# Implications of the Baltimore Rail Tunnel Fire for Full-Scale Testing of Shipping Casks

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# Cask Testing Issues

- Absence of Cask Testing Requirements
- Advantages of Full-Scale Testing
- Nevada Proposal for Regulatory Testing
- Baltimore Tunnel Rail Fire (July 2001)
- Proposal for Extra-regulatory Testing

# Absence of Cask Testing Requirements

- NRC does not require physical testing
- 16 shipping cask designs currently certified
- No currently certified US cask has been tested full-scale to demonstrate compliance with 10CFR71(drop, puncture, fire, immersion)
- 2 truck cask designs drop-tested using half-scale models (TN-8 & GA-4)
- 3 rail cask designs drop-tested using 1/3- or 1/4-scale models (125-B, NAC-STC, TN-68)
- Scale-model impact limiter tests (9 casks)

# Advantages of Full-Scale Testing – 1
(S.E.Gianoulakis, SNL, 1993)

- Single cask can be sequentially subjected to all normal and accident conditions defined by regulations; directly demonstrate compliance
- Clear characterization of package behavior and opportunities for design refinement (also achievable through half-scale model testing)
- Package closure and seal response can be directly measured; results represent actual package containment system response

# Advantages of Full-Scale Testing – 2
(S.E.Gianoulakis, SNL, 1993)

- Allows early evaluation and monitoring of fabrication process
- Allows early operational testing
- Direct measurements (acceleration and surface deformation) eliminate need for scaling relationships
- Visual evidence (photos and videos) for system analyses and public demonstration
- Major disadvantage: Cost of fabrication and testing

# Nevada Proposal for Regulatory Testing

- Meaningful stakeholder role in development of testing protocols & selection of test facilities and personnel
- Full-scalephysical testing (sequential drop, fire, puncture, and immersion) prior to NRC certification
- Additional computer simulations to determine performance in extra-regulatory accidents and to determine failure thresholds
- Reevaluate Modal Study findings , and if appropriate, revise NRC cask performance standards
- Evaluate costs and benefits of destructive testing of a randomly-selected production model cask

# Estimated Cost of Nevada Proposal for Regulatory Testing (2003 Dollars)

- Legal-Weight Truck Cask: $7.8-8.4 Million
- First Rail Cask (130 ton): $19.1-22.0 Million
- Subsequent Rail Cask: $9.1-12.0 Million
- Assume one-time cost of $10 Million to upgrade test facility to lift and drop 130 ton cask

# Baltimore Tunnel Rail Fire
(July 18-23, 2001)

- CSX freight train derailed in Howard Street Tunnel, Baltimore, MD
- Fire fueled by tripropylene tanker and other flammable cargo
- Fire burned for 3 days, with temperatures as high as 1800°F (1000°C)
- Tunnel is located on potential shipping route from Calvert Cliffs to Yucca Mountain
- USDOT allows SNF shipment in mixed freight trains; DOE may ship in general freight service

# Hypothetical SNF Accident Based on Baltimore Fire

- Nevada commissioned study by Radioactive Waste Management Associates (RWMA)
- Assumed fire at 1500°F (800°C), single large rail cask, 10-year-cooled SNF, PNL gap inventory for Cs-134/137, NUREG/CR-6672 failure threshold for fuel cladding (750°C), actual weather conditions, US Census data (1990,2000)
- Concluded steel-lead-steel cask would have failed after 6.3 hours; monolithic steel cask would have failed after 11-12.5 hours

# Consequences of Hypothetical SNF Accident Estimated by RWMA

- 73,000 curies of Cs-134 & Cs-137 released from cask; 50% of release escapes from tunnel and dispersed down-wind as respirable aerosol
- Impacts modeled using RISKIND, HOTSPOT, and RADTRAN economic spreadsheets
- Contaminated Area: 32 square miles (82 sq. km.)
- Latent cancer fatalities: 4,000-28,000 over 50 years (200-1,400 during first year)
- Cleanup cost:  $13.7 Billion (2001 Dollars)

# Implications of Hypothetical Baltimore Fire Analysis For Cask Testing

- Real world fires could potentially result in significant release of radioactive materials
- Each shipping cask would contain an enormous radionuclide inventory (average rail cask would contain 816,000 curies Cs-137)
- Long-duration, high-temperature fires represent most severe accident environments evaluated by DOE and Nevada
- There is little physical data on rail cask performance in severe accident environments

# High-Priority Cask Testing Issues to be Addressed in NRC PPS

- Extent of stakeholder participation
- Selection of cask testing facilities
- Selection of casks to be tested
- Selection of test scenarios
- Availability of funding
- Commitment to testing program