

**State of Nevada**  
**Agency for Nuclear Projects**  
**Comments on**  
**SPENT NUCLEAR FUEL TRANSPORTATION PACKAGE PERFORMANCE**  
**STUDY ISSUES REPORT (30 June 2000)**  
**Prepared for**  
**U.S. Nuclear Regulatory Commission**  
**By**  
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**Inadequate Background Discussion of Stakeholder  
Transportation Risk Issues**

The Issues Report background discussion (Pp. 1-2) does not adequately represent the general spent nuclear fuel (SNF) transportation risk concerns raised by the State of Nevada and other stakeholders at the public meetings held in Bethesda, MD on 17 November 1999 and in Henderson, NV on 8 December 1999.

Nevada and other stakeholders are concerned that the relatively small number of domestic SNF shipments over the past two decades provide scant basis for confidence in the safety of future shipments. The Issues Report fails to provide any meaningful information on historical shipments of SNF in United States. At a minimum, the Issues Report should have presented and analyzed the information periodically reported by the U.S. Nuclear Regulatory Commission. Table 1 summarizes U.S. SNF shipment experience over the past two decades. There have been on average only 70 SNF shipments per year, primarily truck shipments between Eastern U.S. origins and destinations.

**Table 1**  
**U.S. SNF Shipment Experience, 1979 - 1997**

- Amount Shipped: 1,453 MTU (77 MTU per year)
  - Truck Shipments: 1,181 (62 per year)
  - Rail Shipments: 153 (8 per year)
  - Truck Share of Shipments: 89%
  - Rail Share of MTU: 76%
  - Average Truck Distance: 684 miles (82% < 900 miles)
  - Average Rail Distance: 327 miles (80% < 600 miles)
  - Origin & Destination East of Mississippi River: 70% (935/1334)
  - Reactor Sites Shipping SNF: 27 ( 9 sites >2 shipments)
- Source: NUREG-0725, Rev. 13 (Oct., 1998)

The Issues Report barely acknowledges the magnitude of the expected increase in SNF shipments if the U.S. Department of Energy (DOE) begins operation of the geologic

repository proposed for Yucca Mountain, NV. The Issues Report should have included the estimates of projected SNF and high-level radioactive waste (HLW) shipments developed by DOE and by the State of Nevada. Tables 2 and 3 present DOE estimates ranging from 600 to 2,500 shipments per year, every year for about four decades. Table 4 presents Nevada's estimate of the most probable repository transportation scenario, averaging more than 1,000 shipments per year over about four decades.

**Table 2**  
**Projected SNF/HLW Shipments to Yucca Mountain,**  
**DOE Mostly Truck Scenario,**  
**38 Years (2010-2048)**

- 96,000 Legal-Weight Truck (LWT) Shipments
  - 300 Rail Shipments (Naval SNF)
  - 2,534 Shipments per Year
  - 105,000 MTU Civilian SNF
  - 15,000 MTU Equivalent Defense HLW, DOE SNF, Naval SNF, Civilian HLW
- Source: DOE/EIS-0250D, July, 1999, Appendix J

**Table 3**  
**Projected SNF/HLW Shipments to Yucca Mountain,**  
**DOE Mostly Rail Scenario,**  
**38 Years (2010-2048)**

- 19,800 Rail Shipments
  - 3,700 Legal-Weight Truck (LWT) Shipments
  - 618 Shipments per Year
  - 105,000 MTU Civilian SNF
  - 15,000 MTU Equivalent Defense HLW, DOE SNF, Naval SNF, Civilian HLW
- Source: DOE/EIS-0250D, July, 1999, Appendix J

**Table 4**  
**Projected SNF/HLW Shipments to Yucca Mountain,**  
**State of Nevada Current Capabilities Scenario, 38 Years (2010-2048)**

- 26,400 Legal-Weight Truck (LWT) Shipments from 32 reactor sites (40% of Civilian SNF total)
  - 8,200 Rail Shipments from 40 reactor sites (60% of Civilian SNF total)
  - 5,900 Rail Shipments from 5 DOE Sites
  - 1,066 Shipments per Year
- Source: Halstead, Nov., 2000 (forthcoming), based on PIC, Sept., 1996, & DOE/EIS-0250D, July, 1999, Appendix J

As stated at the Henderson meeting, Nevada believes that the Issues Report should discuss the actual accident and incident rates for historical SNF shipments, and the resulting potential for future accidents and incidents. Table 5 presents the historical accident and incident rates through 1990 calculated by Science Applications International Corporation. Nevada is currently updating these rates, but little change is expected because of the small number of shipments and shipment-miles during the decade of the

1900s. Table 6 presents Nevada's estimates of future accidents and regulatory incidents for three repository shipment scenarios.

**Table 5**

**U.S. SNF Accident/Incident Record**

- No accidents resulting in releases since 1962
  - No accidents resulting in death since 1971
  - 6 accidents, 47 regulatory incidents, 1971 - 1990
  - SAIC calculated accident/incident rates for loaded commercial SNF shipments, 1970 - 1990:
    - SNF truck accident rate: 0.7 per million miles
    - SNF rail accident rate: 9.7 per million miles
    - SNF truck incident rate: 10.5 per million miles
    - SNF rail incident rate: 19.4 per million miles
- Source: SAIC, YMP/91-17, Sept., 1991

**Table 6**

**Projected SNF/HLW Accidents & Incidents**

- DOE Mostly Truck National Scenario, 38 Years
    - 129 Truck Accidents
    - 1,935 Truck Regulatory Incidents
  - DOE Mostly Rail National Scenario, 38 Years
    - 433 Rail/ 7 Truck Accidents
    - 866 Rail/ 103 Truck Regulatory Incidents
  - Nevada Current Capabilities National Scenario, 38 Years
    - 199 Rail/ 43 Truck Accidents
    - 399 Rail/ 639 Truck Regulatory Incidents
- Source: Halstead, Nov., 2000 (forthcoming)

During the Bethesda and Henderson meetings, Nevada presented information on expected changes in future SNF shipment characteristics that could contribute to increases in both the frequency and consequences of accidents. Table 7 summarizes the expected changes in shipment characteristics. The dramatic increases in average rail and truck shipment distances could impact equipment performance and human factors. Challenging route characteristics and operating conditions in the West also could affect transportation safety.

**Table 7**  
**Future SNF Shipment Characteristics**  
**Projected Shipments to Yucca Mountain (2010-2048)**  
**Compared to U.S. Historical Shipments (1979-1997)**

- 35 Times More SNF Shipped Per Year
- 8 to 36 Times More Shipments Per Year
- 680% Increase In Average Rail Shipment Distance
- 290% Increase In Average Truck Shipment Distance
- Western Route Characteristics (Mountainous Terrain, Severe Weather Conditions)
- Western Operating Conditions (Higher Speeds, Longer Emergency Response Times)
- Potential Unprecedented Reliance on Long-Distance Heavy Haul Truck Shipments

Nevada also presented information at the Bethesda and Henderson meetings about the potential radiological and economic consequences of severe accidents resulting in release of radioactive materials. The Issues Report fails to provide this information, which is essential to understanding Nevada's (and other stakeholders') concerns about SNF package performance. Table 8 provides DOE's and Nevada's estimates of the radiological consequences of a very severe rail accident in an urban area, using the RADTRAN computer code and varying assumptions. Nevada believes that even more severe accidents are possible, but for purposes of this analysis Nevada accepted DOE's definition of a maximum reasonably foreseeable accident. Table 8 also provides Nevada's estimate of SNF accident economic impacts.

**Table 8**  
**Consequences of Credible Severe Accident**  
**DOE Maximum Reasonably Foreseeable Rail Accident in Urban Area**  
**(Probability 1.4 in 10 million)**

- DOE estimated impacts [DEIS, Table 6-12]
- Population dose (person-rem): 61,000
- Latent cancer fatalities: 31  
(RADTRAN4, 26year-old PWR, mostly stable atmospheric conditions)
- Nevada estimated impacts [RWMA, 6/28/00]
- Population dose (person-rem): 711,000 - 863,000
- Latent cancer fatalities: 356 - 432
- Economic cost (2000\$): \$63 - 108 Billion  
(RADTRAN4/5, 10 & 26 year-old PWR, weighted average atmospheric conditions)

During the Bethesda meeting, stakeholders took differing positions on how the Package Performance Study should address the vulnerability of shipping casks to terrorist attacks using high-energy explosive devices. The Issues Report is silent in this regard. In a separate forum, Nevada has petitioned the NRC to reassess the consequences of such attacks [Docket PRM-73-10], and Nevada generally believes that the consequences of radiological sabotage should be addressed in the requested rulemaking. However, a current NRC publication summarizing the Modal Study findings cites an outdated terrorism consequence assessment as an upper bound estimate of a release from a cask involved in a severe accident. [W.R. LaHS,

Transporting Spent Fuel: Protection Provided Against Severe Highway and Railroad Accidents, NUREG/BR-0111 (March, 1987), page 30] Table 9 presents recent DOE and Nevada estimates of the consequences of a successful terrorist attack on a truck cask.

**Table 9**

**Consequences of Successful Terrorist Attack**

**DOE successful act of sabotage against truck cask in urban area**

**(High-energy explosive device)**

- DOE estimated impacts [DEIS, Pp. 6-33 to 6-34]
- Population dose (person-rem): 31,000
- Latent cancer fatalities: 15  
(RISKIND, 26year-old PWR, 90% penetration, average atmospheric conditions)
- Nevada estimated impacts [RWMA, 6/28/00]
- Population dose (person-rem): 12,700 - 329,000
- Latent cancer fatalities: 6 - 165
- Economic cost (2000\$): \$13.5 - 20.9 Billion  
(RISKIND/RADTRAN5, 26 year-old PWR, 90% & 100% penetration, weighted average atmospheric conditions)

**Sandia Recommendations Regarding Full-scale Cask Collision-Impact Testing**

The State of Nevada has advocated full-scale physical testing of SNF shipping casks for more a decade. However, Nevada must strongly oppose the Sandia recommendations for collision-impact testing of a full-size rail cask [Issues Report, pages 14-16] as part of the Package Performance Study. Sandia's testing proposal is poorly developed and does not specify selection of a current generation, large (125 ton) rail cask for testing.

At the Henderson meeting, Nevada restated its recommended approach to cask testing. Nevada advocates full-scale physical testing of cask prototypes prior to NRC certification to demonstrate compliance with the NRC performance standards (sequential drop, fire, puncture, and immersion tests). Nevada believes that stakeholders must be involved in all aspects of test planning, including development of cask testing protocols, selection of test facilities, and peer review. In addition to demonstrating compliance with NRC standards, full-scale testing can increase confidence in both qualitative and probabilistic risk analysis techniques, increase public acceptance of shipments, and reduce adverse socioeconomic impacts caused by public perception of risk. Nevada estimates the cost of such testing would be \$8 million to \$15 million for a truck cask, and \$12 million to \$25 million for a large (125 tons) rail cask, including the cost of the cask procurement and preparation, and the cost of test facility upgrades.

In our opinion, Section 2.9 is the least satisfactory portion of the Issues Report. The discussion of comments and issues raised [page 14] does not accurately report the discussions of scale-model and full-scale testing which occurred at the Bethesda and Henderson meetings. Sandia's background discussion of these issues [page 15] is

wholly inadequate, and ignores key references [such as D. Snedeker, Nuclear Waste Transportation Package Testing: A Review of Several Programs in the United States and Abroad, NWPO-TN-004-90(1990)] Sandia also failed to realistically examine testing costs. Nevada believes that the test program proposed by Sandia, using a current generation large (125 ton) rail cask, could cost \$10 million.

Even where Nevada strongly agrees in concept with Sandia, for example regarding the value of beyond regulatory impact testing to evaluate closure or penetration failures which could result in release of radioactive materials, we cannot endorse the proposed approach. We are disturbed by Sandia's premature conclusion that: "A side benefit of this type of test is that the outcome can be used to dramatically demonstrate that casks do not fail catastrophically when subjected to impacts that are significantly beyond the Part 71 tests." To our knowledge, no current generation U.S. casks have been subjected to extra-regulatory impact tests, so there is no basis for Sandia's assertion that casks cannot fail catastrophically. Moreover, catastrophic failure of a cask is not necessary to result in a release of radioactive materials sufficient to cause hundreds of latent cancer fatalities and billions of dollars in cleanup costs.

Section 2.9 of the Issues Report fails to answer the following critical questions: Why should a rail cask, rather than a truck cask, be tested? Which available rail cask, if any, is most representative of the rail casks which will be used for future shipments? Why should a head-on collision impact be evaluated, rather than some other impact configuration? Why should the test be performed horizontally on a sled track, rather than dropped onto an unyielding target? To what extent should cost constrain the selection of the rail cask to be tested and the selection of the testing facility?

Most importantly, Sandia apparently does not understand the stakeholder comments that full-scale testing, in and of itself, will not necessarily result in higher public acceptance. An ill-conceived testing program, using an obsolete or unrepresentative cask, will only further deepen public cynicism.

### **Sandia Recommendations Regarding Full-scale Cask Pool Fire Testing**

The State of Nevada supports, with conditions, the Sandia recommendation for an extra-regulatory pool fire test of "a real, full-scale, spent fuel cask" as part of the Package Performance Study. [Issues Report, pages 21 –22]

Nevada support is conditioned upon use of an undamaged, currently-licensed truck cask such as the NAC-LWT or the GA-4, and meaningful stakeholder in development of the testing program. Nevada estimates that such a test would cost about \$4 million

A new Nevada contractor report, "Spent Nuclear Fuel Shipping Cask Performance in Severe Fires: Performance Envelope Analysis, Fire Environment Modeling, and Full-Scale Physical Testing," by Prof. Miles Greiner, Mechanical Engineering Department, University of Nevada, Reno, will be submitted to NRC upon publication.

### **Sandia Recommendations Regarding Spent Nuclear Fuel Behavior During Accidents**

The State of Nevada strongly agrees with Sandia's recommendations regarding further study of pellet and rod behavior during severe accidents. [Issues Report, pages 30-31] The implications of higher fuel burnup and variation in cooling time require additional, specific attention.

### **Sandia Recommendations Regarding Accident Conditions and Probabilities**

The State of Nevada believes that Sandia's discussion of accident rate issues [Issues Report, pages 35-36] does not adequately respond to stakeholder comments made at the Bethesda and Henderson meetings. Sandia merely reasserts the purported merits of the approach used in NUREG/CR-6672 (development of risk estimates for four possible real shipment routes and 200 generic routes constructed using Monte Carlo sampling methods).

Nonetheless, Nevada generally agrees with Sandia's recommendations for future work in this area, especially further studies of occurrence frequencies of route wayside surfaces and specific historic severe accidents. Nevada believes that further study of human errors should be given an A rating, rather than the B rating assigned by Sandia.