INEEL/CON-97-01175
CONF-9710102--

Reduced Enrichment for Research and Test Reactors
1997 International Meeting
Jackson, Wyoming
USA

Status of the TRIGA Shipments to the INEEL from Asia

October 9, 1997

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Abstract

This paper will report on preparations being made for returning Training, Research, Isotope, General Atomics (TRIGA) foreign research reactor (FRR) spent fuel from South Korea and Indonesia to the Idaho National Engineering and Environmental Laboratory (INEEL). The roles of U.S. Department of Energy, INEEL, and NAC International in implementing a safe shipment are provided. Special preparations necessitated by making a shipment through a west coast port of the United States to the INEEL will be explained.

The institutional planning and actions needed to meet the unique political and operational environment for making a shipment from Asia to INEEL will be discussed. Facility preparation at both the INEEL and the FRRs is discussed.

Cask analysis needed to properly characterize the various TRIGA configurations, compositions, and enrichments is discussed. Shipping preparations will include an explanation of the integrated team of spent fuel transportation specialists, and shipping resources needed to retrieve the fuel from foreign research reactor sites and deliver it to the INEEL.

Status of the TRIGA Shipments to the INEEL

Background

In February 1996, the U.S. Department of Energy (DOE), in consultation with the U.S. Department of State (DOS), issued the *Final Environmental Impact Statement on a Proposed Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel* (DOE/EIS-218F). On May 13, 1997, DOE announced it's new spent fuel (SNF) program in a Record of Decision (ROD). The purpose of the acceptance policy is to support the broad United States' nuclear nonproliferation policy calling for the reduction and eventual elimination of the use of highly enriched (weapons-grade) uranium in civil commerce worldwide.

According to the ROD, the Savannah River Site (SRS) is to receive all the aluminum based (material test reactor, MTR) SNF and the Idaho National Engineering and Environmental Laboratory (INEEL) is to receive the Training, Research, Isotope, General Atomics (TRIGA) SNF. There is a total of 41 countries that could participate in the program of which 19 countries have TRIGA fuel. There is a total of 20 metric tons of material available worldwide that could be returned to the United States, of which 1 metric ton is TRIGA fuel.

This Foreign Research Reactor SNF acceptance policy expires May 13, 2006. Any country desiring to participate in this policy must have either completed their shipments to the United Sates or have removed their SNF from the reactor by that date. The policy provides a three (3) year period, until May 12, 2009, to allow SNF removed from the research reactor by, no later than May 12, 2006, to cool down before being shipped. The United States will not extend the policy beyond May 12, 2009. All countries will need to be prepared to provide their own disposition of their SNF after the policy period is over.

Once the ROD had been issued and INEEL was identified to receive all of the TRIGA SNF, the Department determined which countries would be ready to ship their SNF in the near future. To assist in identifying which countries are ready to ship, a team representing DOE-HQ, DOE-ID, Argonne National Laboratory, and support service contractors visited TRIGA Research Reactors in three countries in Asia, i.e., South Korea, Thailand, and Indonesia. The purpose of the visit was to introduce the research reactor operators to the program, identify key contacts, assess the fuel and cask handling capabilities, and determine if they are ready to ship and want to participate in the program. It was determined that South Korea and Indonesia had SNF they wanted considered for the return program. Thailand has TRIGA fuel, however, they do not have enough SNF to participate in the first shipment.

In order for the first TRIGA shipment to be made, there is a significant amount of planning, coordination, and preparations required. The rest of this paper describes the roles of the major participants in the program; facility preparations at the research reactor facilities; special preparations needed to make a shipment from the west coast sea port, Naval Weapons Station Concord (NWSCo) to INEEL; facility preparations at the INEEL; and the shipping preparations, including the unique challenges for licensing a shipping cask and resources for making the shipment.

Roles

A critical part of successfully completing this program requires identifying the roles and responsibilities of the major participants. The following are the key participants for the Foreign Research Reactor Program and their roles and responsibilities:

- Department of Energy Headquarters (DOE-HQ), Office of Environmental Management, Office of Spent Fuel Managements is responsible for implementing the Policy. They provide overall guidance, set policy, and coordinate all activities including, i.e., determine which countries will go first, with the State Department and foreign governments

- Department of Energy Idaho Operations Office (DOE-ID) FRR Program is responsible for all preparations and execution of all TRIGA SNF shipments to INEEL. Provides oversight of all INEEL FRR Program activities. Negotiates and executes the contract between DOE and the research reactors. DOE-ID also participates in the selection of the transportation services contractor for each shipment destined for INEEL.

- Lockhead Martin Idaho Technologies Company (LMITCO) is responsible for planning, preparation, coordination, and execution of all activities needed to accept, transport and store the TRIGA SNF from the foreign countries to the INEEL.

- Nuclear Assurance Corporation (NAC) International is responsible for the transportation services contract for this shipment. They are responsible for providing certified shipping casks, preparation of the SNF and casks at the research reactors, loading of the fuel in to the casks, transport of the casks to INEEL, and providing technical support to INEEL.

Foreign Research Reactor Preparations

Preparing the TRIGA research reactor facilities in South Korea and Indonesia for fuel and cask handling began in October 1996 with the preliminary visit of the DOE team. Both countries have SNF stored in two different facilities, i.e., South Korea has facilities in Seoul and Taejon, and Indonesia has facilities in Bandung and Yogyakarta The team discussed with reactor operators the INEEL requirements for acceptance of the SNF and discussed the special requirements and/or limitations within the reactor facility.

Once it was clear that South Korea and Indonesia wanted to participate in the program and make a shipment, a follow up detailed assessment was made. A team of technical experts from the INEEL took specialized underwater camera and recording equipment to the reactor facilities. A detailed examination of all the SNF proposed to be returned to the INEEL was done (a detailed discussion of the results from these examinations can be found in References 1 and 2, papers being presented at this conference). The team performed detailed evaluation of the fuel and cask handling capabilities for the facilities. Finally, the team began contract negotiations and discussions about the fuel acceptance criteria for returning the SNF to the INEEL.

In July 1997, DOE-SRS awarded the carrier contract for the INEEL Asian shipment to NAC International (NAC). Information from the INEEL preliminary and detailed assessments were provided to NAC so they could start planning for the shipments. On September 22, 1997, NAC sent a team of fuel, cask, and transport experts to both countries to evaluate the facilities, fuel and cask handling capabilities, and identify the requirements for making the shipments within the countries. NAC will provide DOE-ID with results from the evaluation. DOE will use that information to finalize the contract with the reactor operators and finalize the fuel and cask handling, and shipping planning and preparations.

West Coast Transportation Preparations

The ROD identified two (2) preferred sea ports for receiving the SNF into the United States. All Asian Pacific Rim TRIGA shipments, except Japan, are to be received through the Naval Weapons Station Concord (NWSCo). All other shipments are to be received through the Naval Weapons Station Charleston. A maximum of five (5) shipments are to be received through NWSCo over the life of the policy.

The potential for transporting SNF through the San Francisco Bay area, across California, Nevada, Utah, and Idaho poses unique challenges for the program. Even though the route through these states is through sparsely populated areas and the San Francisco Bay area is very industrialized with numerous refineries, chemical processing facilities and the NWSCo handles military ordnance on a regular basis, there is a very strong and vocal anti-nuclear sentiment, especially in California and Nevada. There is minimal opposition to the nonproliferation aspects of the program, however, there is opposition to transporting the SNF along the proposed route.

To work through these challenges, the program has implemented a very proactive effort to inform the public of the importance and safety of the shipments; prepare the States Tribes and local governments for the shipments; ensure that all the affected agencies are informed of the shipments, their requirements are clearly understood and procedures are in place to meet the requirements; and, the shipments are made safely, and securely with minimal impact on the States, Tribes, and local governments.

To accomplish this, the program has been meeting with regional organizations, such as, the Western Governors Association, representatives from all four (4) states, representatives from tribes along the route, and federal and local agencies. Needs assessments have been conducted that introduce the representatives to the cargo being shipped and the minimal public safety risk that will result from the shipment. The needs assessments also identified; roles and responsibilities; existing capabilities, i.e., manpower, technical expertise, and equipment availability; procedures; and, interface and coordination with each other. From these assessments, deficiencies are identified and corrective actions are taken. Some of the more important observations from the assessments are:

- These shipments do not impose any real risks. The rigorous performance based Type B packaging for SNF make the shipments safe;

- In many cases the Emergency Responders are adequately trained for responding to an incident involving these shipments, however, some radiological specific training may be required to show the responders that they can take life saving actions without endangering their own lives;

- Specialized equipment is not required for most emergency responders. The training for using and the cost for maintaining specialized equipment is expensive and should be limited to a few experts that can be quickly transported to the incident, if necessary.

Once all of the needs assessments are completed, the corrective actions identified will be made. Prior to the shipment there will be a table top exercise(s) to verify that all of the procedures, roles and responsibilities, equipment, and requirements are clearly understood and will be implemented before commencing the shipment.

Facility Preparations at INEEL

The SNF from this program will be stored in a remote handled dry storage facility within the Idaho Chemical Processing Plant (ICPP). The receipt of the FRR SNF at INEEL requires several items be completed. Since the cask used for this shipment has not previously been handled at ICPP, INEEL facility safety evaluations are being performed, i.e., Safety Analysis Reports and Criticality Safety Evacuations. The safety evaluations cover receipt, storage, and the possibility of a drop scenario of the casks with the impact limiters removed. Cask and fuel handling hardware is being designed and fabricated to safely handle the fuel and casks, i.e., a sliding saddle, used to secure the cask to the facility cask transfer device, and a cask lid handling tool. An air supply line to operate the fuel basket grappling tool is being installed in the facility.

The INEEL Nuclear Operations Organization is working with the cask vendor, NAC, to design and fabricate a canister spacer to be used in the cask for alignment of the NAC basket loaded with TRIGA fuel. This will allow the receiving facility, ICPP-603, to use the cask baskets for loading the SNF directly into the storage facility.

A training plan and procedures have been written for the unloading of the cask. All of the facility operators must be train on the procedure. This is accomplished in part by conducting a dry run with the cask using the procedures to check out the operations and equipment from start to finish. The dry run validates the procedures, identifies any potential equipment deficiencies, and serves as training for the operations personnel that will conduct the unloading. INEEL will complete the dry run using the NAC-LWT cask at the end of October 1997.

Once all of the fabrication is complete and the training finished, a Management Self Assessment (MSA) is conducted to verify all of the required items are in place for receipt of the fuel. If all items pass the MSA, the facility and personnel are deemed ready to receive the fuel.

Preparations for Fuel Transport

The transportation of spent TRIGA fuels is complicated by the diversity in materials, enrichments, and configurations, by the physical limitations of the reactor facilities, and by the requirements of the DOE receipt facility. NAC's preparations for the initial TRIGA shipment are oriented toward enveloping this diverse set of requirements in a manner that provides efficient and cost effective performance to the reactor operator and to Department.

Differing cladding materials, such as, stainless steel and aluminum, uranium enrichments varying between 20% and 93% U-235, as well as instrumented fuel pins and fuel follower control rods are present in the mix of fuel forms to be returned to the United States under the FRR Program. Degraded fuel requiring canning under DOE's acceptance criteria may be present as well. Several of these fuel forms will be routinely included in the inventory of spent fuel intended for shipment from a single reactor facility. Consequently, the packaging design and certification must accommodate a mixed loading if it is to achieve efficient transport. The NAC-LWT shipping cask internal configuration and hardware is being tailored to meet these requirements.

To accommodate the physical variations in the TRIGA fuel and the potential presence of degraded fuel in the NAC-LWT shipping cask, a basket system is being introduced with two different lengths in a single cask loading. A third length is possible if needed to accommodate failed fuel follower control rods. These basket configurations are an extrapolation from the proven seven position MTR basket that has been used very successfully in both domestic and international research reactor shipments. In a typical configuration, four baskets of approximately 81 cm (32 inch) length and one of approximately 122cm (48 inch) length would be used in a single cask loading. With up to four TRIGA rods in each of the seven storage positions in each basket, the cask will accommodate up to 112 standard length rods and 28 over-length rods (instrumented assemblies or fuel follower control rods.) Standard rods can also be shipped in the long basket through the use of spacers. The baskets are sized to be able to accept either bare or canisterized fuel. Consequently, the new NAC-LWT TRIGA basket design provides a efficient package capable of high loading density (up to 140 rods) regardless of the TRIGA fuel configuration or condition.

In order to provide the maximum flexibility to the reactor operator and to meet the objectives to minimize costs to both the reactor operator and to DOE, it is necessary that the cask loading accept intermixing of the TRIGA fuel form and enrichments. The analysis developed for submission to the Nuclear Regulatory Commission (NRC) is based on the basket configuration described above, including the potential for mixed loadings. In order to demonstrate that criticality is avoided for any cask loading, a parametric evaluation is being performed of various configurations. The intent is to show that HEU fuel can be placed in any of the basket positions without adverse consequences. The long, small diameter configuration of the NAC-LWT cask provides a favorable geometry for this purpose. In addition to the criticality calculations, the license amendment will, of necessity, address thermal, shielding, and structural acceptability as well. Of these, only the structural analysis is expected to pose any difficulty. The large number of TRIGA rods possible in an NAC-LWT loading results in a package weight considerably in excess of that of an MTR loading. These calculations are in progress with the objective of submitting a license amendment to the NRC in early fall.

The physical restraints present in many TRIGA reactor facilities pose an additional difficulty in preparing for transport of the spent fuel. Small passages, restricted access, and limited crane capacity combined to impede fuel loading into most contemporary spent fuel shipping casks. These casks, weighing 20 metric tons or more, are of a weight and configuration which normally precludes their access to the reactor. To overcome this difficulty, the NAC-LWT TRIGA basket system is being designed to be compatible with the NAC Dry Transfer System (NAC-DTS). The DTS system, field proven at four research reactors and at DOE and university facilities in the U.S., allows individual baskets containing up to 28 TRIGA rods to be moved by use of a lighter and more easily maneuverable cask. Through use of a complement of interface equipment currently under development for TRIGA application, the transfer cask will be usable with a variety of fuel pool and hot cell configurations. Hardware design and fabrication is design pursued on a schedule compatible with the initial shipment schedule.

The DOE receipt facility at the INEEL is designed for remote-handled hot cell dry unloading of casks and transfer of the spent fuel into storage canisters. Cask unloading difficulty is increased by restricted visibility and limited handling flexibility. NAC-LWT accommodates dry unloading in this environment since the grapple system has been designed to maintain its orientation with the basket handling features absent visual access. The TRIGA rods will be handled in the cell as loaded baskets, greatly simplifying cell operations. The basket, of a size that fits within the INEEL storage canister, precludes the need for additional unloading and loading operations and permits corresponding reduction in the needed equipment complement.

The NAC team that has been assembled to perform the transportation function includes specialists in reactor site services, cask loading and handling, transportation, and security. The team, in addition to NAC, includes Duke Engineering and Services, Schenker International, and Security Consultants Group. Each has a proven track record in its area of expertise and has established a working relationship with each other. This team is now interfacing with DOE, LMITCO personnel at INEEL, and with the state and regional organizations necessary for successfully transport of the TRIGA fuel from South Korea and Indonesia.

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Report Number (14) INEEL/CON--97-01175
CONF-9710102--

Publ. Date (11) 19971009
Sponsor Code (18) DOE/EM, XF
UC Category (19) UC-2000, DOE/ER