

POLICY ISSUE NOTATION VOTE

February 23, 2004

SECY-04-0029

FOR: The Commissioners

FROM: William D. Travers
Executive Director for Operations

SUBJECT: OPTIONS FOR FULL-SCALE SPENT NUCLEAR FUEL
TRANSPORTATION CASK TESTING UNDER THE
PACKAGE PERFORMANCE STUDY

PURPOSE:

To present for the Commission's consideration four options for the full-scale testing of spent nuclear fuel transportation casks. The staff requests guidance from the Commission on the selection of tests to be conducted under the Package Performance Study (PPS).

SUMMARY:

In this paper, the staff describes the background materials that led to the development of NUREG-1768, "United States Nuclear Regulatory Commission Package Performance Study Test Protocols." The staff published this NUREG-series report in February 2003, with a 90-day comment period to continue the enhanced public participatory process that is a key element of the PPS. In response, the staff received more than 250 comment letters, containing more than 2,300 individual comments, suggestions, and questions. In reviewing these comments, the staff identified four common themes, which the staff will address in a comment resolution report that is currently under development. On the basis of the comments received and direction previously provided by the Commission, the staff has developed for Commission consideration the four options presented in this paper, along with their costs and positive and negative implications.

BACKGROUND:

Over the past 25 years, the staff has conducted and published a series of studies assessing the risks associated with the transportation of spent nuclear fuel. The latest of these studies, the PPS, proposed a full-scale test to demonstrate the robustness of spent nuclear fuel transportation casks. This confirmatory research is founded on an enhanced public participatory process, through which a wide range of stakeholders have already provided input to the staff concerning

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the scope and parameters of such a test. Building on that foundation, the staff developed an initial concept that involved a high-speed impact of a full-scale rail cask into a very hard, stiff target, followed by a fire exposure test. The staff discussed this concept with organizations that might have been interested in co-funding the testing. The staff also discussed the concept with the Advisory Committee on Nuclear Waste, and with the Commission as part of a briefing conducted by the Office of Nuclear Regulatory Research. In a staff requirements memorandum (SRM) dated August 30, 2002, the Commission directed that the staff expand the scope of the study to include testing a full-scale truck cask.

In February 2003, the staff published NUREG-1768, "United States Nuclear Regulatory Commission Package Performance Study Test Protocols," which described the following three objectives for the PPS program:

- (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.
- (3) To provide data to refine estimates of the dose risk to the public and workers by replacing conservative assumptions with empirical data and new or updated transport statistics.

In addition, in NUREG-1768, the staff set forth a series of tests to be performed on full-scale transportation casks. These tests included both an impact test and a fire test of two full-scale transportation casks — one rail cask and one truck cask — with NRC-certified designs. Specifically, the staff proposed the following tests:

- (1) An impact test for each cask at 75 mph into an essentially unyielding surface from a tall tower. The rail cask would be oriented with the center of gravity over a corner of the cask; the truck cask would have a "backbreaker" orientation that bypasses the impact limiters.
- (2) A fire test for both the rail and the truck casks, involving a fully engulfing, optically dense, hydrocarbon fire for a duration of more than one-half hour.

In developing NUREG-1768, the staff's primary objective was to elicit public comment, with the comment period closing on May 30, 2003. In addition, the staff held four public workshops to discuss the information included in NUREG-1768 and to elicit additional public comment. These four workshops generated more than 1,000 pages of transcript and the comment period yielded more than 250 comment letters containing more than 2,300 individual comments, suggestions, or questions.

The NRC staff has since reviewed all of this input in detail and categorized the individual comments into 15 categories. In so doing, the staff derived the first 11 categories from specific questions posed in NUREG-1768, which represented topics on which the staff was particularly interested in receiving public comments. The additional 4 categories correspond to additional topics identified by the commentors.

DISCUSSION:

Numerous commentors indicated that the first two objectives of the PPS, in particular, appeared to conflict, and attempting to satisfy the first objective in a comprehensive manner would compete with satisfying the second (i.e., it would be difficult to develop a technical test plan that would adequately satisfy both objectives). Several additional commentors felt that the PPS is too focused on computer modeling and not sufficiently focused on increasing public confidence. Others were confused by the lack of linkages between current regulatory certification and extra-regulatory testing in the PPS. In general, these commentors recommended that the NRC should develop more clearly stated objectives with strong ties to the technical approach of the PPS.

In response to these important comments, the staff has reconsidered the scope of the PPS program and has decided to clarify the testing objective, as follows:

The testing objective of the Package Performance Study is to demonstrate the robustness of full-scale spent nuclear fuel transportation casks by conducting confirmatory research using an enhanced public participatory process.

In addition to this principal theme, the staff has identified the following four dominant themes that are common to many of the comments:

- (1) The NRC should conduct full-scale tests to the regulatory limits.
- (2) The NRC should conduct realistic demonstration tests based on realistic accident scenarios.
- (3) The NRC should test the casks to failure.
- (4) The NRC should address terrorism in the PPS.

During the course of numerous meetings, the staff has deliberated on the content and intent of the comments received from all interested stakeholders. On the basis of that deliberation, the staff has decided that the most appropriate disposition of the comments is as follows:

- (1) The staff is working to include the first two themes in developing test options.
- (2) The staff has considered the third theme, but believes that testing to failure is incompatible with the second theme. Specifically, the staff believes that there are no realistic accident scenarios that are sufficiently severe to lead to cask failure (e.g., rupture, leakage, etc.). Moreover, there is no readily agreed upon definition of cask failure among the various stakeholders. In addition, cask failure is a design-specific issue that would have little generic application to risk insights.
- (3) Regarding the fourth theme, the PPS does not address terrorism because this issue is explicitly addressed by other ongoing NRC activities (i.e., vulnerability assessments that focus upon security and are not suitable for the public participatory approach).

The staff remains confident that the current certification requirements for testing, analysis, or combinations of testing and analysis, as specified in Title 10, Part 71, of the *Code of Federal Regulations* (10 CFR Part 71), would provide reasonable assurance that a transportation cask with an NRC-certified design satisfies the hypothetical accident conditions and acceptance criteria and, therefore, would provide adequate protection to the public. The staff concluded that conducting tests on a full-scale cask to the limits specified in 10 CFR Part 71 would enhance public understanding of the rigor of the regulatory tests and how they result in robust designs.

Thus, to address the first theme, the staff has considered revising the PPS scope to identify a testing option that is limited to testing to the regulatory limits. Based on the comments received, this revision is warranted because (1) the public has requested regulatory tests, (2) NUREG-1768 lacked explicit support for extra-regulatory testing, and (3) the proposed test conditions far exceeded the conditions of normal transportation and severe transportation accidents. Rather than conducting extreme impact and fire tests, this option for PPS testing consists of a full regime of certification testing for a full-scale spent nuclear fuel rail or truck cask or a combination of both. Specifically, the staff is considering the tests specified in 10 CFR 71.73, which include a 30-foot drop test, a puncture test, a fire test, and immersion tests. (See Attachment 1 for a full description of Reg Rail tests and Reg Truck tests and Attachment 2 for the associated cost estimates.)

In addition, to address the stakeholders' recommendation that the PPS tests should be realistic scenarios that represent the types of accidents that would most likely be seen along a highway or rail route, the staff has considered adding full-scale demonstration tests of a rail cask, a truck cask, or both. (See Attachment 1 for a full description of Demo Rail tests and Demo Truck tests.) The accident scenarios would be "realistic" and would include targets, velocity, and other conditions that would be understandable by and credible to the general public. These scenarios would be provided in the detailed test plans.

In addition to the test protocols described in NUREG-1768, the staff has considered combinations of the four tests described in Attachment 1. The staff developed the following four options, each of which involves full-scale spent nuclear fuel cask testing. The staff has also identified the positive and negative characteristics of each of the four options, as discussed below.

Option 1: The proposed test protocols in NUREG-1768 (Total Cost Estimate: \$36.6 M)

The staff proposed an impact test and a fire test for both a full-scale rail cask and a full-scale truck cask with impact limiters but no conveyance. This option is responsive to Commission direction to conduct full-scale testing of a truck cask, as well as full-scale testing of a rail cask. It would also confirm the approaches used for certification of designs under 10 CFR Part 71.

However, this option does not address the four principal themes identified in the public comments; that is, it does not contain provisions for (1) testing full-scale casks to regulatory limits, (2) realistic testing of scenarios that are likely to occur, (3) testing to cask failure, or (4) testing for terrorist attacks. The staff has also identified several issues with the potential use of the General Atomic GA-4 truck cask, as proposed in NUREG-1768, including the fact that (1) a full-scale prototype has not yet been built and (2) it has a complex mechanical design.

Option 2: A combination of a Reg Rail test, a Demo Rail test, and a Demo Truck test (Total Cost Estimate: \$47.3 M)

This option is responsive to Commission direction, in that it includes both a full-scale rail test and a full-scale truck test. This option also fully satisfies two of the four themes from the public comments, namely testing full-scale casks to the regulatory limits and conducting realistic scenario testing of full-scale casks, by providing the Reg Rail test, the Demo Rail test, and Demo Truck test. The testing in this option would also confirm the approaches used for certification of designs under 10 CFR Part 71 and would demonstrate the inherent robustness

of NRC-certified transportation casks in realistic accident scenarios. In addition, it would yield data to confirm the capability of the available finite element codes used in the cask certification process to accurately predict the response of casks, and to provide benchmark data for future code acceptance. Moreover, this testing would enable the staff to compare the results of regulatory testing to regulatory limits with realistic scenario testing to determine and better describe the relation between the two to the public.

As noted above in Option 1, the staff has identified issues with the potential use of the General Atomic GA-4 truck cask.

Option 3: A combination of a Reg Rail test and a Demo Rail test
(Total Cost Estimate: \$32.3 M)

This option satisfies two of the public comment themes, in that it provides for testing to regulatory limits and for realistic scenario testing. This option would also (1) demonstrate the inherent robustness of NRC-certified transportation casks in realistic accident scenarios, (2) confirm the approaches used for certification of designs under 10 CFR Part 71, (3) yield data to confirm the capability of the available finite element codes used in the cask certification process to accurately predict the response of casks, and (4) enable the staff to compare the results of regulatory testing with realistic scenario tests.

This option does not address Commission direction to include a full-scale truck test.

Option 4: A combination of a Reg Rail test and a Reg Truck test
(Total Cost Estimate: \$36.8 M)

This option is responsive to Commission direction to conduct full-scale testing and testing of a truck cask. This option is also responsive to one of the public comment themes in that it provides for full-scale testing to the regulatory limits. Further, and it would confirm the approaches used for certification of designs under 10 CFR Part 71.

The option does not address the theme identified in the public comments to conduct demonstration test based on realistic accident scenarios. Testing the full-scale casks to the regulatory limits will impart forces on the casks that encompass realistic conditions; however, many commentors did not agree with this. As noted in Option 1, above, the staff has also identified issues with the potential use of the General Atomic GA-4 truck cask.

Preliminary annual costs estimates for the four options are listed in Attachment 3.

CONCLUSION:

The staff is requesting guidance from the Commission on the selection of the option to be used in the full-scale testing program for the PPS. In addition to the options presented here which are consistent with either Commission direction and/or public comments, there are other options that can be formulated based on test combinations presented in the attachments. Upon receipt of the Commission's direction, the staff will develop the detailed test plans and procedures for the program. The staff will then initiate cask procurement and develop a comment resolution report describing how the PPS testing addresses the stakeholders'

comments. After completing the detailed plans and the comment resolution report, the staff will continue the enhanced public outreach process by holding several informational meetings in key locations, as was done during the development of NUREG-1768 and during the comment period.

RESOURCES:

The total estimated cost for Option 1 is \$36.6M. Annual cost projections for this Option were developed and used in formulating the FY 2005 budget. (Only an earlier version of Option 1 was under consideration when the FY 2004 budget was being formulated.) The total estimated cost is \$47.3M for Option 2, \$32.3M for Option 3, and \$36.8M for Option 4. (All of the option costs detailed herein cover the total estimated project length, spanning fiscal years 2004–2009.) The resources allowed for the PPS in the FY 2004 and FY 2005 budgets, including carryover funds, are as follows:

OFFICE	FY 2004 BUDGET	FY 2005 BUDGET
RESEARCH	\$8.00M ¹ /1.0 FTE	\$10.250M/1.0 FTE
NMSS	\$0.20M/1.0 FTE	\$0.40M/1.0 FTE
TOTAL	\$8.20M/2.0 FTE	\$10.650M/2.0 FTE
1/Includes \$4.50M of FY 2003 committed carryover.		

COORDINATION:

The Office of the General Counsel has reviewed this paper and has no legal objections. The Office of the Chief Financial Officer has also reviewed this paper for resource implications and has no objections.

/RA/

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Attachments: 1. Additional Impact and Fire Tests
2. Cost Estimates for Tests
3. Cost Estimates for Tests Options

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Additional Impact and Fire Tests

Using Commission guidance provided in the SRM dated August 30, 2002, and the public comments received, the staff has identified four alternative tests that could be conducted in various combinations as part of the PPS, as described below. All of the tests described below include cask testing with impact limiters. Tests 3 and 4 also include the conveyances.

1. A test of a rail cask to the regulatory limits (Reg Rail)

This is a test of a full-scale rail cask addressing the test specifications in 10 CFR 71.73. The first three elements must be applied to the same cask before the acceptance criteria are applied:

- A 9-meter free drop of the cask onto an essentially unyielding surface in the orientation for which maximum damage is expected (71.73)
- A 1-meter free drop of the cask onto a mild steel bar, 15 cm in diameter and at least 20 cm long, mounted vertically on an essentially unyielding surface in the orientation for which maximum damage is expected (71.73)
- Exposure to a 30-minute, optically dense, fully-engulfing, hydrocarbon fire, that extends from 1 to 3 meters beyond the cask, which is mounted 1 meter above the surface of the fuel source (71.73)
- A shallow immersion test of an undamaged cask under a head of water of at least 15 meters (71.73)

A potential additional element for this test is:

- A 2-Mpa (200-meter) submersion test of a separate undamaged cask under a head of water of at least 2 Mpa. (This element responds to public commentors' concerns about barge shipments across Lake Michigan.)

2. A test of a truck cask to the regulatory limits (Reg Truck)

This is a test of a full-scale truck cask addressing the regulatory criteria in 10 CFR Part 71. The specifications for this test are the same as for Test 1; however, if the Reg Truck test is done in combination with the Reg Rail test, the 200-meter submersion test may be omitted.

3. A demonstration rail cask test (Demo Rail)

This is a test of a full-scale rail cask on its actual conveyance under realistic accident conditions. For this test, the staff envisions a collision of a rail cask with a simulated bridge abutment at about 75 mph followed by a fire from a ruptured tank car.

4. A demonstration truck cask test (Demo Truck)

This is a test of a full-scale truck cask on its actual conveyance under realistic accident conditions. For this test, the staff envisions a collision of a truck cask with a locomotive traveling at about 75 mph on a grade crossing followed by a fire.

Attachment 2 presents the estimated costs for these tests. The table in Attachment 2 includes two columns for the Reg Truck test. The first is the cost estimate for the Reg Truck test as a standalone test, and the second is for the Reg Truck test in combination with the Reg Rail test. The principal difference between the standalone and combination costs is that the \$7.6M test facility has already been built for the Reg Rail test.

Cost Estimates for Tests in \$K

Fiscal Year	Reg Rail	Reg Truck (Standalone)	Reg Truck (Combination)	Demo Rail	Demo Truck
2004	\$8,000	\$1,450	\$0	\$0	\$0
2005	\$9,935	\$10,200	\$1,800	\$785	\$880
2006	\$2,675	\$8,325	\$8,100	\$4,850	\$6,650
2007	\$115	\$5,950	\$5,710	\$4,245	\$6,090
2008	\$0	\$0	\$0	\$960	\$840
2009	\$250	\$250	\$250	\$500	\$500
Totals	\$20,975	\$26,175	\$15,860	\$11,340	\$14,960

The costs for FY 2004 include the costs incurred in FY 2003, the funds carried over to FY 2004, and the funds budgeted for FY 2004.

Cost Estimates for Test Options in \$K

Fiscal Year	Option 1 NUREG-1768	Option 2 Reg Rail, Demo Rail & Demo Truck	Option 3 Reg Rail & Demo Rail	Option 4 Reg Rail & Reg Truck
2004	\$8,000	\$8,000	\$8,000	\$8,000
2005	\$10,250	\$11,600	\$10,720	\$11,735
2006	\$9,350	\$14,175	\$7,525	\$10,775
2007	\$6,950	\$10,450	\$4,360	\$5,825
2008	\$1,800	\$1,800	\$960	\$0
2009	\$1,250	\$1,250	\$750	\$500
Totals	\$36,600	\$47,275	\$32,315	\$36,835