moored off shore for ten days without sufficient fresh water. The nuclear fuel acceptance policy requires implementation of the program to minimize the number of shipments to transport the spent fuel through the United States to SRS. A single shipment can be comprised of more than one vessel, which are off-loaded onto a single train for transit to SRS. Therefore, the ocean going vessels must enter the Port of Charleston simultaneously and be sequentially off-loaded as a single evolution to classify the activity as one shipment. Once an arrival date is set, a vessel that does not arrive on time will cause all vessels to standby at the port entry until a new port arrival date is established. The next authorized arrival date may not be the next calendar day after arrival of all vessels at the port entry. The new date will be established as soon as possible, but is primarily contingent on the port and terminal availability. It is the responsibility of the shipping agent(s), on behalf of the reactor operator(s), to plan, coordinate, schedule, and implement the shipping activities.

Contract Issues

Contracts between the reactor operator and DOE-SR should be established as early as possible as soon as the reactor operator decides to participate in the program to accept nuclear fuel in the United States. The contract ensures that the reactor operator is an eligible participant and that all terms are identified and understood before any significant effort is taken toward implementation of this program. This program supports the United States' RERTR Program to suspend use of HEU in these reactors. In summary, as a condition of the contract, the reactor operator must either already use LEU fuel, be permanently shutdown, convert to the use of LEU fuel, or shutdown the participating reactor. Further detail may be found in the EIS or ROD. Ideally, contract negotiation should be initiated at least one year in advance of the first desired shipment date with a goal of issuing an approved contract approximately nine months in advance.

The contract also requires that all regulatory requirements be met allowing a shipment to proceed. Cask certifications must be valid in all involved countries, import and export permits must be obtained including transient packages, specific advance notifications are required to be made to the proper authorities, and details of the shipment are not allowed to be released to the general public until 10 days after it arrives at the destination in the United States. Several errors occurred in complying with these requirements in past shipments due to improper notification or coordination with regulatory authorities.

An Appendix A, Spent Nuclear Fuel Acceptance Criteria, and Appendix B, Transport Package (Cask) Acceptance Criteria, are included with the contract. Requirements contained within these documents have significantly changed since they wer first issued on May 13, 1996. The changes usually benefit the reactor operator. Reactor operators and affected participants should ensure they obtain the latest version of these documents from DOE prior to initiating planning for each shipment.

Security

Although there have been no security related incidents, security remains a high priority due to the nature of the cargo and the sensitivities that accompany these types of shipments. Shipping dates are protected in accordance with the U.S. Nuclear Regulatory Commission (NRC) regulations and by contract between the reactor operator and DOE-SR. For this reason, all organizations should coordinate any release of information with the DOE-SR Public Affairs Officer who is responsible for knowing and implementing these requirements. This information can only be shared with organizations with the need to know to carry out their function in support of the shipment. The shipment can not be announced publicly until ten days after the shipment arrives at SRS. Variances have been allowed to publicly announce the shipment arrival at SRS immediately upon arrival. In one case, a release of information was inappropriately made to the news media by an organization unfamiliar with the regulation prior to shipment arrival.

Security plans are established for all legs of a shipment. For countries with high income economies, the reactor operator is responsible for providing appropriate security for the entire

duration of the shipment. The only exception to this responsibility is during the unloading at the terminal within the port of entry in the United States. Security as well as unloading responsibilities are provided by DOE through established security at the terminal. The reactor operator, shipping agent, and DOE work together to ensure security for all phases of the shipment.

For reactor operators in countries with other than high income economies, the security of the shipment is a shared responsibility. Within the reactor operator's country, the reactor operator's local law enforcement is responsible within the country's jurisdictional capabilities. Any additional security requirements identified by a security assessment to support the security plan is provided by the DOE's Transportation Services Contractor. In one case, security concerns necessitated the need to air transport the package from the reactor facility to the country's port of export. Although air transport of a loaded cask is extremely rare, air transport was determined to be safer than exposure to the potential threat due to a lengthy transience to the port without adequate protection. The responsibility for security of the shipment after the material is loaded on the ocean going vessel at the reactor operator's port depends on the resolution provided within the contract between the reactor operator and DOE as allowed by the latest revision of the ROD. However, regardless of responsibility, the security assessment includes all segments of the transportation route from the reactor site to SRS.

Technical Issues

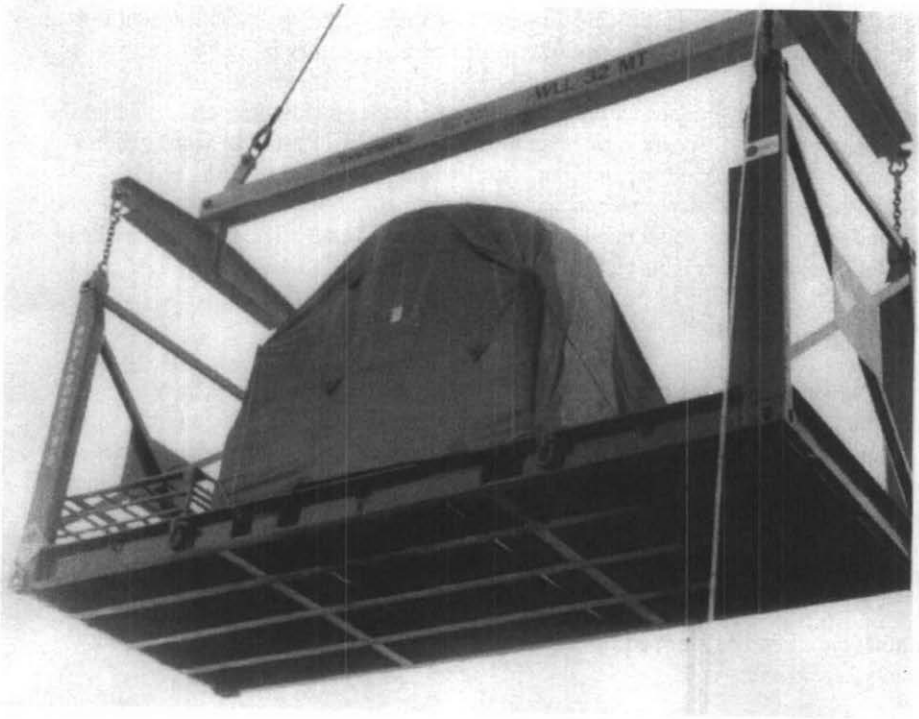
There are several technical issues that have caused concern during planning and implementing shipments. Any potential technical concern should be raised as soon as possible to ensure to best possible chance for resolution to prevent possible delays or non-acceptance of spent fuel intended for shipment.

In 1997, problems with determining fuel conditions acceptable for shipment and storage at SRS without encapsulation led DOE to assess the basis for the requirement. Initially, required fuel condition for transport and storage was not well defined. A strict interpretation was established based on studies conducted at SRS and other reactor facilities. This criteria led to one assembly stored at the United Kingdom Atomic Energy Agency's Dounreay facility being encapsulated prior to shipment due to the identification of nodules indicating through clad pits. Further evaluation of the physical behavior of metallic fuels led to a revision to the requirements enabling significantly more assemblies to qualify for return without encapsulation. Fuel condition must now meet cask certificate requirements as well as requirements specified in most current revision of the Appendix B.

Additionally, early issuance of a comprehensive Appendix A and verification of the cask's U.S. Certificate of Compliance is essential for DOE to complete all prerequisites to issue an Authorization to Ship letter. This letter acknowledges receipt of an acceptable Appendix A(s), specifies that DOE has made all preparations to accept the material, and provides authorization to ship the material, but does not direct the shipment of material. Coordination and scheduling is conducted by the reactor operator or authorized agent. Although a reactor operator may choose to "load at risk," the reactor operator cannot allow the material to depart

operator may choose to "load at risk," the reactor operator cannot allow the material to depart the reactor site until this letter is received by facsimile. Any activity conducted prior to receipt of this letter is a risk taken by the reactor operator. Good coordination and cooperation by the reactor operator, Shipper of Record, and DOE usually ensures the advance issuance of the "Authorization to Ship" prior to its need.

Casks are required to be loaded into standard 20 foot ISO containers. Flat racks or skids that may be handled in the same manner as a standard 20 foot ISO container may also be used. However, the cask should be covered in some manner such as the Japanese cask shown below.



Reactor operators, contractors, and vendors should ensure any special tools and equipment are maintained with the packages and all required shipping papers. Special shipments of cask handling tools have been made in the past causing a delay in the proper packaging of a transport package. Delays such as this can occur when time is critical due to the massive effort to coordinate the next critical path activity requiring coordination of support organizations and equipment.

To date, every shipment has had multiple technical and logistical issues which required resolution prior to shipment. Early identification of issues will allow DOE-SR, DOE contractors, and shipping agents, as appropriate, to mitigate any potential obstructions.

Public Relations

Public relations is an important part of the successful implementation of the program to return U.S. origin spent nuclear fuel to the United States. The DOE has made a concerted effort to inform and involve the public and to obtain public support for the implementation of this policy. Although many articles are written in local newspapers and other media have been used to inform the public, Edie Lau, a Sacramento Bee Newspaper staff writer from Sacramento, California, indicates in her September 14, 1997 article, that little information is reaching the average person in the Charleston shipment corridor areas. The DOE continues to work with anyone raising issues associated with this program. Public affairs activities are particularly active in planning and initiating the first shipment of spent nuclear fuel through California to the Idaho Engineering and Environmental Laboratory in Idaho.

Reactor operators have similar, but uniquely different, issues facing their effort to ship the fuel out of their country. As one may imagine, depending on the attitude of the general population as well as special interest groups, each reactor operator must proceed in accordance with their country's acceptance of the shipment of this material thorough their country and the transfer of spent nuclear fuel to the United States. The DOE can assist in public relation activities as requested by the reactor operator.

Other Lessons Learned

Lessons Learned reviews are conducted by DOE with participating United States organizations after each shipment so that future shipments can be conducted in the safest and most effective manner possible. Any issue raised is documented, evaluated, and tracked to closure. Through this process, DOE hopes to improve the efficiency of these shipments into the United States.

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