U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Transportation of Spent Fuel – Safety by Design

Earl Easton
Division of Spent Fuel Storage and Transportation
U.S. Nuclear Regulatory Commission

Today's Topics

- Major factors that influence the risk of transporting spent fuel.
  - **why the risk is low**
  - **how the risk factors differ from other hazmat**
- How the risk is managed (minimized).
  - **based on robust, accident resistant shipping containers**
- Ongoing efforts to assure that NRC safety requirements address future transportation safety and security needs
  - **continuous evaluation of transportation events**
  - **examination of long-term behavior of materials**

What determines the Risk of Spent Fuel Shipments ?

Risk = probability x consequences

Frequency of shipments

Accident rate

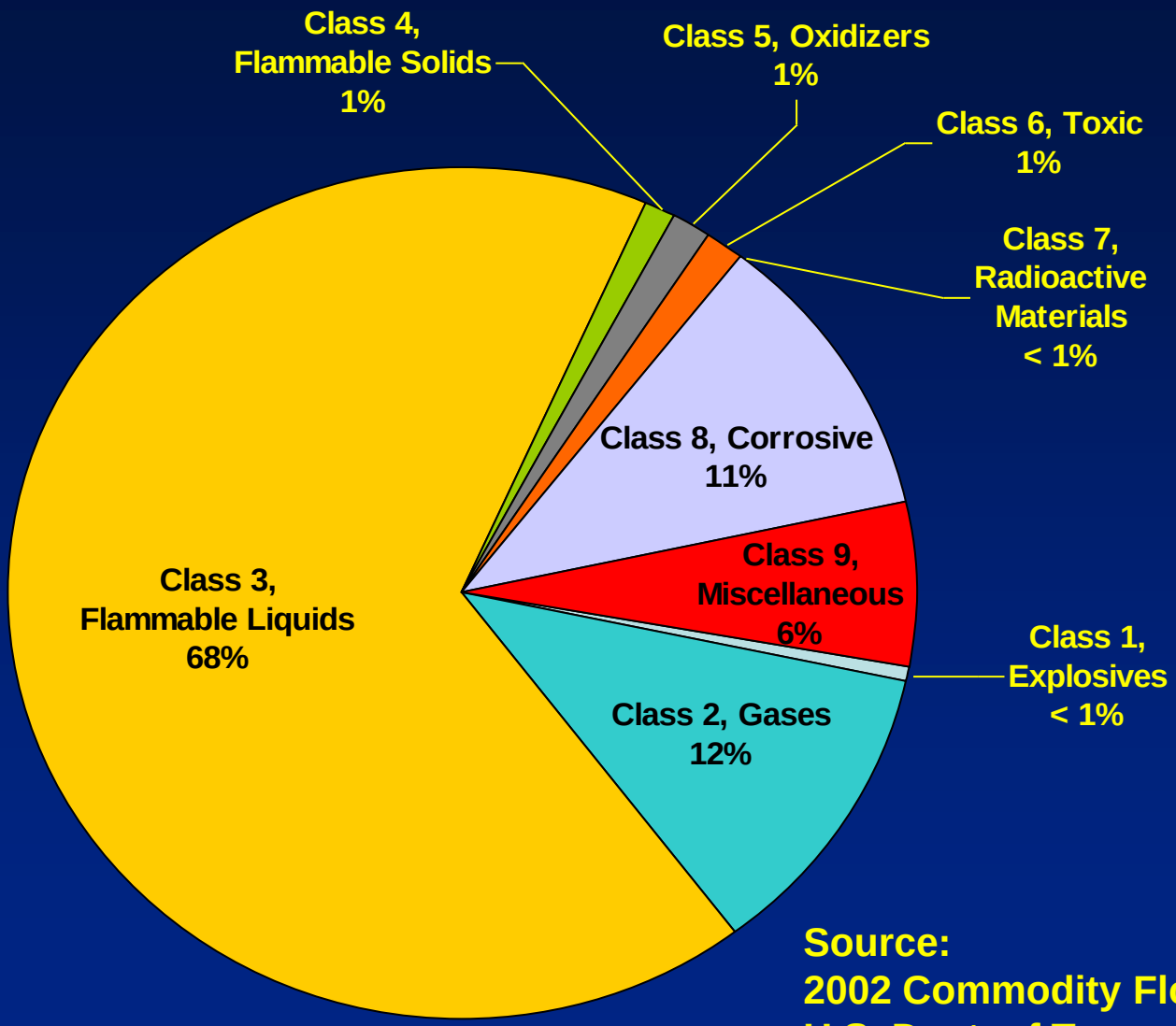
Accident severity

Nature of hazard

Physical form

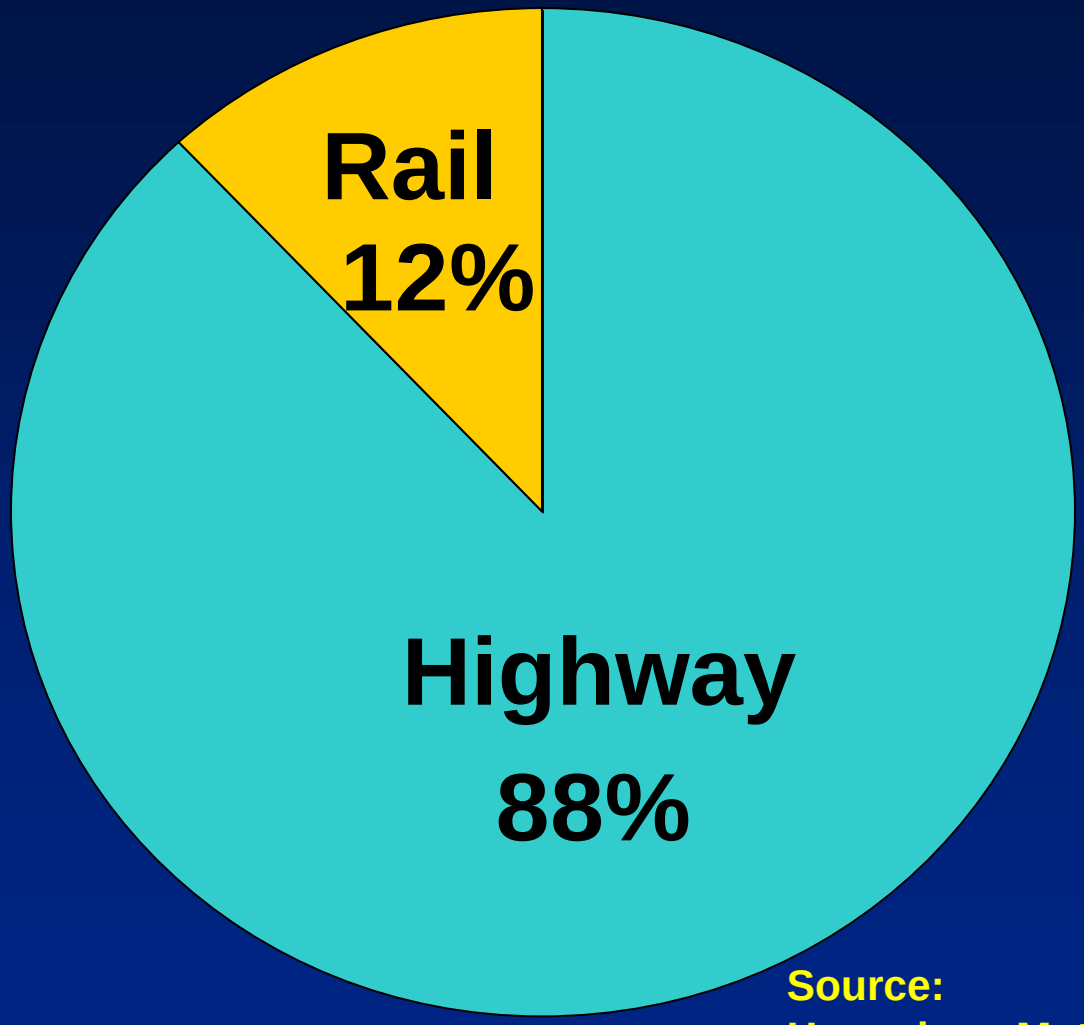
Shipping container

Hazardous Material Shipments in ton-miles (2002)



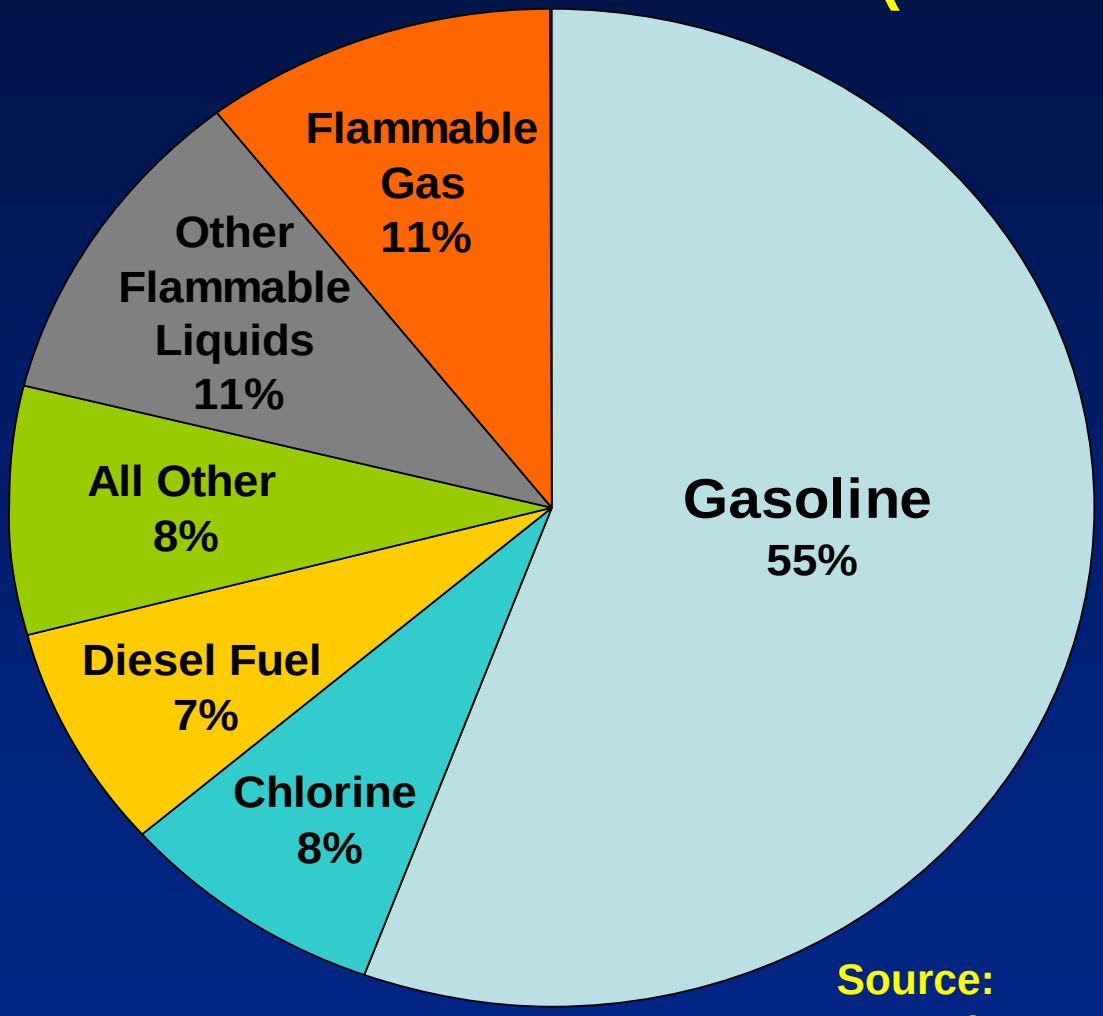
Source:
2002 Commodity Flow Survey
U.S. Dept. of Transportation (2004)

Hazardous Material Shipments
Fatalities by Mode (1997-2006)



Source:
Hazardous Material Information System
U.S. Dept. of Transportation (2007)

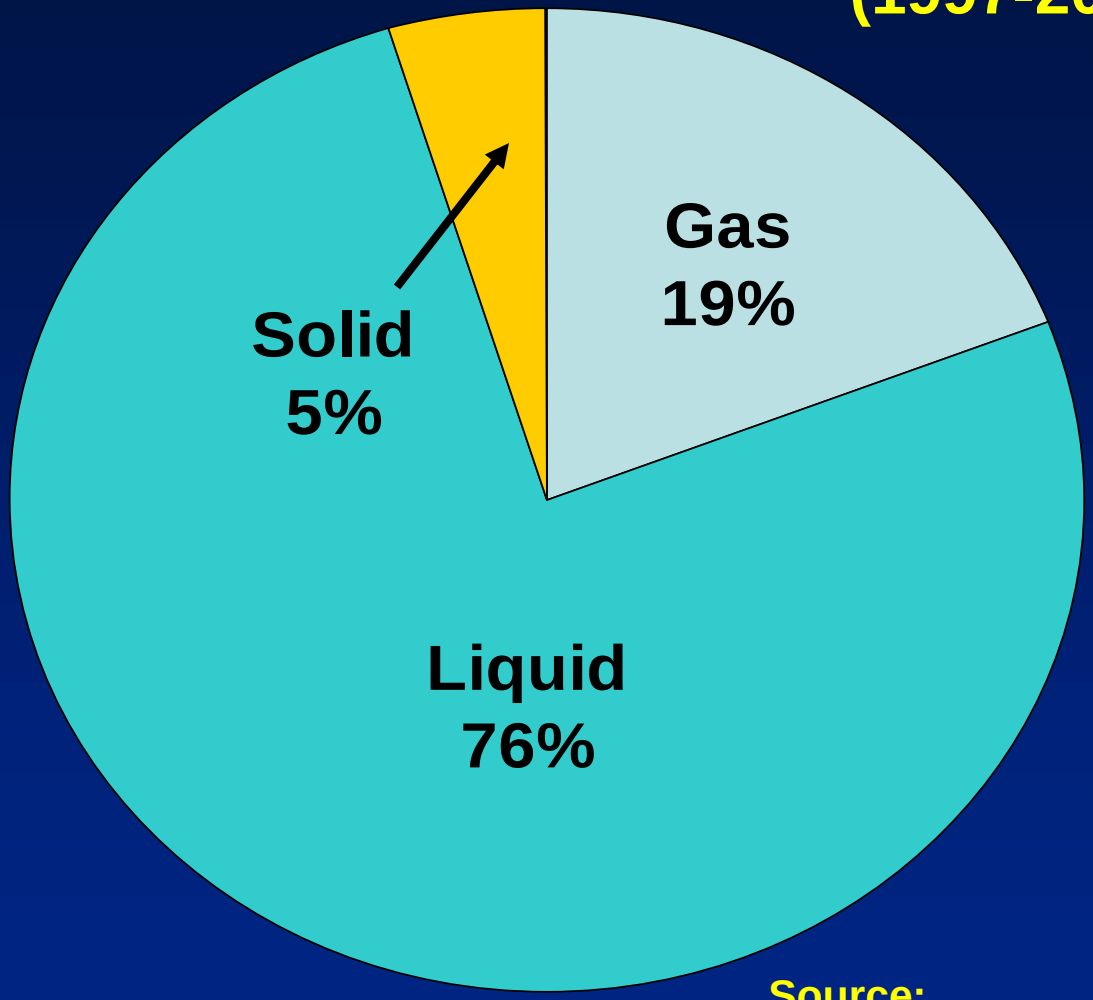
Hazardous Material Shipments
Fatalities by Hazardous Material (1997-2006)



Source:
Hazardous Material Information System
U.S. Dept. of Transportation (2007)

Hazardous Material Shipments

Fatalities by Hazardous Material (1997-2006)



Source:
Hazardous Material Information System
U.S. Dept. of Transportation (2007)

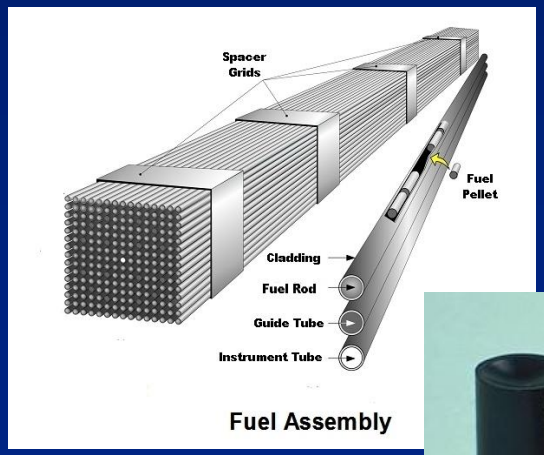
General Characteristics of Hazardous Material Transportation Accidents resulting in Fatalities

- Materials with high frequency of shipments
- Highly dispersible materials – primarily gases and liquids
- Poisonous, flammable, or explosive properties
- “Thin-walled” containers with top and bottom fittings

Characteristics of Spent Fuel Shipments

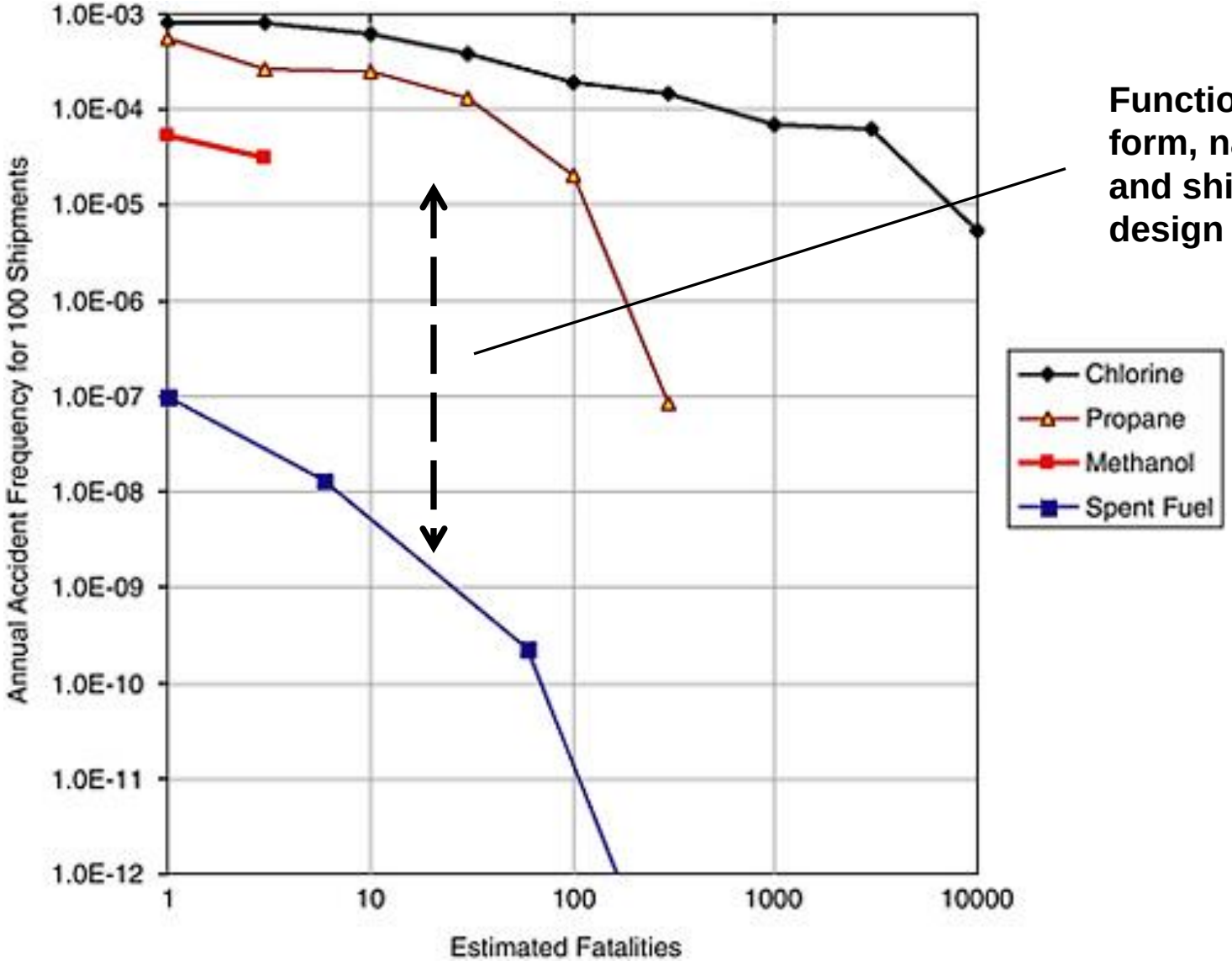
- Materials with low frequency of shipments
- Low dispersible materials – primarily solids
- Not flammable or explosive
- “Thick-walled” containers with no top and bottom fittings

Spent fuel is shipped as solid ceramic pellets encased in sealed metal tubes.



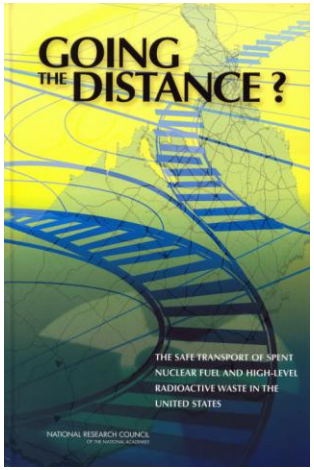
Comparison of Transportation Risks for Selected Hazardous Materials

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment



Function of material form, nature of hazard and shipping container design

Source:



Shipping Container Design

Spent fuel casks are designed to resist severe transportation accidents.

The NRC periodically assesses the effectiveness of spent fuel cask approval standards in addressing real world accidents.

Full-scale testing – a valuable tool in understanding cask performance.

1970's
United States (SANDIA)

1980's
United Kingdom (CECB)

2000's
Germany (BAM)

1990's
Germany (BAM)

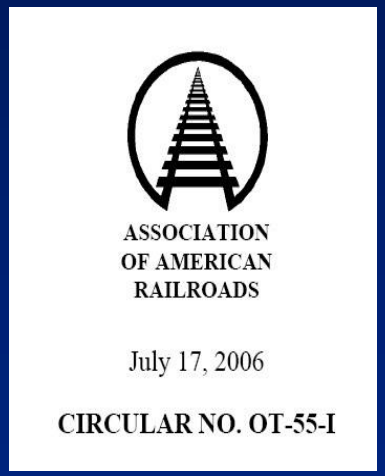
2010's
United States (NRC/DOE)

Package Performance Study

- Analysis of German data from full-scale drop tests.
- Full-scale test of a simulated rail accident.

Additional Studies on Long Duration Fully Engulfing Fires

- Studies on rail and highway tunnel fires completed



- AAR Circular OT-55-I
  - Comprehensive review of railway and highway accident data
  - Case studies of accidents with severe fires

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

MacArthur Maze April 29, 2007

- Single vehicle accident
- Involved a gasoline tanker truck carrying 8,600 gallons of gasoline
- The I-580 overpass directly above I-880 roadway collapsed approximately 17 minutes after the fire started

Newhall Pass (I-5) Fire October 12, 2007

- 15 Tractor trailer rigs and 1 car involved
- Severe fire lasting several hours
- 3 deaths
- 1/10 mile (550 ft) tunnel (truck bypass)

Transportation of High-Burnup Spent Fuel

- Work to support near term transport
  - Hydride reorientation and fatigue in fuel cladding
  - Salt atmosphere corrosion of steels
  - Seal degradation
- Work to support transport after long term storage
  - Evaluation of influence of materials degradation
  - Cooperative studies with DOE, EPRI to quantify degradation effects on transportability
- There is no information to indicate that high-burnup fuel can not be transported in some configuration after long-term storage. The question is whether that configuration would result in greater exposures to workers and transportation risk to the public .

Security and Spent Fuel Shipments

- Focus on security is not new, it has been continual since at least the late 1970's.
- Comprehensive security assessments of cask performance completed since 9-11, basically confirms earlier work.
- Multi-Lateral Agreement with France, Germany, and the UK to conduct sabotage tests on actual spent nuclear fuel - pending funding.
- Additional security measures were implemented after 9-11, to meet today's threats – to be implemented in rulemaking (2010 – 2011)

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Summary

- Transport by highway and rail is a low risk activity when conducted in strict adherence with existing regulations.
- Current safety standards result in robust cask designs that perform well in both severe accidents and credible threat environments.
- Additional security measures that might be needed to meet today's threats have been implemented.
- NRC will continue to review transportation events to assess impact on the safety and security of transportation of radioactive material and spent nuclear fuel