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FOR: The Commissioners  
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SUBJECT: TRANSPORTATION RISK STUDIES

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## **PURPOSE:**

To inform the Commission of the roles of past and present spent nuclear fuel transportation risk studies in the transportation safety program. The staff has already completed two transportation risk studies; a third is presently nearing completion; and a fourth was recently initiated. This paper discusses NRC's continuing efforts in conducting spent fuel transportation risk studies, the contribution of each to the Commission's transportation safety program, and plans for further communication with the public on spent fuel transport risk.

## **BACKGROUND:**

The U.S. Nuclear Regulatory Commission's (NRC's) responsibilities in the transport of spent nuclear fuel include certification of transport packaging designs, approval of transport package Quality Assurance programs, issuance of general licenses authorizing licensees to offer material to carriers for transport, and establishment of physical protection requirements for spent fuel in transit. Pertinent NRC regulations are contained in 10 CFR Part 71, "Packaging and Transportation of Radioactive Material," and in [10 CFR 73.37](#), "Requirements for Irradiated Reactor Fuel in Transit."

The Commission has been studying safety in the transport of spent nuclear fuel under its regulations for nearly 25 years. In December 1977, when the Commission adopted the generic environmental impact statement for transportation, it directed that regulatory policy concerning transportation be subject to close and continuing review. NRC's studies have shown that the risk of release of radioactive material from transport is low. Moreover, NRC's transportation regulations are based on those developed through consensus at the International Atomic Energy Agency (IAEA), and the experience derived from the shipment of spent fuel by IAEA Member States who have corroborated NRC's safety results.

Nevertheless, public concern over spent fuel shipments is high. As an example, when shipment of less than 10 individual spent fuel rods (less than one assembly) from PECO Energy's Limerick reactor to the General Electric facility in Vallecitos, California, was announced, questions from local government and media representatives about shipment safety and security began to arise, particularly in the San Francisco Bay area. NRC Headquarters and Region IV staff held a public meeting during October 1999, in Alameda County, California, to address concerns about the shipment and facility operations at General Electric. Days before the shipment departure, the Ohio Turnpike Authority advised the NRC that it was denying access to the shipment, resulting in a last-minute re-routing of the shipment through Maryland and West Virginia. The State of Illinois also expressed concerns about the shipment route. The Limerick shipment contained 10 spent fuel assembly rods, or a little over 20 kg of 2.8 percent enriched uranium. As large-scale shipment campaigns approach, with much greater quantities of spent fuel going from NRC-licensed facilities to storage and disposal facilities, public interest is expected to increase substantially.

## **DISCUSSION:**

### **Two Past Studies**

The NRC first evaluated the impact on public health and safety resulting from regulated transportation activities in NUREG-0170, "Final Environmental Statement on the Transportation of Radioactive Material by Air and Other Modes" (Vols I and II, December 1977). NUREG-0170 examined impacts from all licensed material by land, air, and sea transport modes under both incident-free and accident conditions. The report contains an assessment of spent fuel shipment risk using the 1975 level of shipments, and a projection of risks for 1985, based on the assumption of a reprocessing fuel cycle. Sandia National Laboratories conducted the risk assessment for NRC, and developed the RADTRAN I radioactive material transport risk code, to perform the related dose calculations. NUREG-0170 was issued for public comment; Volume II contains the comments and responses.

Considering the information developed and received, and the safety record associated with the transportation of radioactive material, the Commission determined that the regulations then in place were adequate to protect the public against unreasonable risk from the transport of radioactive materials, and that no immediate changes in the regulations were needed to improve safety (46 FR 21619). The U.S. Department of Transportation also relied on NUREG-0170 to assess the impact of

radioactive material transportation under its "Hazardous Materials Regulations" (49 CFR Subchapter C, Parts 171-180). The Commission concluded that prudence dictated that regulatory policy concerning transportation of radioactive materials be subject to close and continuing review.

In the mid-1980s, several spent fuel shipment campaigns were initiated to return spent fuel from the West Valley facility in western New York to the originating utilities. These campaigns drew considerable public interest, and questions focused on the difficulty in comparing NRC's spent fuel cask accident standards with actual accident conditions. These standards are expressed as a series of hypothetical tests and acceptance criteria which are contained in [10 CFR 71.73](#). The NRC addressed the level of safety provided by its regulations with respect to accident conditions in a study, which is frequently referred to as the "Modal Study," conducted for NRC by Lawrence Livermore National Laboratory ("Shipping Container Response to Severe Highway and Railway Accident Conditions," NUREG/CR-4829, Volumes I and II, February 1987).

To elaborate on the NUREG-0170 spent fuel shipment accident risk estimate, the "Modal Study" included an assessment of the probabilities and forces associated with severe transportation accidents. The "Modal Study" also examined transport cask response to accidents by using finite element modeling of generic cask responses to accident forces. The results indicated that annual spent fuel shipment risks were about one-third those estimated in NUREG-0170. Staff concluded from the "Modal Study" that NUREG-0170 clearly bounded spent fuel shipment risks which supported the Commission's previous decision that there was no need to change transportation regulations to improve safety.

## Two Current Studies

The "Reexamination of Spent Nuclear Fuel Risk Estimates" is an NRC effort currently underway at Sandia National Laboratories. Its purpose is to assess the characteristics of large-scale spent-fuel shipment campaigns currently anticipated and, using the results of the "Modal Study" and the most recent risk assessment code (RADTRAN V), to determine whether the original NUREG-0170 risk estimates bounded those for the anticipated shipment campaigns. Like NUREG-0170, this study calculates the risks for spent fuel shipments under both incident-free and accident conditions, but unlike that study, takes into account such factors as the design, enrichment, burn-up, and cooling time of fuel currently anticipated to be shipped; the capacity and designs of newer casks; and current population densities along road and rail routes. The "Reexamination" will contain the results of two analyses, one based on "Modal Study" cask response and release information, and another based on newer cask response and release information developed in the "Reexamination" study. Preliminary results using the "Modal Study" cask information, coupled with the data representative of anticipated shipments, continue to show that accident risk estimates are less than those in NUREG-0170.

The "Reexamination" also attempts to provide a best estimate of accident risk, by extending the "Modal Study" methodology to examine the response of the cask closure mechanism to mechanical and thermal loads. The best-estimate spent-fuel shipment risks from the reexamination appear to be less than the "Modal Study"-based estimates by as much as 2 orders of magnitude. This is also much less than the NUREG-0170 estimates. However, several technical questions on the Sandia methodology require resolution before the best-estimate results can be completed. If the resolution of best-estimate risks requires additional analysis, that effort will be undertaken in the "Package Performance Study," as described below. A plain English summary of the "Reexamination Study" will be prepared after the publication of the contractor report.

The most recent staff initiative in the transportation area is the "Package Performance Study." This study will focus on spent nuclear fuel cask responses to severe transportation accidents. The objective of the "Package Performance Study" is to address remaining spent fuel transportation issues from the "Modal Study" and the "Reexamination of Spent Fuel Transportation Risk Estimates," using a public-participation approach to solicit public and stakeholder interests in developing the study's scope and parameters for review. Further, whereas the preceding studies have all been analytical in nature, the "Package Performance Study" will consider the use of physical testing to address issues, where appropriate. Risk insights obtained using current analysis techniques, physical testing, and through interaction with stakeholders and the public, will support NRC's ongoing efforts to assure that its regulatory actions are risk-informed and effective. The staff is using an enhanced public participation process to both design and eventually conduct the "Package Performance Study."

Sandia has been tasked with the first phase of the "Package Performance Study," which is a scoping study of possible follow-on work to the previous studies. Two roundtable public meetings, in Bethesda, Maryland, and Henderson, Nevada, and two additional public meetings, in Henderson and Pahrump, Nevada, have already been held on the "Package Performance Study." A World Wide Web site <http://ttd.sandia.gov/nrc/modal.htm> has been established to facilitate interactions on the project. Ongoing public interactions throughout this project will help ensure that public concerns are effectively identified and understood, and that the study design considers these issues. The first product of this study will be an "Issues and Resolutions Option Report," scheduled for Summer 2000.

Since spent fuel transportation occurs in the public domain, shipments have, and will continue, to raise considerable interest, particularly as the series of new large-scale shipments approaches. The Commission studied public interest issues associated with spent fuel shipments ("Case Histories of West Valley Spent Fuel Shipments," NUREG/CR-4847, January 1987), as a way to identify effective measures to help address public concerns before commencement of spent fuel shipment campaigns. That study found that the development and implementation of comprehensive public information (and educational) programs that explain the technical, operational, safety, and physical protection aspects of spent fuel transport in layman's terms improve public confidence in spent fuel shipping campaigns. Staff is implementing this lesson learned in its transportation risk study plans.

## CONCLUSION:

The transportation risk studies described here provide a technical basis for determining that current regulations are sufficient to prevent releases of radioactive material during transport. The most recent "Package Performance Study" provides a process for public involvement in the decision making process for further studies.

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