MOVING INTO THE 21ST CENTURY – THE UNITED STATES' RESEARCH REACTOR SPENT NUCLEAR FUEL ACCEPTANCE PROGRAM

by

David G. Huizenga, United States Department of Energy
Tracy P. Mustin, United States Department of Energy
Elizabeth C. Saris, Science Applications International Corporation
Jill E. Reilly, Science Applications International Corporation

22nd International Meeting
on Reduced Enrichment for Research and Test Reactors (RERTR)
October 3-8, 1999
Budapest, Hungary

ABSTRACT

Since 1996, when the United States Department of Energy and the Department of State jointly adopted the Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel, twelve shipments totaling 2,985 MTR and TRIGA spent nuclear fuel assemblies from research reactors around the world have been accepted into the United States. These shipments have contained approximately 1.7 metric tons of HEU and 0.6 metric tons of LEU. Foreign research reactor operators played a significant role in this success.

A new milestone in the acceptance program occurred during the summer of 1999 with the arrival of TRIGA spent nuclear fuel from Europe through the Charleston Naval Weapons Station via the Savannah River Site to the Idaho National Engineering and Environmental Laboratory. This shipment consisted of five casks of TRIGA spent nuclear fuel from research reactors in Germany, Italy, Slovenia, and Romania. These casks were transported by truck approximately 2,400 miles across the United States (one cask packaged in an ISO container per truck). Drawing upon lessons learned in previous shipments, significant technical, legal, and political challenges were addressed to complete this cross-country shipment. Other program activities since the last RERTR meeting have included: formulation of a methodology to determine the quantity of spent nuclear fuel in a damaged condition that may be transported in a particular cask (containment analysis for transportation casks); publication of clarification of the fee policy; and continued planning for the outyears of the acceptance policy including review of reactors and eligible material quantities. The United States Foreign Research Reactor Spent Nuclear Fuel Acceptance Program continues to demonstrate success due to the continuing commitment between the United States and the research reactor community to make this program work. We strongly encourage all eligible research reactors to decide as soon as possible to participate in the program. As we move into the 21st century we will continue to work together to eliminate the use of highly enriched uranium in civil commerce and support our mutual nonproliferation objectives.

PAPER

The Foreign Research Reactor (FRR) Spent Nuclear Fuel (SNF) Acceptance Program in its fourth year and continues to support worldwide nonproliferation objectives to reduce and eventually eliminate highly enriched uranium (HEU) in civil commerce. To date, twelve shipments consisting of 2,985 spent nuclear fuel assemblies from 29 research reactor facilities in 22 countries have been successfully completed. While we continue to anticipate that activities under this program will become more routine, we still find that each year presents new situations and challenges.

A major success of the past year was our completion of the first U.S. cross-country shipment of FRR SNF on August 31, 1999. A ship, containing eight casks of SNF from six countries in Europe arrived at the Charleston Naval Weapons Station on the 19th of August. These casks were loaded onto a train and transported to the Savannah River Site (SRS). At SRS, three of the casks, which contained aluminum-based MTR fuel from Denmark and Portugal, were transferred to SRS facilities for unloading. The five remaining casks contained Training, Research, Isotope, General Atomic (TRIGA) spent nuclear fuel from Germany, Italy, Romania, and Slovenia. These casks were loaded onto trucks (one cask per truck) and transported approximately 2,400 miles (3862 km) overland to the Idaho National Engineering and Environmental Laboratory (INEEL).

The success of this shipment was due to the detailed planning and cooperation of a great number of parties. The Department's Savannah River Office, which is also the lead office for implementation of the acceptance program, had the lead for planning the U.S. overland portion of the shipment. Since this was another significant "first" for the program, DOE embarked on a planning and preparation process that took almost a year to complete. Beginning in late Summer 1998, with the formulation of a Cross-Country Transportation Working Group (CCTWG), DOE initiated contact with all parties having a role in shipment planning. The CCTWG was composed of representatives from 17 States and two Tribal Nations, state regional groups, DOE, the Nuclear Regulatory Commission (NRC), the Federal Bureau of Investigation (FBI), and the Department of Transportation (DOT). The CCTWG met three times between December 1998 and June 1999 to ensure that all aspects of transportation, security, and emergency preparedness were addressed. The CCTWG identified issues and proposed resolutions, provided input on potential highway routes, helped develop the transportation plan, and generally provided a forum for DOE to gain perspective on states and tribal transportation issues related to the shipment. The first two meetings addressed logistical and planning issues associated with transportation of spent nuclear fuel. The third meeting was a transportation plan validation exercise which allowed states and tribes to address specific shipment scenarios to determine their readiness and the effectiveness of DOE's transportation plan. As a result, the Department of Energy established a strong working relationship with states potentially impacted by these shipments. Over the course of the next nine years of the program, we will continue to work with this group to ensure that future cross-country shipments are equally successful.

One of the most sensitive issues we had to resolve in planning for this shipment was the overland transportation route selection. While the U.S. DOT and the U.S. NRC have regulations that address routing for spent nuclear fuel shipments, there was a great deal of discussion and

interaction with the CCTWG on which route would be used for this shipment. Regulations basically require shippers to use highway routes that will minimize the time a shipment is in transit. Using a routing model that considers the regulations (the HIGHWAY model), DOE identified four potential routes from SRS to INEEL. At our request, states and tribes provided input on travel day and time restrictions in metropolitan areas, the inspections they would perform within their state or tribal boundary, and other considerations of importance to them. A risk analysis which evaluated the radiological and non-radiological risk of transit along these four routes was also completed. After considering all of this information, one of the four routes was eliminated from further analysis because of the mountainous terrain and extreme weather conditions. Of the three remaining routes, one was chosen for the first cross-country shipment. The remaining two routes are still eligible for use in future shipments of foreign research reactor spent nuclear fuel from SRS to INEEL. By having three viable highway routes from SRS to INEEL, we believe we have given ourselves adequate flexibility to complete one to two cross-country shipments per year over the remainder of the program period.

Although this was the largest planning effort undertaken to date in the acceptance program, we were able to take advantage of our experience and lessons learned in planning the previous shipments. With ten states and two tribes along the selected route, logistics and communication were major issues. While all states were largely prepared from an emergency preparedness perspective, DOE assisted the states and tribes in preparing for the shipment if they requested.

In addition to the logistical and communications challenges, there were political challenges as well. While most of our planning efforts were focused at the state and tribal level, the Congressional representatives from all of the potentially affected states were invited to a briefing in January 1999. This briefing provided an overview of the acceptance program as well as specifics on the first cross-country shipment. Throughout the planning process, additional presentations were given to state and local officials at their request and information materials were provided. The Governors' designees in states along the route were given standard official notification prior to the shipment departure. States and tribes were also given access to TRANSCOM (a near real-time satellite tracking system used during the U.S. portion of the shipments) to view the shipment en route. As a result, state governments were informed and supportive, making the shipment a success.

In addition to our cross-country planning efforts over the past year, we have faced other domestic and international issues as well. For example, the transportation of operationally failed and damaged fuel continues to be a major issue. Last year, we talked to you about our efforts to develop a clarification document regarding transport of fuel with damage greater than hairline cracks and pinhole leaks (i.e., with exposed fuel meat). Since that time, we have issued a document to be used by cask owners in evaluating their casks for transport of damaged fuel. This clarification was necessary to distinguish failed fuel for purposes of transportation and storage from the reactor failed fuel which is no longer suitable for use in the reactor. Fuel that is no longer suitable for use in reactor is not necessarily unsuitable for transportation and storage. This methodology may be used to determine the amount of spent nuclear fuel in a damaged condition that may be transported in a particular cask (containment analysis for transportation casks). This methodology was developed in consultation with the U.S. NRC. The document, entitled "Basis for Containment Analysis of Transportation of Aluminum-Based Spent Nuclear

Fuel," identifies a methodology for determining radionuclide release fractions of MTR-type fuel with exposed fuel meat. This methodology may be incorporated into requests for Certificates of Compliance or Certificates of Competent Authority in the originating country and in the U.S., as appropriate. It is our hope that this document will allow reactor operators and DOE to characterize fuel for transportation more efficiently and make the transportation planning process easier.

On the transportation package front, two new casks were made available or will soon be available for the shipment of spent fuel under the program: the GE-2000 and the TN-MTR. The GE-2000, manufactured by General Electric, was recertified in July 1999 for the transportation of spent fuel in the U.S. The TN-MTR, owned by Transnucleaire, France, has been certified in France. Certification of this cask in the U.S. is still pending. It is our hope that these casks will provide added flexibility to reactor operators in planning for shipments of fuel under the program. The GNS-16 cask, manufactured by Gesellchaft fur Nuklear-Service GmbH (GNS) and owned by Nuclear Cargo and Servicing (NCS), has also come into service since last year's meeting and has been used in two research reactor shipments over the past year.

On the programmatic side, on April 13, 1999, DOE published a clarification of the Fee Policy for Acceptance of Foreign Research Reactor Spent Nuclear Fuel in the U.S. Federal Register. The Federal Register notice clarified the initial notice, published on May 28, 1996, which established the fee policy, to address changes in a country's economic status during the program period. Specifically, if a country's economic status (as determined by the World Bank) changes from "other-than-high-income" to "high-income," shipments from research reactors in that country will be treated as shipments from "high-income" economy countries after a grace period of approximately one year. Research reactor operators considered "high-income" economy countries will be responsible for transportation costs and a fee will be charged for receipt and management of the spent fuel by DOE. In the event that a country's economic status changes from "high-income" to "other-than-high-income," DOE's subsidy of shipments and waiver of the management fee would apply to any shipments initiated after publication of such a change. The World Bank publishes its economic development report annually in October. The new fee policy became effective on October 1, 1999. For shipments of spent fuel made to the U.S. prior to October 1, 1999, fees were based on the countries' economic status as reported in the May 1996 Record of Decision. With the one year grace period built into the clarification, the clarification is expected to have minimal impact on reactor operators. There are in fact very few research reactors with spent fuel eligible for shipment under this program, whose host country's economic status is likely to change during the program period.

As reported last year, the Department continues to work on an amendment to the Record of Decision regarding the number of spent fuel casks allowed to be transported per vessel in a shipment. At the start of the acceptance program, it was assumed that eight casks per vessel would be the maximum number of casks that would be available for any one shipment. This assumption was based on the worldwide supply of available casks for transporting spent fuel. This supply of casks has increased since 1996, and the Department has confirmed that increasing the maximum number of casks per vessel from eight per ship to sixteen per ship is still within the bounds of the analysis presented in the Final EIS and within all regulatory requirements. Increasing the number of casks per ship makes shipment planning more efficient, allows more

spent fuel to be returned per shipment, reduces the total number of shipments, and lowers the cost of transporting spent fuel to the United States. In reality, it is unlikely that the number of casks on a ship for any given shipment will increase dramatically due to the number of casks currently available. However, this amendment will give us more flexibility in those cases where more than eight casks may be available for a shipment.

We continue to reach out to research reactor operators around the world to discuss the program with them and to learn their plans with respect to the long-term management and disposition of their research reactor spent nuclear fuel. As stated earlier, spent fuel from 29 research reactor facilities in 22 countries has been shipped to the U.S. for interim management pending ultimate disposition. We currently have signed contracts, or are negotiating contracts, with 38 reactor operators. However, there are still a significant number of reactor operators who have not yet made a final decision regarding their participation in the program or who have indicated that they do not plan to participate. Since our last meeting, representatives from the Department of Energy have visited reactor operators in Brazil, Argentina, Mexico, Finland, Democratic Republic of Congo, South Africa, The Netherlands, Austria, Germany, and Portugal to discuss program requirements and to determine interest in participating. For those of you who continue to delay your decision about participating or who have indicated that you will not participate, we urge you to carefully consider this decision. The acceptance program has a limited duration and will not be extended beyond 2006 (policy ends May 2009). There are still openings on the shipping schedule in 2000 and beyond. Representatives from the Savannah River Site and the Idaho National Engineering and Environmental Laboratory would be happy to meet with you to discuss planning for a shipment. We continue to have the capacity to support approximately six shipments per year through the Charleston Naval Weapons Station and anticipate up to four more shipments via the Concord Naval Weapons Station over the remainder of the program period.

In support of our efforts to establish contact with all eligible reactor operators, we are preparing to send letters to those reactor operators with whom we have not yet made contact to remind them of the program's existence and re-emphasize its limited duration. We also plan to provide similar information to the government agencies responsible for the reactors to ensure that they are aware of the program and the opportunity it presents. For those countries with eligible reactors deciding not to participate in the Acceptance Program, we strongly urge you to aggressively pursue the planning necessary for your own disposition program. It has been our experience that establishing an acceptable program can take many years. The Department of Energy has been and will continue to be available to participate in any discussions on these issues and to share our lessons learned as appropriate.

In the United States, the Department continues to prepare its environmental impact statement (EIS) to consider the potential impacts associated with options for the management and treatment of approximately 28 metric tons heavy metal of aluminum-clad spent nuclear fuel, from both foreign and domestic research reactors, at or to be shipped to SRS. Alternatives to conventional reprocessing are currently being studied. They include **Direct Disposal/Direct Co-Disposal** which calls for the fuel to remain intact but be repackaged in a way to eliminate the possibility of criticality and the need for elaborate treatment processes and equipment. A second option is the **Melt and Dilute** technology which involves melting the aluminum-based SNF and then diluting the HEU to a level appropriate for disposition. A third option is **Mechanical Dilution** which

involves either the Press and Dilute or the Chop and Dilute options which are similar to the Melt and Dilute except the fuel assemblies would be pressed or chopped as opposed to a melting process. A fourth option is **Vitrification**, in which the spent fuel is mixed with molten glass or ceramic material for storage in a solid form and includes technologies such as Plasma Arch Treatment, Glass Material Oxidation and Dissolution System, and Dissolve and Vitrify. The last option being studied is **Electrometallurgical Treatment**. This treatment is an electrorefining process that would separate HEU from the aluminum and fission products in the SNF and then the HEU would be blended down to low-enriched uranium. The Department's preferred alternative is the Melt and Dilute Technology. The *Savannah River Site Spent Nuclear Fuel Management Draft Environmental Impact Statement (EIS)* was issued in December 1998 and has undergone public review and comment. The final EIS is expected to be released this year.

Looking toward next year, we anticipate more challenges and successes. First, a possible overland shipment from Canada's University of Toronto research reactor is being planned. This shipment would traverse the Eastern seaboard, most likely by truck, to SRS. States along the potential route, the U.S. DOT, and other federal and state agencies will be involved in the planning process to ensure a safe and efficient shipment. Another potential technical and logistical challenge is a shipment of spent fuel from the RA-3 reactor in Argentina. This fuel, currently in an underground tube storage in a facility in Buenos Aires, could present not only cask loading issues due to its current storage configuration but also significant radiological health issues due to the radiation levels associated with some of the material. Finally, we anticipate one or two cross-country shipments from SRS to INEEL next year. While we expect that each of these shipments will consist of only one or two casks, there will inevitably be new issues which must be addressed.

The U.S. Foreign Research Reactor Spent Nuclear Fuel Acceptance Program continues to make significant achievements in support of nonproliferation efforts. The Department seeks to ensure that as much eligible spent fuel as possible is shipped to the U.S. during the program period. The continued cooperation between participating research reactor operators, their governments, and DOE is critical to our future success in this effort. Research reactor operators are strongly encouraged to decide as soon as possible if they will participate so that planning preparations can be initiated to ensure shipment of their fuel to DOE facilities. At this point in the program, shipments have already been scheduled through 2002, however, there are still shipping opportunities available in this time frame. Experience has shown that the circumstances at any given reactor in any country pose technical issues that have the potential to impact shipment scheduling in a profound way. The earlier that reactor operators participate, the sooner pro-active planning may begin, thus avoiding last minute and costly problems during the shipment process. The Department hopes to have the opportunity to work with many more reactor operators and their governments in the coming year to continue to make the program a continuing success.

REFERENCES

[1] U.S. Department of Energy Final Environmental Impact Statement, Proposed Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel, DOE/EIS-0218F (February 1996).

[2] U.S. Department of Energy Record of Decision for the Final Impact Statement, Proposed Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel (May 13, 1996).

[3] N.C. Iyer, et al., "Bases for Containment Analysis of Transportation of Aluminum-Based Spent Nuclear Fuel," October 1999.

[4] U.S. Department of Energy, Draft Environmental Impact Statement, Savannah River Site Spent Nuclear Fuel Management (December 1998).