



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS  
WASHINGTON, DC 20555 - 0001

August 30, 2012

MEMORANDUM TO: Dr. Michael Ryan, Chairman  
Subcommittee on Radiation Protection & Nuclear Materials

FROM: Christopher L. Brown, Senior Staff Engineer

SUBJECT: STATUS REPORT FOR THE MEETING OF THE  
SUBCOMMITTEE ON SPENT FUEL TRANSPORTATION RISK  
ASSESSMENT (SFTRA)  
September 18, 2012 IN ROCKVILLE, MARYLAND

The purpose of this memorandum is to forward written materials for your use in preparing for the meeting of the ACRS Subcommittee on September 18, 2012 concerning the staff's technical and regulatory activities associated with EST.

Attendance by the following members is anticipated, and reservations have been made at the following hotels for September 17, 2012.

Armijo	BETHESDA N MARRIOTT	Sieber	THE LEGACY
Ray	BETHESDA N MARRIOTT	Powers	RESIDENCE INN
Skillman	BETHESDA N MARRIOTT		
Bley	None		
Ryan	BETHESDA N MARRIOTT		

SFTRA NUREG was given to you during the July FC meeting. NUREG is not only on SharePoint but available via Google search. Please notify ACRS Travel via email if you need to change or cancel the above reservations.

cc: C. Santos

**Advisory Committee on Reactor Safeguards**  
 Meeting of the Subcommittee on Radiation Protection & Nuclear Materials  
**Spent Fuel Transportation Risk Assessment (SFTRA)**  
 Rockville, MD

Under Development

Tuesday, September 18, 2012

Cognizant Staff Engineer: Christopher L. Brown (301) 415-7111, [Christopher.Brown@nrc.gov](mailto:Christopher.Brown@nrc.gov)

Item	Topic	Presenter(s)	Time
1	Opening Remarks and Objectives	Dr. Michael Ryan, ACRS	1:00 – 1:05 p.m.
2	Staff Opening Remarks	John Cook, NMSS	1:05 - 1:15 p.m.
3			1:15 – 2:45 p.m.
4	Break		2:45 - 3:00 p.m.
5			3:00 - 3:30 p.m.
6			3:30 – 4:00 p.m.
7			4:00 – 4:30 p.m.
8	NRC Staff Closing Remarks	John Cook, NMSS	4:30 – 4:45 p.m.
9	Committee Discussion	Dr. Ryan, ACRS	4:45 – 5:00 p.m.
10	Adjourn		5:00 p.m.

NMSS/SFST Notes:

- During the meeting, 301-415-7360 should be used to contact anyone in the ACRS Office.
- Presentation time should not exceed 50 percent of the total time allocated for a given item. The remaining 50 percent of the time is reserved for discussion.
- Thirty five (35) hard copies (2 B&W slides per page) of each presentation or handout should be provided to the Designated Federal Official 30 minutes before the meeting.
- 10 full page colored copies for the ACRS members and the court reporter.

## ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

# Spent Fuel Transportation Risk Assessment (SFTRA)

September 18, 2012

Rockville, Maryland

### - Status Report -

## PURPOSE

Review an updated Spent Fuel Transportation Risk Assessment (NUREG-2125).

## INTRODUCTION

Current regulations specify that spent nuclear fuel (SNF) transportation casks must be designed to survive a free fall from a height of 9 meters (30-foot) falling onto a flat, essentially unyielding, target in the orientation most likely to damage the cask (10 CFR Part 71). Current regulations also specify that SNF transportation packages must be designed to survive exposure to a fully engulfing fire accident lasting no less than 30 minutes with an average flame temperature of no less than 1475°F (802°C). The package must maintain containment, shielding, and criticality functions throughout the fire event and post-fire cool down in order to meet NRC requirements.

## BACKGROUND

- Sandia performed finite element analysis of cask response to impact and thermal accident conditions
- Use DOT “event trees” used to estimate probabilities of accident conditions
- Use RADTRAN<sup>1</sup> to calculate routine doses and accident dose risks for representative truck and rail shipments
- Approach similar to that in NUREG-0170 and NUREG/CR-6672<sup>2</sup>
- New rail and truck event trees
- RADTRAN new Version 6:
  - Elevated releases
  - New loss of shielding analysis
- Updated population data (2000 Census; trying to revise to 2010 Census pending TRAGIS update)
- Updated traffic density and accident data for truck and rail

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<sup>1</sup> RADTRAN is the national and international standard for transportation risk assessment for radioactive materials. The code was developed at Sandia National Laboratories. RADTRAN combines user-determined demographic, routing, transportation, packaging, and materials data with meteorological data (partly user-determined) and health physics data to calculate expected radiological consequences of incident-free radioactive materials transportation and associated accident risks.

<sup>2</sup> Three NRC publications demonstrate the progress that has been made in transportation safety risk assessments over the last 30 years.

– NUREG-0170 (1977): original transportation EIS for transportation of radioactive materials

– NUREG/CR-4829: aka; The Modal Study (1987)

– NUREG/CR-6672: “Re-examination of Spent Fuel Shipment Risk Assessments” (2000)

- Hi-fidelity HI-STAR 100 and NAC-STC cask finite element models, including impact limiters
- Direct loaded fuel and welded inner canister fuel
- More precise structural (e.g., bolt model) and thermal (e.g., 3-D) analyses
  - better estimate of cask-to-environment release fractions

The report presents the results of a fourth NRC investigation into the safety of SNF transportation. The risks associated with SNF transportation arise from the radiation the SNF gives off and the possibility of the release of some quantity of radioactive material in the event of a severe accident. The transportation casks greatly minimize the radiation emitted from the SNF, but do not completely eliminate it. The SFTRA investigation shows, however, that the “risk from the radiation emitted from the casks is a small fraction of naturally occurring background radiation and the risk from accidental release of radioactive material is several orders of magnitude less.”

## **DISCUSSION**

Although the actual per shipment risk has not changed over the last 35 years that the agency has studied transportation risks, the calculated risks have changed due to the improved ability to evaluate cask responses and their SNF contents. Since the last study was published, “the improved analysis tools, improved data availability, and a reduction in the number of conservative assumptions has made the estimate of accident risk from the release of radioactive material in this study approximately five orders of magnitude less than what was estimated in NUREG-0170.”

SFTRA estimated the behavior of three NRC certified casks during routine transportation and in transportation accidents. Two of the casks studied are designed for rail transport and a third cask with depleted uranium gamma shielding is designed to transport directly loaded spent fuel by highway.

The study resulted in the following findings (quoted from the introduction):

- The collective dose risks from routine transportation are vanishingly small. These doses are approximately four to five orders of magnitude less than the collective background radiation dose.
- The routes selected for this study adequately represent the routes for SNF transport, and there was relatively little variation in the risks per kilometer over these routes.
- Radioactive material would not be released in an accident if the fuel is contained in an inner welded canister inside the cask.
- Only rail casks without inner welded canisters would release radioactive material, and only then in exceptionally severe accidents.
- If there were an accident during a spent fuel shipment, there is only about one in a billion chance that the accident would result in the release of radioactive material.

• If there were a release of radioactive material in a spent fuel shipment accident, the dose to the maximally exposed individual (MEI) would be less than 2 sieverts (Sv) (200 rem) and would be neither acute nor lethal.

• The collective dose risks for the two types of extremely severe accidents (accidents involving a release of radio-active material and loss of lead shielding (LOS) accidents) are negligible compared to the risk from a no-release, no loss of shielding accident.

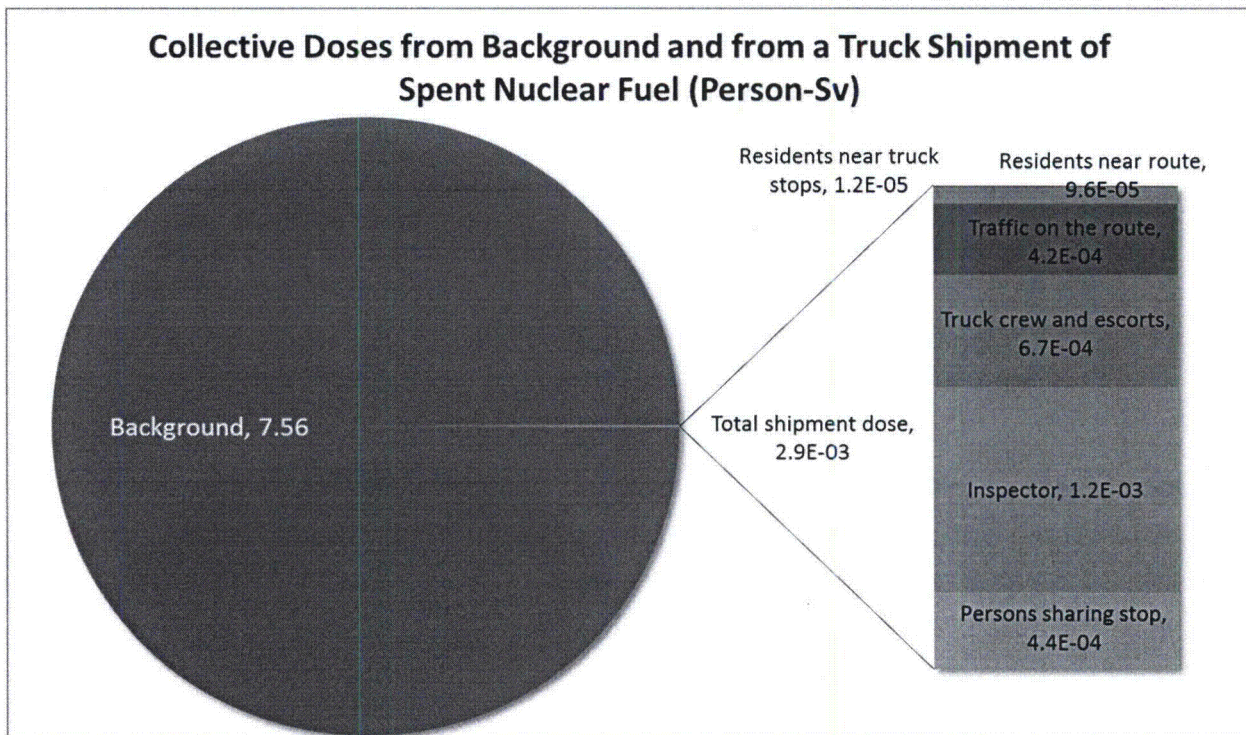
• The risk of gamma shielding loss from a fire is negligible.

None of the fire accidents investigated in this study resulted in a release of radioactive material.

The report includes analyses of impact accidents, fire accidents, and transportation accidents. It does not consider the effects of transporting high burnup SNF.

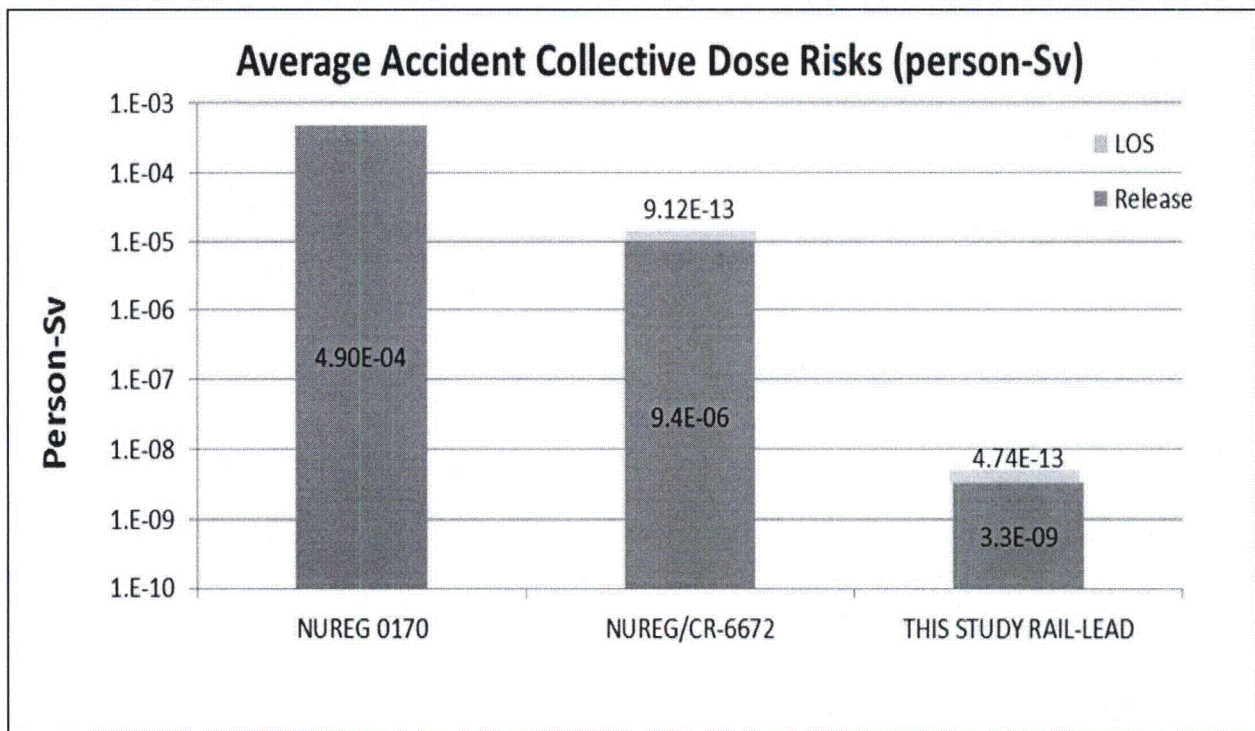
**SFTRA Results: Routine conditions**

**Collective doses from background and from Maine Yankee to ORNL truck shipments of spent nuclear fuel (person-Sv).**



### SFTRA Results: Accident conditions

Accident collective dose risks from release and loss of gamma shielding (LOS) accidents.  
The LOS bars are not to scale.



#### SFTRA Conclusion

- Based on these findings, this study reconfirms that radiological impacts from spent fuel transportation *conducted in compliance* with NRC regulations are low, in fact generally less than previous, already low, estimates.

Accordingly, with respect to SNF transportation, the previous NRC conclusion that the regulations for transportation of radioactive material are adequate to protect the public against unreasonable risk is also reconfirmed by this study.

#### Some Public Comments

1. We strongly recommend that when finalizing this report, that the NRC does not include the Hanford Site as a representative destination for spent fuel shipments. Issues related to the import of waste to Hanford are highly contentious and divisive and can and have interfered with the environmental cleanup that is now in its 24th year. While we recognize Hanford was selected as a representative site to allow for analysis of long distance routes, identifying it in a manner such as this perpetuates the belief that Hanford should be considered for further waste disposal and storage missions. Hanford is not a suitable location for receipt of spent nuclear fuel from commercial reactors or other waste streams. NRC staff certainly recognized the political sensitivity of not selecting Yucca Mountain as a representative destination. The same considerations should have been made with regards to Hanford.

2. There is no explanation of why this study was done at this time. Just because the tools are available to conduct a more detailed study does not explain why a decision was made to take a new look at potential spent fuel transportation risks - especially given that they were already calculated to be very low. A compelling explanation of why the new study was conducted at this time should be added.
3. The document - especially the Executive Summary and Appendix F - should better reflect risk communication techniques. There are numerous examples within both sections where unlike risks are compared with one another (for example, transport risk versus natural background, and transport risk versus cancer therapy treatment).
4. The text on page F-9 refers to an "improbable accident," and the text on page F-II states that "if there were an accident during a spent fuel shipment, there is only about a one in a billion chance the accident would result in a release of radioactive materials." Given recent experiences with Deepwater Horizon and Fukushima, the public has rightly become skeptical about government proclamations of the unlikelihood of a severe accident. The public has clearly seen that severe accidents are very much possible.

#### **POSSIBLE QUESTIONS FOR THE COMMITTEE TO ASK STAFF**

1. How will the staff address possible post-Fukushima public apprehension over nuclear activities?
2. There already is a substantial amount of work that has been done in assessing safety of spent nuclear fuel transportation. SFTRA is a big RADTRAN calculation (done by Sandia) that already has been done with no new useful information. RADTRAN is used to calculate routine doses and accident dose risks for representative truck and rail shipments. This approach is similar to that in NUREG-0170 and NUREG/CR-6672. No real world accidents were considered, such as very long fire duration of cask. The study does not even analyze a particular fire type. Only the basic regulatory tests (drop tests) were done. SFTRA does use updated DOT information. No source terms. No use of the Baltimore Tunnel or Caldecott fire data. NMSS has done many studies of a SNF cask in a tunnel on fire. Also, SFTRA is not going to be used to develop regulatory guidance or be used to update 10 CFR Part 71. Hence, why should the Committee endorse this NUREG/study?
3. We understand that the state of Nevada had many questions on SFTRA. Why? What were some of the questions asked by Nevada (Mr. Halstead)?
4. Should Yucca Mountain become resurrected, will this study be useful?
5. Why didn't the staff analyze the risk of terrorist attacks on SNF as rigorously as they analyze nuclear power plant safety?
6. What about potential releases from failed fuel with CRUD? Was the fuel cool time considered in the study?
7. Were there any peer reviews conducted for this report? If so, who?

## **RECOMMENDATION**

The staff should have included an examination of the potential for fuel cladding failure and release of radioactive materials for high burnup fuels (>45 GWd/MTU), specifically addressing the issues of radiation embrittlement, hydride reorientation, pellet degradation due to thermal cycling, and fission product buildup. It is unclear why this was not done since this has been a staff/industry issues for past 7 years.

## **REFERENCES**

1. Spent Fuel Transportation Risk Assessment (NUREG-2125)
2. 10 CFR Part 71