



# ***Transportation of Spent Nuclear Fuel***



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# Overview

- US DOT/US NRC Memorandum of Understanding
- Regulatory Structure
- Package-specific Requirements
- Advance notification
- Physical protection of irradiated fuel in transit
- Spent Fuel Transportation Risk Assessment
- Safety of Spent Fuel Transportation
- Radiation levels during transportation
- Questions

# DOT/NRC Memorandum of Understanding (MOU) July 1979


## DOT

- Regulates Carriers
- Regulates Type A and Low Specific Activity (LSA) Packages
- Issues Certificates of Competent Authority for International Shipments

## NRC

- Certifies the design of Type B and Fissile material packages
- Transportation Safeguards
- Investigates Accidents/Incidents
- Technical Advisor to DOT

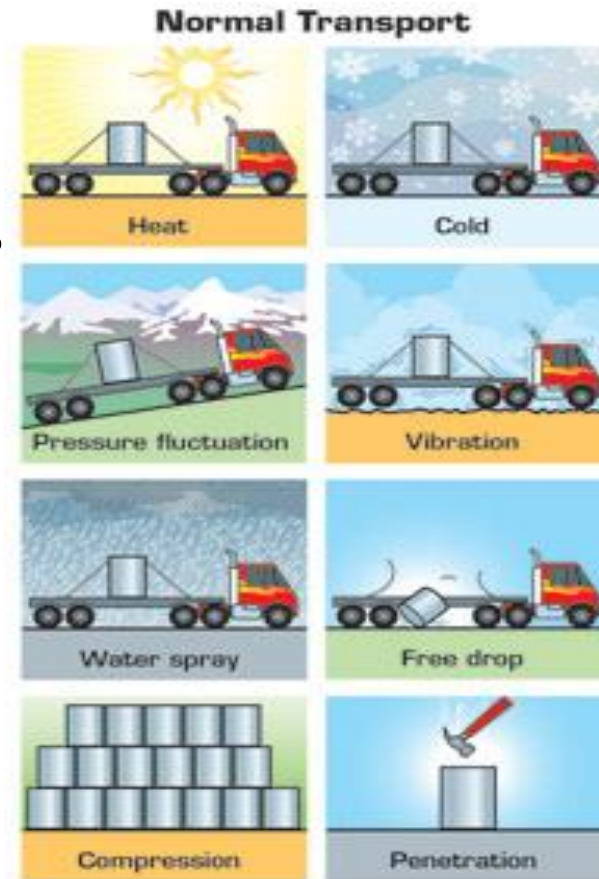
# Regulatory Structure

- 10 CFR Part 71 – Packaging and transportation of radioactive material
  - Type B Fissile packaging required for transport of spent fuel
  - Subject to Normal Conditions of Transportation and Hypothetical Accident Conditions tests
    - Conditions that are typical in transportation
    - Packages are designed to be accident resistant
  - Acceptance criteria after the accident conditions tests
    - Remain subcritical
    - No escape of radioactive material exceeding a total  $A_2$  in one week
    - External dose rate may not exceed 1 rem/hr at 1 m from the external surface of the package
  - Harmonized with IAEA requirements for transportation
    - New US DOT and US NRC final rules went into effect on July 13, 2015
    - Compatible with  and Regulations (SSR-6, 2009)



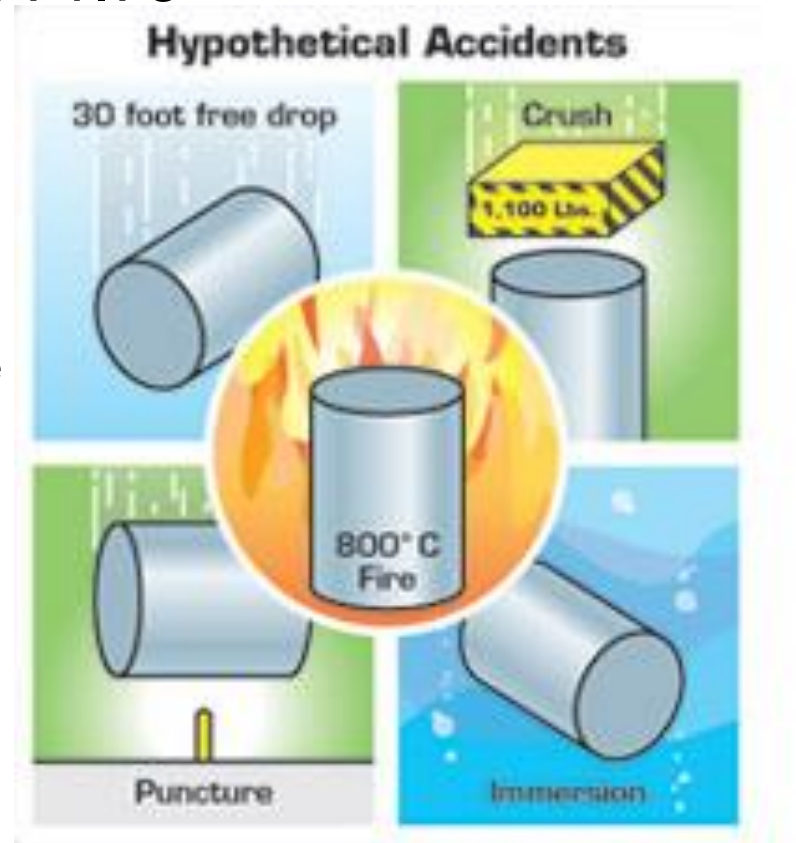
## Normal Conditions of Transport 10 CFR 71.71

1. Heat
2. Cold
3. Pressure changes
4. Vibration
5. Water spray
6. Free drop
7. Compression
8. Penetration



## Hypothetical Accident Condition Tests for Type B Packagings 10 CFR 71.73

1. Free Drop
2. Crush
3. Puncture
4. Thermal
5. Immersion - fissile package
6. Immersion - all packages



# Package-specific Requirements - Transportation

Transportation is performed in the public domain.

- Subcriticality
  - Transportation regulations require analysis of multiple packages (limiting the number of packages that can be shipped together)
  - Transportation regulations require consideration of water in-leakage
- Radiation Protection
  - During transportation, the radiation limit is 10 mrem/hr at 2 meters from the outer lateral surfaces/vertical planes of the vehicle
- Temperature
  - The temperature of accessible surfaces may not exceed 185° F as prepared for transport



# Advance Notification 10 CFR 71.97

- Required for shipments of irradiated reactor fuel
- Made in writing to the appropriate governor or designee and Tribal official or designee
- Timeline required for coordination
- The updated list published on/before June 30 each year



# Physical protection of irradiated fuel in transit

## 10 CFR 73.37

- Objectives
  - Minimize the potential for theft, diversion, or radiological sabotage
  - Facilitate the location and recovery of shipments that may have come under unauthorized control
- Physical protection system must be established
  - Pre-plan and coordinate
  - Advance notifications
  - Transportation physical protection program
  - Contingency and response procedures

# NUREG-2125, Spent Fuel Transportation Risk Assessment

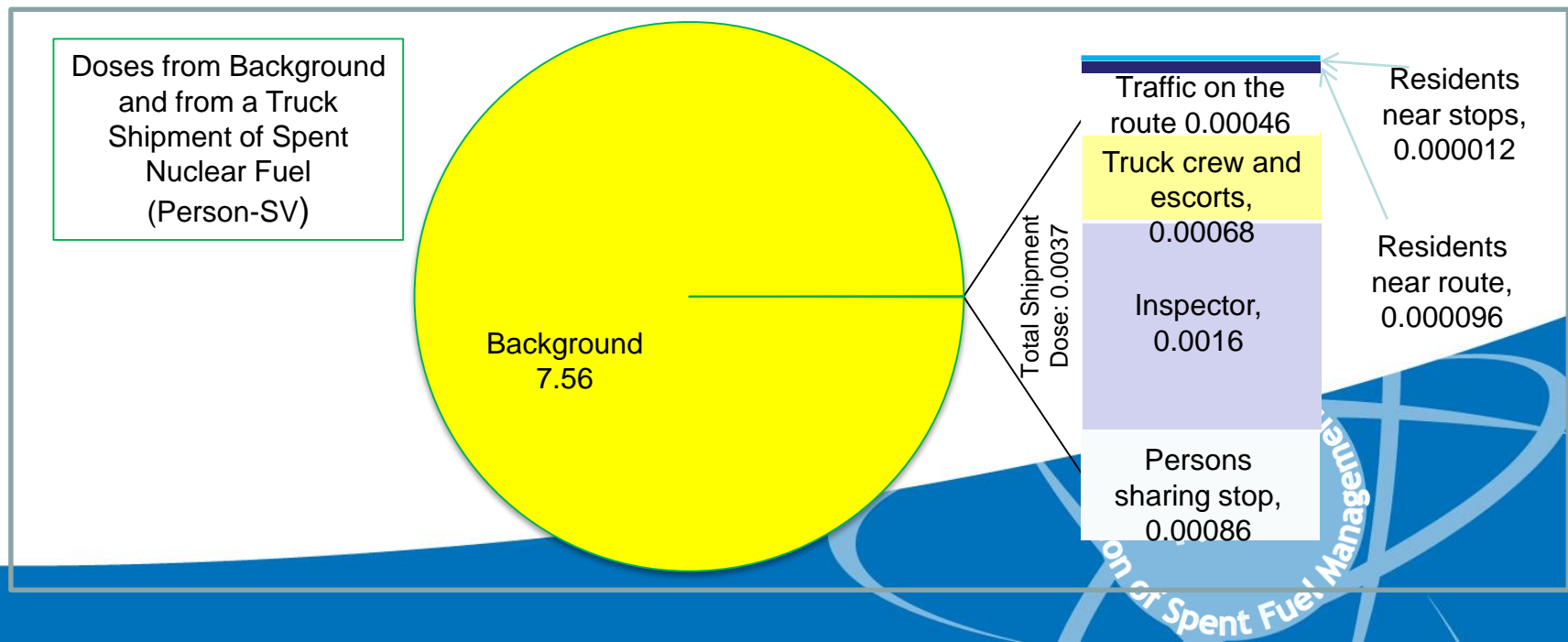
- Investigates safety provided by regulations during spent fuel transportation under both routine and accident conditions
- NRC's fourth investigation over the last 35 years
- Improvements in accident analysis
  - finite element analysis of NRC-certified rail and truck cask designs
  - direct loaded and canistered fuel contents
  - example U.S. cross-country truck and rail routes with updated accident statistics

# NUREG-2125, Spent Fuel Transportation Risk Assessment

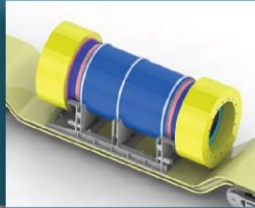
- Results
  - Routine conditions: collective doses are about four to five orders of magnitude less than collective background radiation dose over the same time period and exposed population as the shipment.
  - Accident conditions: contents would not be released in any U.S. historical accident if the fuel is contained in a welded canister inside the cask.

# NUREG-2125, Spent Fuel Transportation Risk Assessment

- Radiation emitted from a cask during transportation is a fraction of the natural background radiation
- The risk from accidental release is extremely low
- Regulations are adequate to protect the public against unreasonable risk



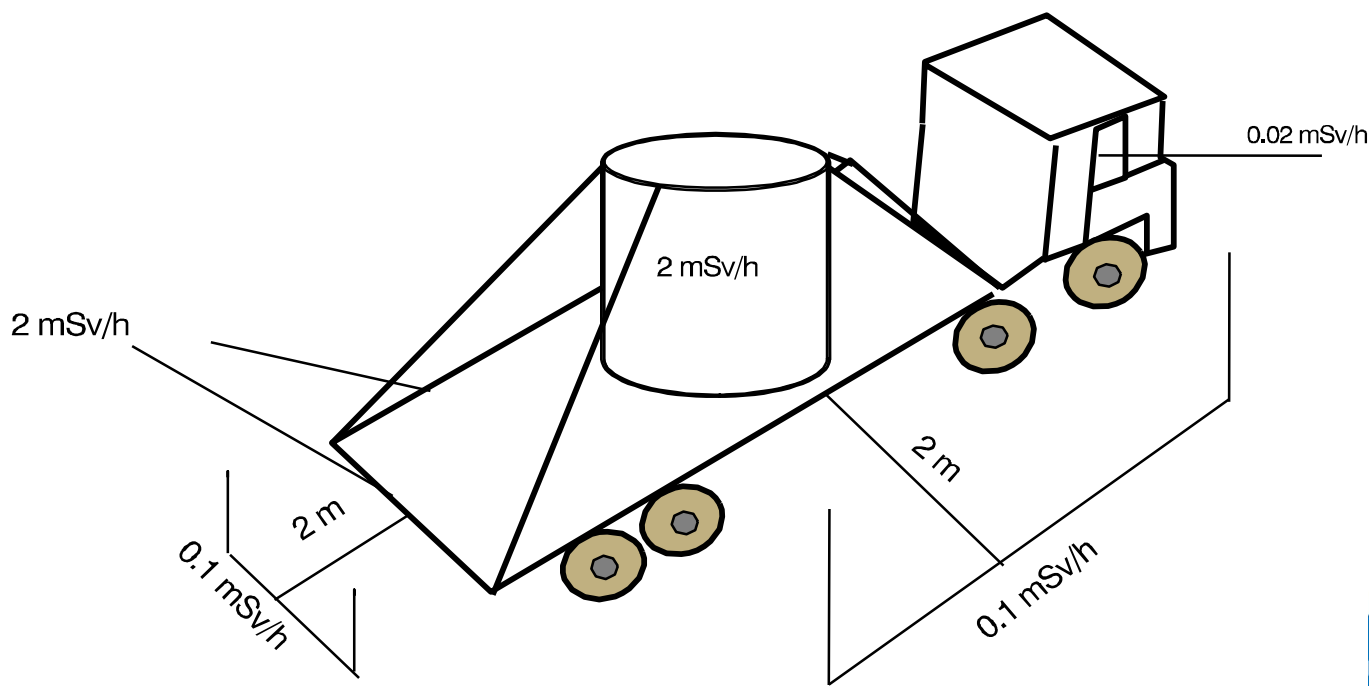
# Safety of Spent Fuel Transportation



- NUREG/BR-0292, Rev 1
- August 2016
- ML16237A133

# Radiation level limits 49 CFR 173.441(b)

- Open transport
- Exclusive use



# Radiation level limits 49 CFR 173.441(b)

- Closed transport
- Exclusive use

