IMPACTS ON THE PACKAGE PERFORMANCE STUDY TESTING STRATEGY

A. Snyder, L. Camper, R. Lewis, A. Murphy, B. Tegeler
United States Nuclear Regulatory Commission

The views expressed in this paper do not necessarily reflect those of The U.S. Nuclear Regulatory Commission

ABSTRACT

In February 2003, the United States Nuclear Regulatory Commission (NRC) published for comment NUREG-1768, titled, "United States Nuclear Regulatory Commission Package Performance Study Test Protocols." This document summarizes the field tests, an impact test and a thermal test of each of two full-scale certified transportation casks, that the NRC proposed to perform under the Package Performance Study (PPS). The report also summarized some of the analyses performed to develop the protocols. PPS is a program that will extend over several years and includes using the results of existing transportation accident studies as well as updating transportation accident statistics for use in risk assessments. NRC plans to complete the testing aspects of the study by the end of FY 09. A wide range of the testing objectives were suggested by the public comments. Currently PPS testing objectives and test plans are being reexamined in light of the extensive comments provided on NUREG-1768 and during related public meetings.

INTRODUCTION

The NRC plans to conduct, using an enhanced public participation process, confirmatory research including physical full-scale testing, to demonstrate the robustness of full-scale spent nuclear fuel (SNF) transportation casks. This confirmatory research is identified as the Package Performance Study (PPS) and the NRC's proposed testing strategy published for public review and comment in February 2003, is found in the Package Performance Study Test Protocols Report, NUREG-1768 [1]. As explained in NUREG-1768, NRC proposed that this study will involve testing of both full-scale rail and truck transportation casks as well as analyses to develop and validate methods of analysis for use in transportation risk assessments.

The NRC=s primary role in transportation of spent fuel to a repository would be certification of the packages used for transport. Section 180 (a) of the Nuclear Waste Policy Act prohibits the Secretary of Energy from transporting spent nuclear fuel or high-level waste except in packages certified for such purpose by the Commission. The NRC has reviewed and certified a number of package designs which could be used for transport of spent fuel to a repository, and has additional designs under review. NRC regulations permit certification through testing, analyses, comparison to similar approved designs, or combinations of these methods. Typically, spent fuel casks have been certified through a combination of engineering analyses and scale or component testing.

A full scale test is not necessary for the NRC staff to achieve confidence that a design satisfies the regulatory tests, as long as the analyses are based on sound and proven analytic techniques.

The casks themselves are not complicated structures and the physics and mechanical properties can be accurately modeled by computer simulation. Computer analyses using well established engineering codes and some scale model testing is used to determine if a cask design will meet NRC safety requirements. Reliance on computer models for such structures is common, just as the seismic, wind, and fire performance of bridges and buildings is modeled rather than tested in a full-scale mockup. NRC requires that casks be designed to survive a sequence of tests including a 30 foot drop onto an unyielding surface. This is a very severe test that equates to the cask hitting a concrete upright along a highway at a high speed and encompasses an extremely high fraction (over 99%) of vehicle impacts.

Although NRC is entirely confident in the safety of NRC certified cask designs, in 1999 the NRC initiated the PPS to review the latest information and investigate the potential technical and public confidence benefits of a small set of physical demonstration tests. NUREG-1768 was published on February 21, 2003 for a 90 day comment period, ending May 30, 2003. During the public comment period, NRC held four (4) facilitated meetings throughout the nation and informed the public that NRC would consider all comments before making a final decision on the conduct of the testing. NRC plans to continue an extensive public outreach process throughout the PPS to address stakeholder concerns and to keep everyone fully aware of the testing process and outcomes.

PROPOSED TESTING APPROACHES

It is important to realize that the regulatory criteria for cask certification (e.g., the hypothetical accident conditions found in 10 CFR 71.73) are not mode dependent and encompass an extremely high fraction (over 99%) of possible real-world vehicle impacts and fires [2]. Due to the rigorous requirements, the NRC's independent design reviews, an exceptional accumulated safety record, and a series of risk studies, the NRC is confident in its cask certification criteria and certification process.

Early Approach

In 8 public meetings on spent nuclear fuel concerns conducted in 1999-2000, a large number of people requested the NRC to conduct full scale transportation cask testing. Commenters offered that these tests would help to further confirm NRC's conclusions about cask safety and would demonstrate that casks are able to survive real-world accidents. Initially, the NRC staff proposed to perform high speed impact testing and severe thermal testing on a rail cask. The reasons for this are as follows:

First, responses in cask designs to the forces created by the regulatory certification tests, as predicted by computer codes, is well understood, technically. The use of computer models to simulate real conditions in a design process is common in many industries including building design and construction, aircraft and spacecraft design, as well as bridge and tunnel design and construction. However, many members of the public were not comfortable with the fact that that no spent fuel transportation cask was certified through full-scale testing. Full scale testing of cask designs for certification is not a requirement in NRC regulations [3]. Thus, full scale testing had goals with respect to increasing public confidence.

Second, the NRC staff believed it would be beneficial to select a testing range, beyond that required by regulation (forces and conditions greater than those created in Part 71.73 tests), that may challenge the predictive capabilities of codes used to demonstrate compliance and risk assessment while at the same time provide data and information that might be used in place of engineering judgment used in transportation risk assessments [4]. Thus, full scale testing had goals associated with increasing the technical knowledge base.

Draft Approach

After internal reviews of draft test plans and objectives, NRC decided to add full scale truck cask tests [5] to the originally envisioned rail cask impact and fire tests, to encompass the two basic types of transportation modes that might be used for large shipment campaigns. The staff completed its test protocol proposal and published it as NUREG-1768 in February 2003. The NRC published NUREG-1768 and a companion notice in the Federal Register [6] on February 13, 2003, for public comment period ending May 30, 2003. In addition, NRC staff conducted four public meetings three of which were held in a "roundtable" format, to discuss the information included in NUREG-1768 and to solicit public comment on the document. One meeting was held in a "town hall" format. The roundtable meetings were held in Rockville, MD on March 6, 2003; Las Vegas, NV on March 12, 2003; and Rosemont, IL on March 18, 2003; the town hall meeting was held in Pahrump, NV, on March 13, 2003. The PPS was designed to obtain meaningful stakeholder input before the NRC makes its final decisions. One of the most important messages that the NRC communicated at these workshops was that the proposed test protocols were not finalized and would not be until staff considered public comments on its testing proposal.

In NUREG-1768, the staff proposed that full-scale testing of both a rail and a truck cask be performed. Specifically, the staff proposed the following:

- An impact test for a rail cask at 75 mph into an unyielding surface with a cask orientation of center of gravity over corner from a tall tower; for the truck cask, the proposed test was a 75 mph impact from a tall tower into an unyielding surface with a "back breaker" orientation, which would bypass the impact limiters

- A thermal test for both the rail and the truck casks with a fully-engulfing, optically dense hydrocarbon fire for more than one-half hour [9].

Although, the NRC proposed to perform impact and fire testing beyond the regulatory range (plastic deformation zone for impact testing) for the reasons stated above, NRC did not define every aspect of the conceptual approach. Rather, NRC requested public thoughts and ideas on the conceptual design of the PPS testing. Eleven specific questions were posed to the public concerning the conduct of the physical testing [8]. For example, the regulations require that fire testing for cask certification purposes be conducted for 30 minutes. The NRC proposed that the fire testing for the PPS be conducted beyond 30 minutes. NRC did not specify the time duration. Instead, NRC asked the public for views on how long the fire test should be conducted.

CONSIDERATION OF PUBLIC COMMENTS

The PPS is the first NRC sponsored large research project that has included enhanced public participation. Public comments received in the 1999 - 2000 time-frame were reflected in NUREG/CR-6768, the Package Performance Issues Report [9]. Public comments from the 2003 Public Meetings and Comment Response on NUREG-1768 will be reflected in a comment response document. NRC plans to publish this document and currently estimates that it will be available in 2004.

Over one thousand pages of transcript [10] were taken from the four public meetings and over 250 comment letters [11] were received on the PPS Test Protocols Report (NUREG-1768). Four main themes were identified in the public comments: (1) there was a strong request for regulatory full-scale testing, (2) there was a considerable lack of support for extra-regulatory testing, (3) there was an overwhelming opinion that the proposed test conditions were not realistic; they were so far away from conditions of normal transportation and severe transportation accidents and (4) terrorism is not addressed. In addition, many commenters noted that there was an apparent conflict between testing goals associated with public acceptance or confidence, and testing goals associated with technical needs or objectives. As a result, the NRC is in the process of examining new testing goals, options and approaches.

A number of comments were received relating to the objectives of the PPS. In general, many commentors recommended that the NRC develop more clearly stated objectives with strong ties to the technical approach of the PPS. The three objectives for the PPS program, as described in NUREG-1768, are:

1) to confirm finite element analyses as a valuable tool to accurately capture cask and fuel response to extreme mechanical and thermal environments

2) to demonstrate the inherent safety in spent fuel cask design - Public outreach is a significant element and

3) to provide data to refine dose risk estimates to the public and workers by replacing conservative assumptions with empirical data and new or updated transport statistics [12].

Numerous comments received indicated that the first two objectives of PPS, in particular, were conflicting and that attempting to satisfy the first objective in a comprehensive manner would compete with satisfying the second as well, i.e., it would be difficult to develop a technical test plan that would satisfy both objectives well.

A common thread running through many of the comments on the PPS testing protocols (NUREG- 1768) was that the NRC should conduct full-scale regulatory tests instead of the proposed extreme tests. In addition, some commenters did not support extra-regulatory testing and believed that the proposed test conditions were not realistic; they were so far away from conditions of normal transportation and severe transportation accidents. There were a large number of comments from a variety of stakeholders who recommended that tests conducted

under the PPS be realistic and represent the types of accidents that would most likely be seen along a highway or rail route.

Some commentors believe NRC cask licensing regulations should require full-scale physical testing of each cask design for NRC certification, while others stated that full-scale cask tests performed as part of the PPS should not be a reason to eliminate scale-model tests, component tests, material tests and engineering analysis that are used as the current bases for package certification.

COST

NRC estimated the cost of performing PPS testing and analysis, as enumerated in NUREG-1768, to be over $30 million [13]. As part of the NRC's decision making process, it has identified numerous testing options and associated cost estimates, to include those identified through public comment.

CONCLUSION

The PPS will help the NRC to confirm, in part through full scale physical testing, the inherent robustness of casks in severe accident conditions and demonstrate the adequacy of the use of computer models, scale model testing, and analysis in cask certification for stakeholders.

PPS scoping and planning process has included significant public input at public meetings/workshops and through written comments. The NRC staff has considered this input and is in the process of identifying additional testing options to present to the Commission. The NRC has found the public comments received on the PPS to be very insightful and helpful to the NRC in fashioning the goals of the PPS testing.

The PPS test and evaluation schedule is expected to have a final completion date before the end of FY09. The detailed schedule and costs for the program are still under development and will be made publicly available in the future. The public should expect that when the detailed plans for the PPS field tests are developed, they will reflect public comments on these test protocols, constraints imposed by NRC's programmatic priorities, and the available funding to support these tests.

REFERENCES

1 A.J. Murphy, United States Nuclear Regulatory Commission Package Performance Study Test Protocols, Draft Report for Comment, NUREG-1768, February 2003.

2 Title 10, Chapter 1 , Code of Federal Regulations, Part 71, Section 73

3 J.L Sprung, et al., Spent Nuclear Fuel Transportation Package Performance Study Issues Report, NUREG/CR-6768, SAND2001-0811P, June 2002.

4 Transcripts of the ACNW 118th Meeting in Rockville, MD on 000327, Pp.1-105

5 Staff Requirements- COMSECY-02-0036- FY 2004- FY 2005 Budget Proposal, August 30, 2002

6 68 FRN 8530, Solicitation of Public Comments on the Spent Fuel Transportation Package Performance Study (NUREG 1768), February 13, 2003

7 Ibid 1

8 A.J. Murphy, United States Nuclear Regulatory Commission Package Performance Study Test Protocols, Draft Report for Comment, NUREG-1768, February 2003, Executive Summary

9 Ibid 3

10 PPS March 03 Public Workshop Transcripts. ML030930583 (Workshop at Headquarter NRC on March 6, 2003, ML030930588 (Workshop in Las Vegas, NV on March 12, 2003), ML030930601 (Workshop in Chicago, IL on March 19, 2003) in Agency Document Access and Management System (ADAMS).

11 NUREG-1768 Comment Response Letters. Over 250 public response letters on the PPS Test Protocols Report, NUREG-1768 (68 FRN8530) were submitted to NRC. They are available on the Agency Document Access and Management System (ADAMS) on the www.nrc.gov

12 Ibid 1

13 Ibid 10