

## **Going the Distance? NRC's Response to the National Academy of Science's Transportation Study– 8491**

E.P. Easton, C.S. Bajwa  
United States Nuclear Regulatory Commission  
Washington, DC 20555

### **ABSTRACT**

In February 2006, the National Academy of Sciences (NAS) published the results of a 3½-year study, titled *Going the Distance*, that examined the safety of transporting spent nuclear fuel (SNF) and high-level waste (HLW) in the United States. NAS initiated this study to address what it perceived to be a national need for an independent, objective, and authoritative analysis of SNF and HLW transport in the United States. The study was co-sponsored by the U.S. Nuclear Regulatory Commission (NRC), the U.S. Department of Energy (DOE), the U.S. Department of Transportation (DOT), the Electric Power Research Institute and the National Cooperative Highway Research Program.

This paper addresses some of the recommendations made in the NAS study related to the performance of SNF transportation casks in long duration fires, the use of full-scale package testing, and the need for an independent review of transportation security prior to the commencement of large scale shipping campaigns to an interim storage site or geologic repository.

### **INTRODUCTION**

In February 2006, the NAS published the results of a 3½-year study, titled *Going the Distance* that examined the safety of transporting SNF and HLW in the United States. The NAS study made several important findings that dealt with the safety of spent fuel package-design standards, societal concerns with future shipping campaigns, and security. The principal findings on transportation safety and security were:

- The study could identify no fundamental technical barriers to the safe transport of SNF and HLW in the United States. Transport by highway (for small-quantity shipments), and by rail (for large-quantity shipments) is, from a technical viewpoint, a low-radiological-risk activity, with manageable safety, health, and environmental consequences, when conducted with strict adherence to existing regulations; however, there are a number of social and institutional challenges to the successful initial implementation of large-quantity shipping programs that will require resolution. The challenges of sustained implementation should not be underestimated.
- Malevolent acts against SNF and HLW shipments are a major technical and societal concern, especially since the September 11, 2001, terrorist attacks on United States. The NAS committee judges that some of its recommendations for improving transportation safety might also enhance transportation security. NRC is undertaking a series of security studies, but the NAS committee was unable to perform an in-depth technical examination of transportation security because of information constraints.

The study also made a number of specific recommendations for enhancing the safety of transportation package designs, and for addressing societal concerns (primarily focused on a potential large-scale shipping campaign, such as to Yucca Mountain), including perceived risk and security. This paper discusses the NRC actions to address the study recommendations that deal with the safety- and security-related aspects of transportation package design. This is consistent with NRC's primary safety role, in

WM2008 Conference, February 24-28, 2008, Phoenix, AZ

potential Yucca Mountain shipments, of certifying the transportation casks, pursuant to the Nuclear Waste Policy Act.

## **DISCUSSION OF STUDY RECOMMENDATIONS**

There are three recommendations in the NAS study that concern safety and security-related aspects of transportation package design. These involve the use of full-scale package testing, the response of transportation packages in long-duration fires, and an independent examination of the security of SNF transportation before beginning a large-scale shipping campaign to a Federal repository or interim storage.

### Use of Full-Scale Package Testing

The study endorsed the use of full-scale testing as one of a number of analytical tools that could be used to determine how transportation packages would perform under both regulatory and credible extra-regulatory conditions. The study recommended that, “. . . full-scale package testing *should continue* to be used as part of integrated analytical, computer simulation, scale model, and testing programs to validate package performance. Deliberate full-scale testing of packages to destruction should not be required as part of this integrated analysis or for compliance demonstrations.” (Emphasis Added) In addition, NAS has stated, in public meetings, that the study did not endorse full-scale testing as a prerequisite for approving individual package designs.

NRC believes that the recommendation supports NRC’s current practice of using a combination of analytical techniques, such as computer simulation, full or partial scale-model testing, and component testing for package approvals. The study’s recommendation is consistent with NRC’s current plans in the Package Performance Study (PPS) to perform a demonstration test involving a realistic rail impact and fire. The NAS study also supports NRC’s decision not to test a full-scale transportation package to destruction in the PPS. As stated in the NAS study, “Deliberate full-scale testing of packages to destruction through the application of forces that substantially exceed credible accident conditions would be marginally informative and is not justified given the considerable cost for package acquisitions that such testing would require.”

The NRC has signed a cooperative agreement with the German Federal Institute for Materials Research and Testing (BAM) to obtain the full-scale and quarter scale transportation cask package drop test data for two casks. NRC staff is in the process of performing detailed independent structural simulations and finite element analyses of the drop scenarios and comparing the results with the BAM drop test data. This will help establish the magnitude of uncertainty in finite element analysis, and may address the use of scaling methods in the structural analysis of spent nuclear fuel casks.

### Transportation Package Performance in Very Long-Duration, Fully Engulfing Fires

The study concluded that current package performance standards in 10 CFR Part 71 are adequate to ensure package containment effectiveness over a wide range of transportation accidents, including most credible accident conditions. The study did question whether current package performance standards bound accidents involving very long-duration, fully engulfing fires. It recommended that NRC undertake additional analyses of very long-duration fire scenarios that would bound expected real-world accident conditions for representative package designs that are likely to be used in large shipping campaigns. The objective of these analyses would be to examine the need for regulatory or operational changes that could help prevent accidents that could lead to such a fire or to mitigate their consequences.

Since the study was published, the NRC has completed a number of actions that address this recommendation. First, NRC staff has reviewed railroad accident data, from the Federal Railway Administration (FRA) database, covering a period of 30 years (1975-2005), to determine the frequency and severity of rail fires. Based on FRA data and accident reports compiled by the National Transportation Safety Board (NTSB), NRC staff has concluded that the likelihood of a long-term fully engulfing rail fire is extremely low. In the nearly 21 billion miles of rail travel between 1975 and 2005, there have been eight accidents that NRC staff believes could have the potential for a fully engulfing very long-duration fire. Of these eight accidents, seven involved the derailment of a single train and one occurred in a tunnel.

Based on the NTSB accident reports on the seven accidents that did not occur in a tunnel, NRC staff believes that none of them would have actually resulted in a fully engulfing fire for a spent fuel package. This is based on mitigating factors present in all seven accidents. The mitigating factors include the expected location of a spent fuel package in the fire, the flammable material released, and emergency response. In each of the seven accidents, a spent fuel package would not have been positioned close enough to the burning flammable material to be fully engulfed. This is because of the DOT requirement for buffer cars, and is supported by accident diagrams of rail-car configurations taken from NTSB reports. In addition, many of the accidents involved flammable gases, such as propane, that resulted in localized pressure fires, and did not involve the pooling and migration of flammable liquids. These gaseous fires were intentionally allowed to burn for long periods (in some cases, for several days), as a safety measure, to empty ruptured tank cars and reduce the chance of explosion. Finally, emergency response times were fairly rapid in these seven accidents (most were responded to within 1 to 2 hours) and response efforts included cooling the tank cars, effectively minimizing fire intensity and duration. However, none of these mitigating factors was present in the Baltimore Tunnel fire accident - the one accident that occurred in a tunnel.

Second, NRC has completed two studies on the performance of representative spent fuel casks in severe rail and highway tunnel fires: "Spent Fuel Transportation Package Response to the Baltimore Tunnel Fire Scenario," NUREG/CR-6886 (published December 2006), and "Spent Fuel Transportation Package Response to the Caldecott Tunnel Fire Scenario," NUREG/CR-6894 (published February 2007). The Baltimore Tunnel fire study analyzed the potential response of the HI-STAR 100, TN-68, and the NAC-LWT shipping-package designs in a severe rail-tunnel-fire environment, based on an accident that occurred in Baltimore, Maryland, in 2001. The HI-STAR 100 and TN-68 are NRC-certified rail casks, and the NAC-LWT is an NRC-certified truck cask, that has been shipped by rail. The Caldecott Tunnel fire study analyzed the potential response of the NAC-LWT truck cask, based on a severe highway tunnel fire that occurred in California in 1982. The studies indicated that the casks would not be expected to release any fission products from the spent fuel. These studies are important because they address a severe type of fire (i.e., tunnel fire) that is potentially very long-duration and for which it may be difficult to take mitigating actions.

Third, NRC has considered what operating controls could be implemented, for rail shipments, to prevent or mitigate the consequences of long-duration fires. One important operating control would be to prohibit a train carrying flammable gases or liquids from being in a tunnel at the same time as a train carrying spent fuel. In March 2006, NRC staff requested that the Association of American Railroads (AAR) consider revising *AAR Circular No. OT-55, Recommended Railroad Operating Practices For Transportation of Hazardous Materials*. As a result, the AAR issued *AAR Circular No. OT-55, Revision I*, in July 2006. It states that, ". . . when a train carrying SNF or HLRW meets another train carrying loaded tank cars of flammable gas, flammable liquids or combustible liquids in a single bore double track tunnel, one train shall stop outside the tunnel until the other train is completely through the tunnel." NRC is also following FRA's ongoing deliberations on requiring the use of dedicated trains for spent fuel shipments. It should be noted that DOE has already announced a policy for using dedicated trains as its preferred

mode of transport. NRC staff believes that the prohibitions on the use of tunnels in OT-55, coupled with either an FRA requirement or DOE policy on using dedicated trains, will virtually eliminate the chances of rail accidents resulting in long-duration, fully engulfing fires, and that NRC does not need to take any further actions on rail operating practices.

The NRC is also examining two recent transportation accidents that have occurred since the NAS study was published, that involved severe highway fires. One is the MacArthur Maze (Interstate I- 880) accident in Oakland, California that occurred on April 29, 2007, where a gasoline tanker truck carrying 32,500 liters [8,600 gallons] of gasoline crashed and overturned on interstate highway. The resulting fire was intense enough to cause the collapse of a highway overpass located above the overturned tanker truck. The second accident being studied occurred on October 12, 2007, within the Southbound Truck-Only Bypass Tunnel at the I-5/14 Interchange in Northern Los Angeles County (Newhall Pass). In this accident multiple commercial vehicles (trucks) were involved in a severe fire occurring in ventilated short length tunnel. While neither of these accidents involved the actual shipment of radioactive materials, the NRC believes that the examination of these accident scenarios will enhance understanding of how spent fuel transportation packages might perform in real life transportation accidents involving severe fires.

#### Independent Assessment of Transportation Security

The study also recommended that, “. . . an independent examination of the security of spent fuel and high-level waste transportation, should be carried out prior to the commencement of large-quantity shipments to a federal repository or to interim storage.” This recommendation was not based on an identified deficiency in current security practices, but on an inability to access security information. The NAS committee was formed prior to September 11, 2001, and a majority of its members did not have the security clearances required to access important security-related information, particularly the security assessments being done on spent fuel transportation packages by the NRC and Sandia National Laboratories. It should also be noted that a recently completed assessment by the American Physical Society, *Consolidated Interim Storage of Commercial Spent Fuel, (February 2007)*, endorsed the NAS recommendation for an independent examination of the security of spent fuel shipments.

NRC believes that current security measures and standards put in place since September 11, 2001, are adequate for the protection of spent fuel and high level waste transportation even in the event of increased shipping campaigns. Physical protection measures for future shipments must match the threat in place at the time of shipment, and shipment tracking and monitoring technologies are constantly evolving. Shipments to Yucca Mountain would not begin, at the earliest, until 2017, based on current DOE estimates. In addition, whereas NRC would be responsible for overseeing the security requirements for commercial shipments to an interim storage facility, DOE would be responsible for implementing and overseeing the security requirements for Yucca Mountain shipments. Thus, a comprehensive independent security assessment that includes both shipments to Yucca Mountain and an interim storage facility would require substantial financial commitment and participation of both NRC and DOE.

NRC is considering the merits of releasing non-sensitive summaries of current spent fuel package security assessments in partial response to the NAS study recommendation. Spent fuel package designs, recently assessed in the Commission's spent fuel package security assessments, could be used at Yucca Mountain or interim storage facilities. The NRC's spent fuel package assessments adequately demonstrate that the stringent safety standards applied to the design of spent fuel packages provide substantial protection from reasonable threat scenarios. One of the key stakeholder groups, the Council of State Governments Midwestern Radioactive Materials Transportation Committee, has recently endorsed the NAS recommendation for an independent examination of the security of spent fuel shipments, and has specifically requested that NRC share some of the results of its spent fuel package security assessments with the States. In response, NRC staff has begun a dialogue, with representatives of the State Regional

Transportation Groups (SRG's), aimed at eventually sharing information from the NRC spent fuel package security assessments with State and local governments, to help them carry out their emergency response and law enforcement responsibilities more effectively. As part of the dialogue, the SRG's have compiled a list of what information (related to the spent fuel package security assessments) is needed, how and by whom such information would be used, and how shared information would be protected. The NRC is currently considering how it can share the requested information with the States, consistent with the Commission's policy and guidance on protecting security related information.

### Information Sharing

In addition, the study also recommends that NRC and Departments of Energy (DOE), Transportation (DOT) and Homeland Security (DHS) promptly complete the job of developing reasonable criteria for protecting sensitive information about spent fuel and HLW transportation, and commit to the open sharing of information not requiring protection.

NRC has worked jointly with DOE, DHS, and DOT to develop CG-RWT-1, the Joint DOE/NRC/DOT/DHS Classification and Sensitive Unclassified Information Guide for the Transportation of Radioactive Waste to Yucca Mountain. The classification guide was developed to identify the classified and sensitive unclassified aspects for the transport of spent nuclear fuel and high-level radioactive waste to Yucca Mountain, and should facilitate the identification of information that could be openly shared with the public.

The NRC has also developed guidance for the open sharing of non-sensitive information in its *Supplement to the Communication Plan for Security Assessments of Materials and Research & Test Reactors*, dated March 29, 2007.

### **CONCLUSIONS**

The NRC believes that the current regulations in 10 CFR Part 71 for the design of SNF and HLW transportation packages provide a very high level of protection to the public for very severe accidents and credible threat scenarios. As recommended by the NAS study, additional studies of accidents involving severe fires have been completed. These studies have confirmed that spent fuel casks would be expected to withstand very severe fires without the release of any fission products from the spent fuel. Additionally, changes in rail operating procedures such as the use of dedicated trains and prohibition on the co-location of SNF and flammable liquids in rail tunnels can further reduce the already low probability of severe rail accident fires involving SNF and HLW.

### **REFERENCES**

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