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# Package Performance Study: Developments Since PATRAM 13

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September, 2004



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## BRIEFING OUTLINE

- Briefing Objective
- PPS Evolution
- Commission Direction and Current Staff Proposal
- Current Schedule



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## BRIEFING OBJECTIVE

- Describe USNRC current and planned activities associated with the Package Performance Study (PPS)



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## Goal of PPS Program

- Demonstrate the inherent robustness of full-scale spent nuclear fuel transportation casks by conducting confirmatory research using an enhanced public participation process



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# PPS EVOLUTION

- PPS Test Protocols Report, NUREG-1768, Feb 2003
- 90 Day Public Comment Period ended 30 May 2003
  - Four Dominant Themes
    - Full scale testing to regulatory limits
    - Conduct a realistic demonstration test based on realistic accident scenarios
    - Test cask to failure
    - Terrorism



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## PPS EVOLUTION (cont'd)

- Staff developed five test concepts that were consistent with public comments:
  - Extra Regulatory
    - Impact and fire test for a full-scale rail and truck cask
  - Regulatory Rail Test
    - 10 CFR Part 71
  - Regulatory Truck Test
  - Demonstration Rail Test
    - Full-scale rail cask on its conveyance under realistic accident conditions (i.e., railcar collision with a bridge abutment)
  - Demonstration Truck Test
    - Full-scale truck cask on its conveyance under realistic accident conditions (i.e., grade crossing collision)



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## Commission Direction

- Commission approved the testing of a full-scale, NRC certified rail transportation cask, May 2004
  - Authorized staff to purchase a single NRC certified rail cask
  - Realistically conservative test
  - Sufficient instrumentation to collect data for validating analytical methods, including scaling
  - Fully engulfing fire



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# DEMONSTRATION TEST PLAN DEVELOPMENT

- What Can the PPS Demonstration Accomplish?
  - Provide a realistically conservative test of a rail transportation cask
  - Demonstrate the robustness of a rail transportation cask
  - Provide sufficient instrumentation for analytical comparison
  - Demonstrate the ability of analytical methods to predict cask response in complex accident scenarios





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### **DEMONSTRATION TEST PLAN DEVELOPMENT**

- Staff developed a proposal for Commission approval
- Scenario Development
  - Cask transportation accidents are low probability events
    - 8 accidents involving transportation of casks, 1.6 M miles, no releases (2002)
      - 4 truck accidents, 4 train accidents
    - Over 1300 spent fuel shipments in NRC certified packages have taken place in the last 20 years
  - Department of Transportation (DOT) Volpe Center data (1988-1995)
    - Provides a relative ranking of rail accident scenarios
    - Highest conditional probabilities are train derailments resulting in impacts or collisions with soil, roadbeds, rock, structures, railcars, or locomotives



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## **DEMONSTRATION TEST PLAN DEVELOPMENT**

- Staff considered hypothetical cask and railcar accident derailment scenarios:
  - Cask and railcar impact with a rock outcrop
  - Cask and railcar impact with a tunnel entrance
  - Cask and railcar impact with a bridge abutment
  - Collision of a locomotive and a cask (attached to a railcar)



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## **DEMONSTRATION TEST PLAN DEVELOPMENT**

### **– Evaluation of scenarios**

- Impacts with soil are not likely to represent a conservative challenge (i.e., impart significant energy to the cask)
- Impacts with hard rock outcrops judged low probability
- Impacts with bridge abutments and tunnel entrances are not likely to represent a conservative challenge to the cask
- A collision with a locomotive has the potential for a realistically conservative challenge to the cask



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# NRC STAFF PROPOSED TEST PLAN

- Scenario based on an actual rail accident event (Effingham, IL, 1995)
  - Resulted in a derailment of a railcar and subsequent impact by a locomotive
- Test Plan
  - Affix a certified transportation rail cask to a railcar
  - Fully instrument cask, locomotive, and railcar with accelerometers, strain gauges, thermocouples, and displacement transducers for comparison with analysis
  - Impact rail cask and railcar combination with a locomotive
    - Speed and orientation will be determined after further staff assessment
  - Post-impact inspection



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## **NRC STAFF PROPOSED TEST PLAN**

- Subsequent Fire Test
  - Staff recommends the test be a fully-engulfing, optically dense hydrocarbon fire of a 30-minute duration as specified in Title 10, Section 71.73, of the Code of Federal Regulations (10 CFR 71.73)
  - Constitutes a conservative fire test with well-controlled conditions
- Extensive pre and post-test analysis will be conducted
  - Initial assessment of the instrumentation package and ranges of parameters will be provided to the Commission six months after Commission approval
  - Staff to develop a collaborative analysis efforts with domestic and international stakeholders



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## TEST PLAN CHALLENGES

- Realism
  - NRC staff believe that a fully-engulfing fire may not be realistic based on observations from accidents
    - Staff has considered options such as a tanker car fire to improve the realism of the fire test
- The ability to validate scaling methodology
  - For engineering analysis, validation involves the comparison of analysis results with well-defined experiments
- Uncertainties
  - Nonlinear nature of collision (i.e., yielding impact surface)
  - Analysis predictions (railcar behavior, cask tie-downs, friction)



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## **Concluding Remarks**

- Cask certification process provides protection of public health and safety
- NRC staff has developed a test plan for Commission approval
- NRC staff will keep the Public informed of progress



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# QUESTIONS/DISCUSSION