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Preliminary Planning for a Spent Nuclear Fuel Transportation Package Performance Demonstration

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Acknowledgments

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Laura Hay and Steve Maheras
Pacific Northwest National Laboratory

Erica Bickford, Sara Hogan, and Gerry Jackson
U.S. Department of Energy

Douglas Ammerman
Sandia National Laboratories

Package Performance Demonstration (PPD)

- What is a Package Performance Demonstration (PPD), formerly Package Performance Study (PPS)?
- Why is the U.S. Department of Energy (DOE) planning a PPD?
- History
  - U.S. Spent Nuclear Fuel (SNF) package testing
  - Examples of international SNF package testing
  - Previous plans to conduct a PPS/PPD
- Current status
  - Preliminary plans for DOE PPD

DOE Package Performance Demonstration (PPD)

- What is a PPD?
  - Physical testing of a full-sized SNF transportation rail cask
- Why is DOE planning a PPD?
  - Build trust and confidence in the safety of SNF transportation casks and SNF transportation by rail
  - Gather technical data to further validate computer models
  - Record high-resolution video to use in DOE communication products and public outreach
  - Consider public engagement and stakeholder outreach strategies in support of the PPD
    - Explore additional opportunities to strengthen relationships between DOE and the public and further enhance DOE's efforts to build trust

U.S. SNF Package Testing

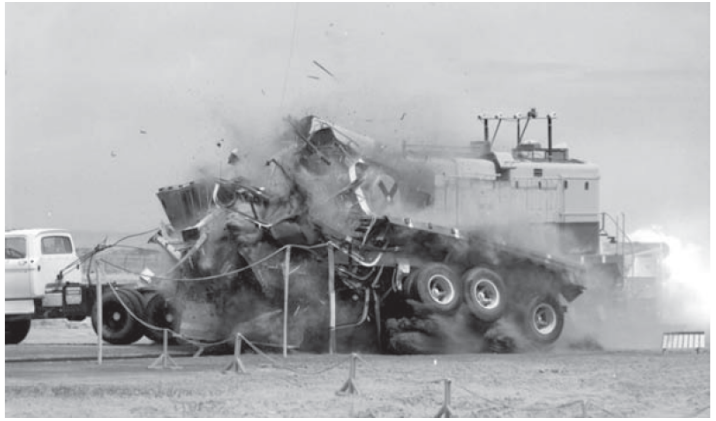
- Test program sponsored by Energy Research and Development Administration (ERDA) – predecessor to DOE – in 1975
  - Conducted at Sandia National Laboratories
  - Included four impact tests
    - Complete cask transport systems in highway and rail transport modes
    - Transportation casks used for testing were no longer in service

U.S. SNF Package Testing (Continued)

- **January 18, 1977 and March 16, 1977[1]**
  - Truck tractor-trailer system with SNF shipping cask impact with massive concrete barrier at two different velocities: 61 mph (98 kph) and 84 mph (135 kph)
    - Cask weight of 45,000 lb (20,500 kg)
- **April 24, 1977[2]**
  - Grade-crossing simulated accident with locomotive traveling at 81 mph (130 kph) and impacting tractor-trailer system with SNF shipping cask
    - Cask weight of 56,000 lb (25,400 kg)
- **September 27, 1977[3]**
  - Crash test of railcar SNF shipping system impacting massive concrete barrier at nominal velocity of 80 mph (129 kph)
    - Cask weight of 150,000 lb (68,000 kg)

NOTE: Specific cask models used for testing have not been determined at this time.

Truck tractor-trailer with SNF shipping cask.[4]



Locomotive impacting a tractor-trailer system.[4]

SNF package mounted in a railcar.[4]

(1) SAND77-0270, *Analysis, Scale Modeling, and Full Scale Tests of a Truck Spent Nuclear Fuel Shipping System in High Velocity Impacts Against a Rigid Barrier*, 1977.
(2) SAND79-2291, *A Study and Full-Scale Test of a High-Velocity Grade-Crossing Simulated Accident of a Locomotive and a Nuclear Spent Fuel Shipping Cask*, 1983
(3) SAND78-0458, *Analysis, Scale Modeling, and Full-Scale Test of a Railcar and Spent Nuclear Fuel Shipping Cask in a High-Velocity Impact Against a Rigid Barrier*, 1981.
(4) National Academy of Sciences, *Going the Distance? The Safe Transport of Spent Nuclear Fuel and High-Level Radioactive Waste in the United States*, 2006.

Examples of International SNF Package Testing

- Central Electricity Generating Board (CEGB) Flask Test Project (aka “Operation Smash Hit”)
  - 1981 testing program conducted in the U.K. by CEGB
    - Testing spanned 4 years
  - Conducted with Magnox spent fuel flask (or cask)
    - Flask weight of 48 metric tons
  - Drop testing of full-sized flask and 1/2, 1/4, and 1/8 scale flasks
  - Testing concluded in 1984 with public demonstration test of locomotive hitting flask at 100 mph (160 kph)

Magnox fuel flasks(1)

CEGB public demonstration test(2)

(1) C.-F. Tso, D. Vince, and C. Young, “Smash hit! Magnox less for today,” *Packaging, Transport, Storage, & Security of Radioactive Material*, Vol. 19, No. 1, pages 11-18, 2008.
(2) National Academy of Sciences, “Going the Distance? The Safe Transport of Spent Nuclear Fuel and High-Level Radioactive Waste in the United States,” The National Academies Press, Washington, D.C. (2006).

Examples of International SNF Package Testing (Continued)

- 9 m drop testing of full-scale casks at BAM during PATRAM 2004
  - GNS CONSTOR® V/TC Cask
    - Manufactured by Gesellschaft für Nuklear-Service mbH, Germany
    - Dropped during PATRAM Technical Tour 1
    - Weight of 181 metric tons
  - MHI MSF-69BG Cask
    - Manufactured by Mitsubishi Heavy Industries, Ltd, Japan
    - Dropped during PATRAM Technical Tour 2
    - Weight of 127 metric tons

GNS CONSTOR® V/TC Cask(1)


MHI MSF-69BG Cask(2)

(1) André Musolff, Karsten Müller, Martin Neumann, Arsène Kadji, and Bernhard Droste, "Drop Test Results of the Full-Scale CONSTOR® V/TC Prototype," PATRAM 2007, Miami, Florida.
(2) Bernhard Droste, "Experiences and Perspectives of Package Testing Under Hypothetical Accident Conditions," PATRAM 2007, Miami, Florida.

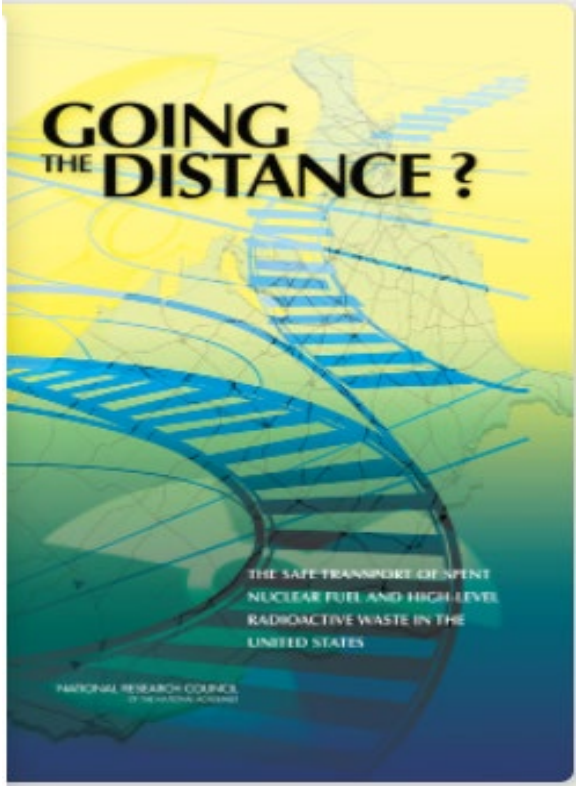
Previous Plans to Conduct a PPS

- Plans for U.S. Nuclear Regulatory Commission (NRC) PPS
  - Initiated in 1999 and was suspended around 2006
    - No testing conducted
  - Published
    - NUREG/CR-6768 (“Issues Report”) in 2002
      - Scoping phase of the PPS
      - Solicit public and stakeholder comments to identify type of research to increase public confidence in safety of SNF transportation
    - NUREG-1768 (“Test Protocols Report”) in 2003
      - Requested comments on preliminary plans from public and stakeholders
        - Test approaches and plans, as well as 11 specific issues listed

NUREG/CR-6768, “Spent Nuclear Fuel Transportation Package Performance Study Issues Report,” U.S. Nuclear Regulatory Commission, Washington, D.C. (June 2002).
NUREG-1768, “”United States Nuclear Regulatory Commission Package Performance Study Test Protocols,” U.S. Nuclear Regulatory Commission, Washington, D.C. (February 2003).

Previous Endorsements to Conduct a PPS (Continued)

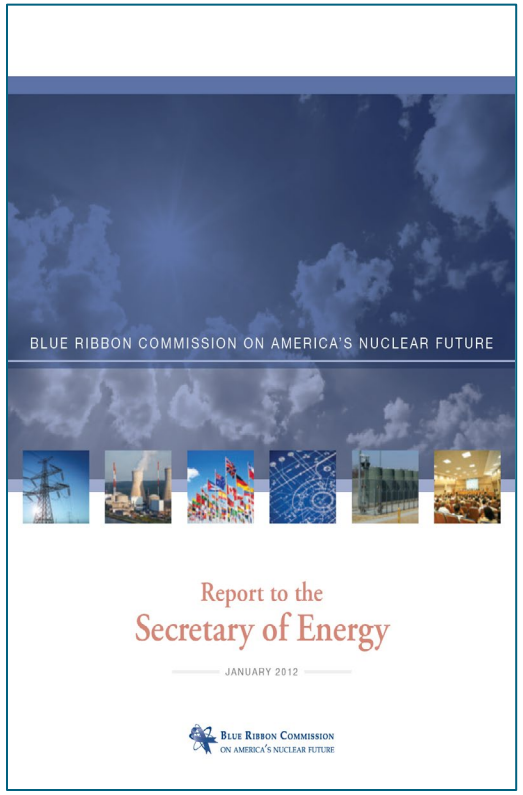
- 2006 National Academy of Sciences (NAS) *Going the Distance?* Report
  - Endorsed the NRC's PPS approach, NAS recommended:
    - "Full-scale package testing should continue to be used as part of integrated analytical, computer simulation, scale-model, and testing programs to validate package performance."
    - "Deliberate full-scale testing of packages to destruction should not be required as part of this integrated analysis or for compliance demonstrations."



National Academy of Sciences, "Going the Distance? The Safe Transport of Spent Nuclear Fuel and High-Level Radioactive Waste in the United States," The National Academies Press, Washington, D.C. (2006).

Previous Endorsements to Conduct a PPS (Continued)

- 2012 Blue Ribbon Commission on America's Nuclear Future
  - Recommended conducting the PPS with full-scale rail cask for the purpose of building public trust and confidence
    - "… numerous parties have suggested that expanded full-scale testing of transportation casks (in addition to computer modeling) could be useful in enhancing public confidence in transport safety."
    - "In 2005, the NRC approved a staff proposal for full-scale testing of a rail cask… in a scenario involving a collision with a locomotive traveling at high speed followed by a hydrocarbon fire. DOE supported the proposed Package Performance Study…"



Blue Ribbon Commission on America's Nuclear Future, "Report to the Secretary of Energy," January 2012.

Preliminary Plans for DOE PPD

- Developing a Functions and Requirements Document
  - Multi-Laboratory effort
  - Document includes:
    - Stakeholder outreach and external engagement
    - Functions and requirements for:
      - Potential tests to be performed (e.g., regulatory, demonstration)
      - Potential test sites
      - Potential transportation casks
      - Potential analytical tools
- **Preliminary** Functions and Requirements Document Transmitted September 2023 to DOE

Preliminary Plans for DOE PPD (Continued)

- Considering regulatory tests (i.e., 10 CFR Part 71)
  - Assume transportation cask will weigh nominally ~250,000 lb (~113,000 kg)
  - Few facilities available with "unyielding surface" for transportation cask weight assumed
    - Criteria per International Atomic Energy Agency (IAEA) Specific Safety Guide (SSG)-26[1]: "The combined mass of the steel and concrete should be at least 10 times that of the specimen for the tests…"
    - Facility needs a drop pad weighing at least 2.5 million lb or 1,250 tons
- Considering other tests
  - Train collision with transportation package in a "realistic" type of scenario
    - Example – 1984 CEGB test "Operation Smash Hit"
  - Immersion test in a body of water/waterbody retrieval demonstration

10 CFR Part 71, "Packaging and Transportation of Radioactive Material," Code of Federal Regulations, U.S. Nuclear Regulatory Commission, Washington, D.C.

Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material (2012 Edition), SSG-26, International Atomic Energy Agency, Vienna, Austria.

Preliminary Plans for DOE PPD (Continued)

- DOE would lead the PPD
  - Welcome NRC participation
    - NRC is the regulator for casks used to transport SNF
  - DOE has confidence in NRC's cask certification process
- DOE will continue external engagement activities regarding the PPD
    - For more information, please contact Gerry Jackson (gerard.jackson@nuclear.energy.gov)
- **Completion of the PPD depends on availability of funding**

PPD Team

- U.S. Department of Energy
  - Erica Bickford
  - Gerard Jackson
  - Sara Hogan
- Pacific Northwest National Laboratory
  - Steven Maheras
  - Harold Adkins, Jr.
  - Laura Hay
  - Miriam Juckett
  - Ennea Fairchild-Grant
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  - Marc Fialkoff
  - Ryan Karkkainen
  - Zoe Chicketti
- Savannah River National Laboratory
  - Daniel Leduc
  - William Johnson
  - William Housley
  - Richard Wyrwas

Preliminary Stakeholder Engagement Plan

- For a PPD being conducted to bolster stakeholder confidence, success hinges on stakeholder buy-in
- **Purpose**: Thoughtfully plan for and execute meaningful stakeholder engagement throughout the PPD process so that the goal of stakeholder confidence is achieved.

Atlas railcar

Aerial shot of the Atlas railcar carrying a test load simulating a shipment of spent nuclear fuel.
U.S. Department of Energy photo

Preliminary Stakeholder Engagement Plan

- Addresses topics such as:
  - Who is considered a stakeholder (internal/external)?
  - What will be the scope of stakeholder input?
  - Methods for stakeholder interactions
  - Timing and process for stakeholder interactions
  - Potential challenges and mitigations
  - Post PPD actions

Preliminary Stakeholder Engagement Plan

- The **preliminary** plan provides for:
  - "Core" stakeholder group to provide input throughout the process and reach-back to their own stakeholders
  - Utilizing State Regional Groups (SRG) and Tribal Radioactive Materials Transportation Committee (TRMTC) working groups
  - Transparency and openness in documentation
  - Forethought about how PPD results and media will be utilized to optimize our planning

Questions for Discussion with Stakeholders

With the understanding that a PPD is subject to constraints of authorization, funding, and practical/technical feasibility…

If the DOE conducts a PPD:

1. Which stakeholders (or whom from your respective constituents/stakeholder groups) should a PPD be designed for?
2. What concerns from your constituents could a PPD address?
3. What would make a PPD "believable" to your constituents?
4. What would you most want to see in a PPD (test, process, etc.)?
5. What would make a PPD successful vs. not successful in meeting its goal of bolstering public confidence?
6. What related research could be designed into the PPD?

Thank you!

For more info…

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