SAND2008-0422P

# Regulatory and Extra-Regulatory Testing – A Refresher

## KHNP Training Program

### Module 13: Packaging and Transportation

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Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

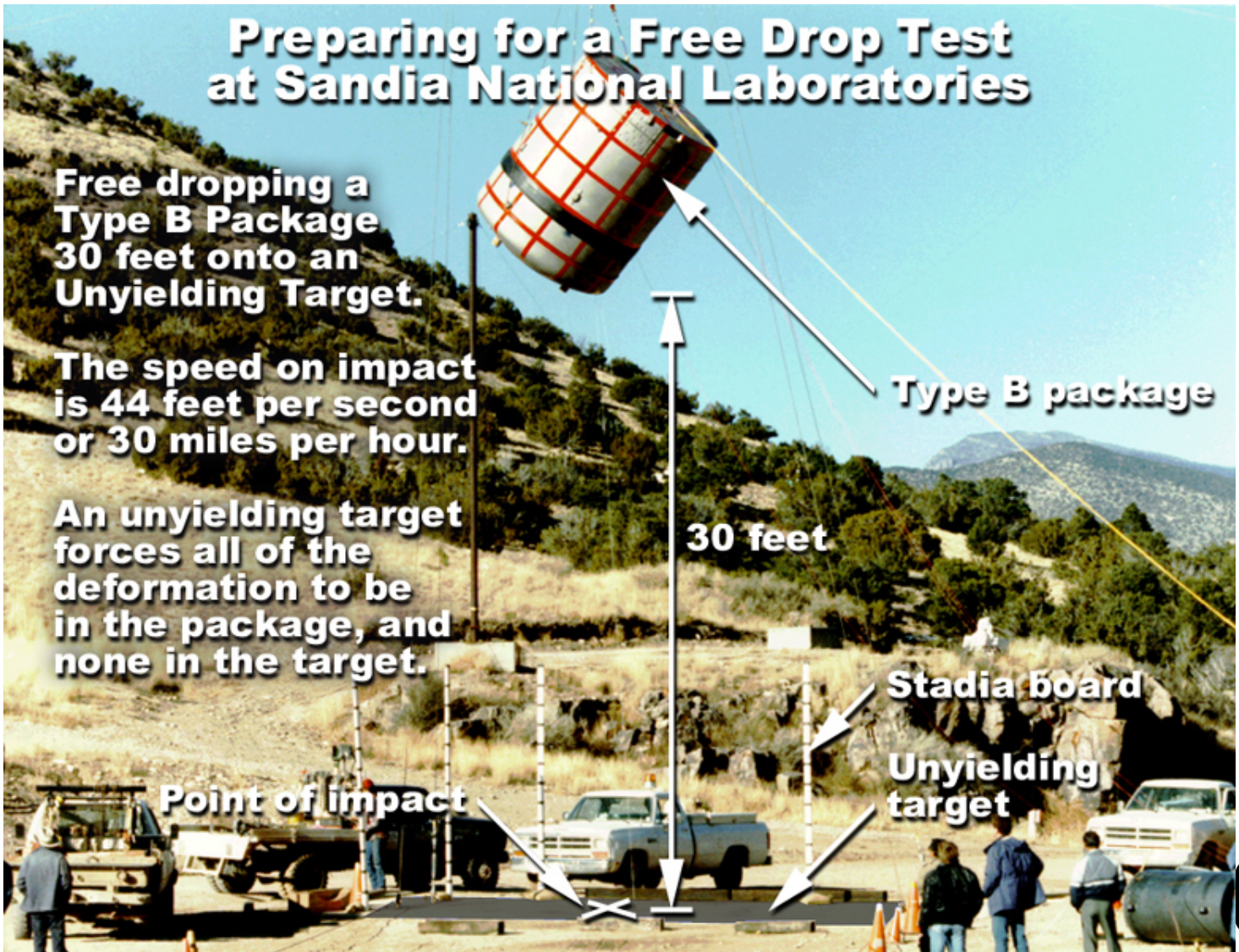
# Safety Functions of SNF Transport Packages

- Spent Nuclear Fuel (SNF) transport packages are Type B and are designed to address four principal safety functions:
  - Containment – package must contain contents during normal and accident conditions
  - Shielding - package must provide shielding from gamma and neutron radiation
  - Criticality Control - package must prevent a nuclear chain reaction
  - Heat Dissipation - package must dissipate heat from spent fuel assemblies

# Certification Tests for Type B Packages

- Type B packages that transport radioactive materials must demonstrate survivability from a sequence of impact, crush, puncture, and fire loadings designed to replicate transportation accident conditions. Survivability from immersion must also be demonstrated.
  - The Hypothetical Accident Conditions tests 1 through 4 (Drop, Crush, Puncture and Fire) are sequential
  - Test 5 (Immersion) is performed on either a previously tested or untested package.

# Certification Tests for Type B Packages

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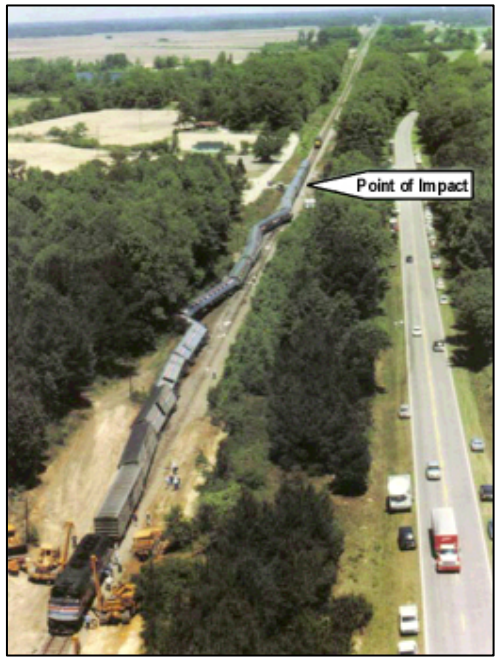
# Regulatory Testing Environments

- Drop Test
  - 9 meters = 48 kph (30 mph)
  - Unyielding target = 40 – 300 g's
  - Package oriented to cause maximum damage

**1,300,000 kgs (~3,000,000 lbs.) of force present in this full-scale drop test**




**Train-Tractor/Trailer Impact: South Carolina, May 2, 1995**

**Less than 450,000 kgs (~1,000,000 lbs.) of force present in this real-life non-nuclear accident.**

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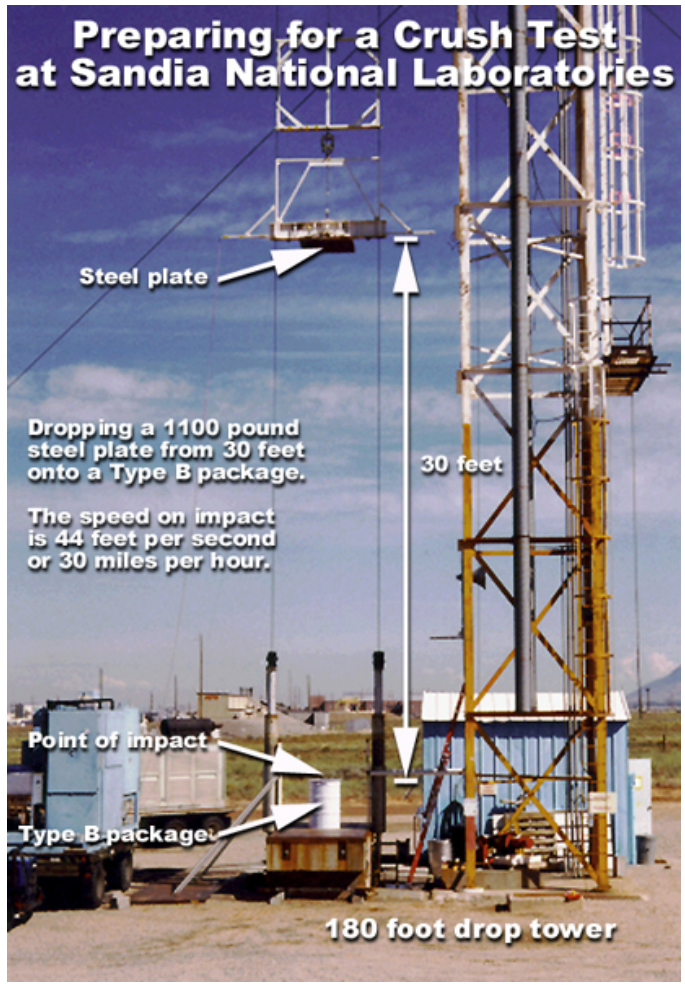
# Certification Tests for Type B Packages

## Crush:

- Dropping a 1100 pound steel plate from 30 feet onto a package. This test is only required for packages weighing less than 1100 pounds. The speed on impact is 44 feet per second or 30 miles per hour.

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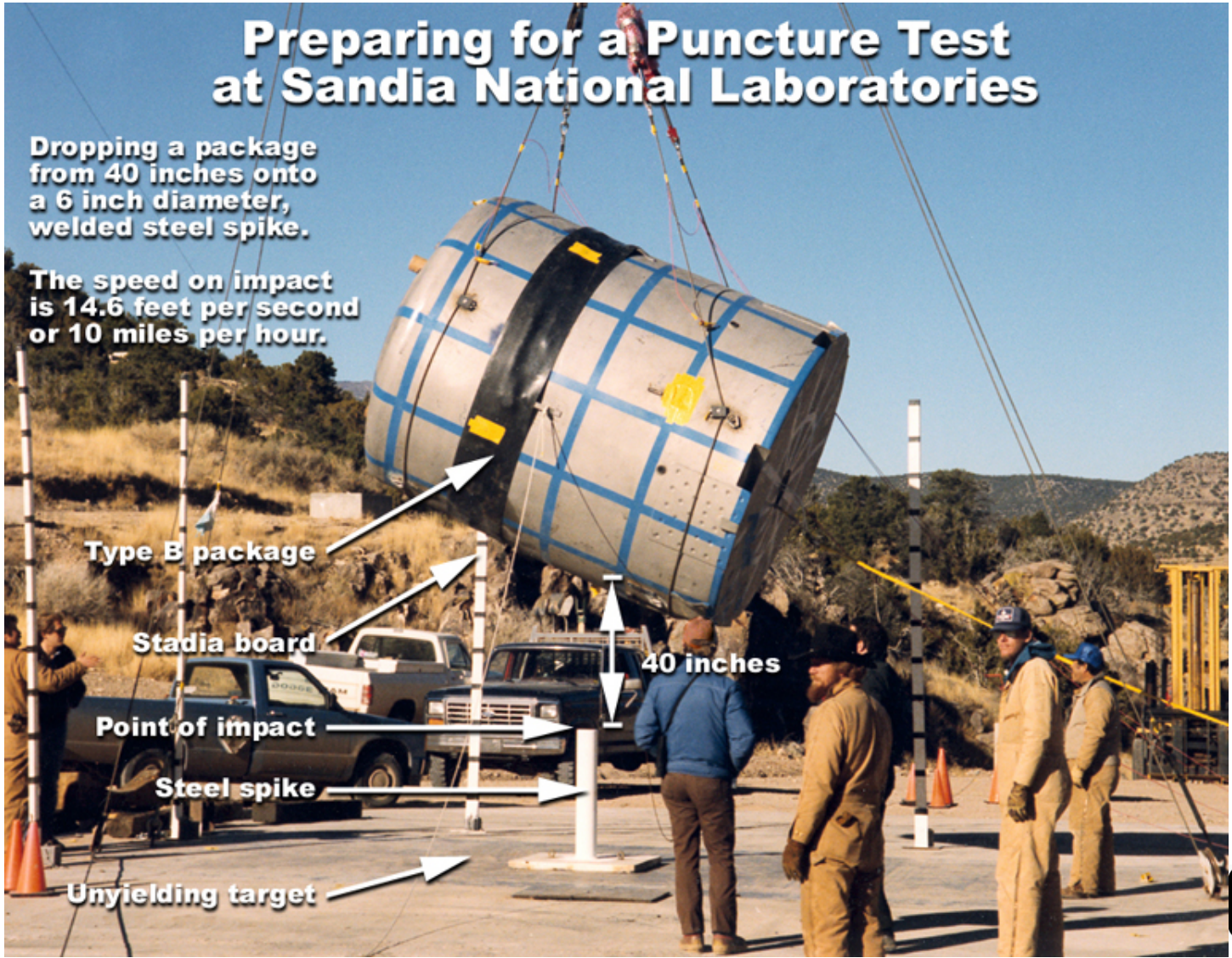
# Certification Tests for Type B Packages

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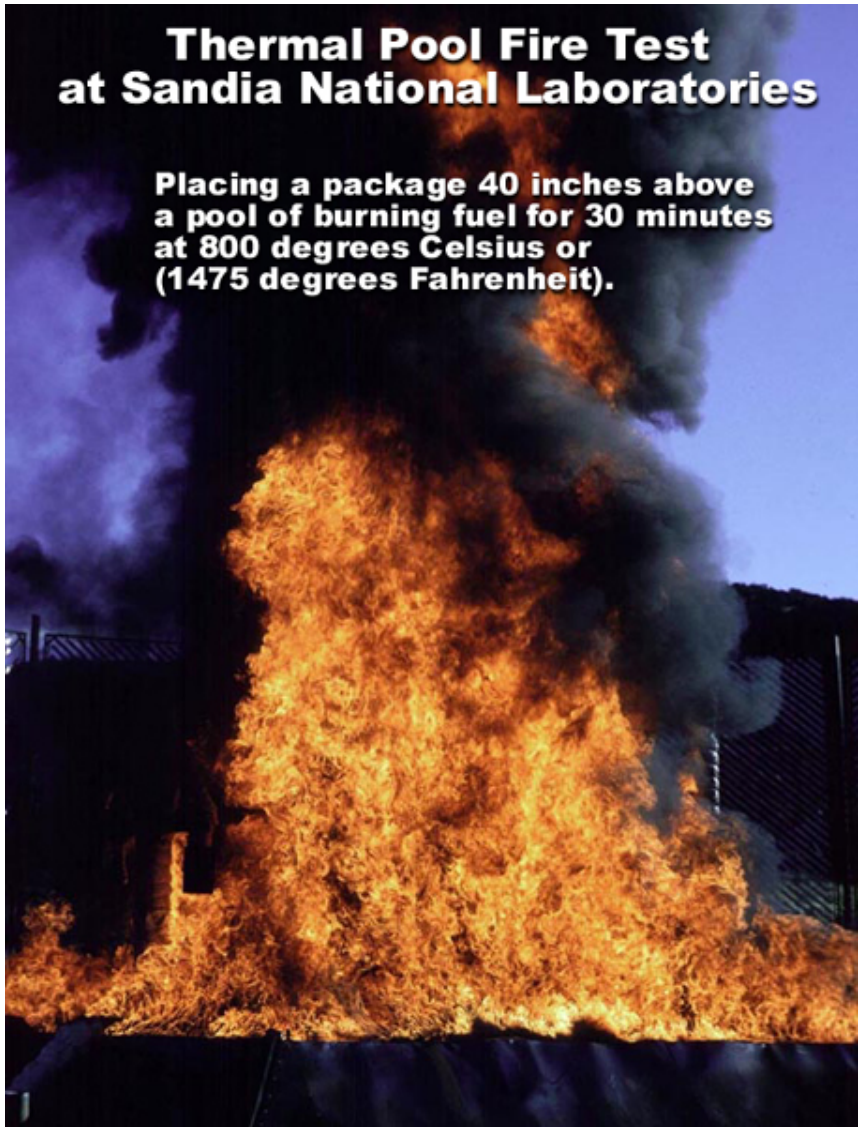
# Regulatory Testing Environments

- **Puncture Test**
  - **1 meter = 16 kph (10 mph)**
  - **15 cm (6″) ø steel pin welded to unyielding surface**
  - **Package oriented to cause maximum damage**

# Certification Tests for Type B Packages

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# Regulatory Testing Environments

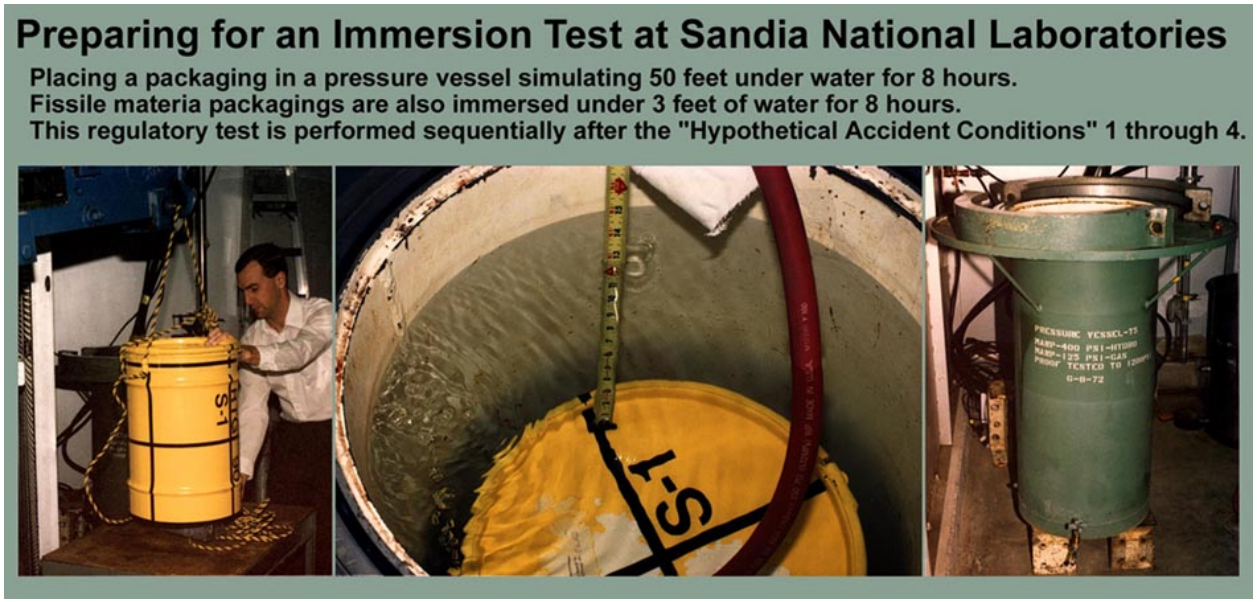
- Thermal Test
  - 30 minutes
  - Fully engulfing
  - 800°C (1475°F) minimum

- Howard Street Tunnel Fire

  Baltimore, Maryland July 18, 2001
  - Peak Temperature ~1000C (1800F)
  - Intense fire duration ~3 hours
  - NRC analyses indicate that a Type B package would have survived the fire environment without release of contents

# Certification Tests for Type B Packages

## Immersion:




- Placing a package under 50 feet of water for 8 hours. Fissile material packages are also immersed under 3 feet of water for 8 hours sequentially after tests 1 through 4.
- Additionally, packages with $>10^5$ $A_2$ must withstand external water pressure of 2 MPa.

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# Extra-Regulatory Testing

- **Full-Scale Rail Test at SNL**
  - **A 74-ton package on a railcar crashed into a 690-ton concrete block at 130 kph (81) mph**

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# Extra-Regulatory Testing

- Full-Scale Railroad Grade Crossing Test at SNL
  - A 25-ton packaging on a semi-trailer was struck by a 120-ton diesel locomotive traveling at 130 kph (81 mph)
  - ~30 g loading

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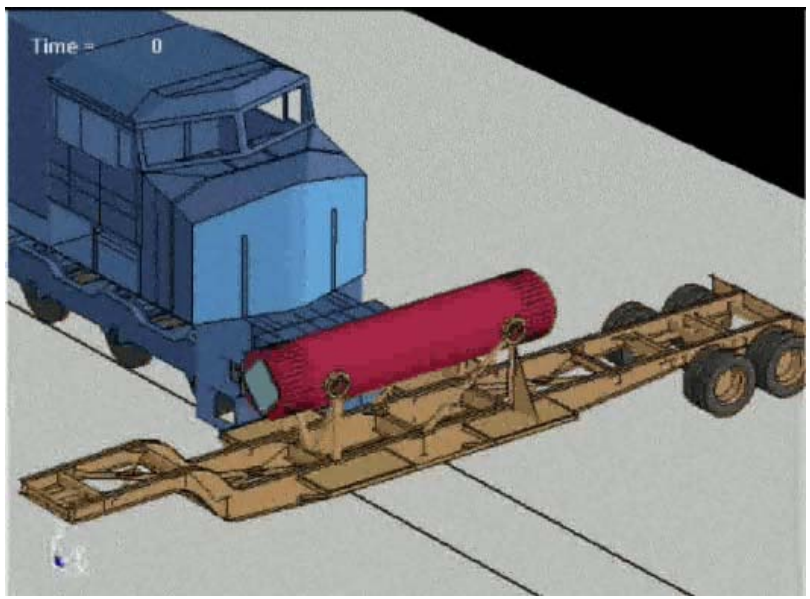
# Extra-Regulatory Analysis

- **Locomotive impact into a truck package at a railroad grade crossing.**
  - **Analyses at 113 kph (70mph) and 130 kph (80mph)**
  - **Limited plastic strains in bolts and localized plastic strain in the containment boundary**
  - **No failure in seal region or packaging containment boundary**

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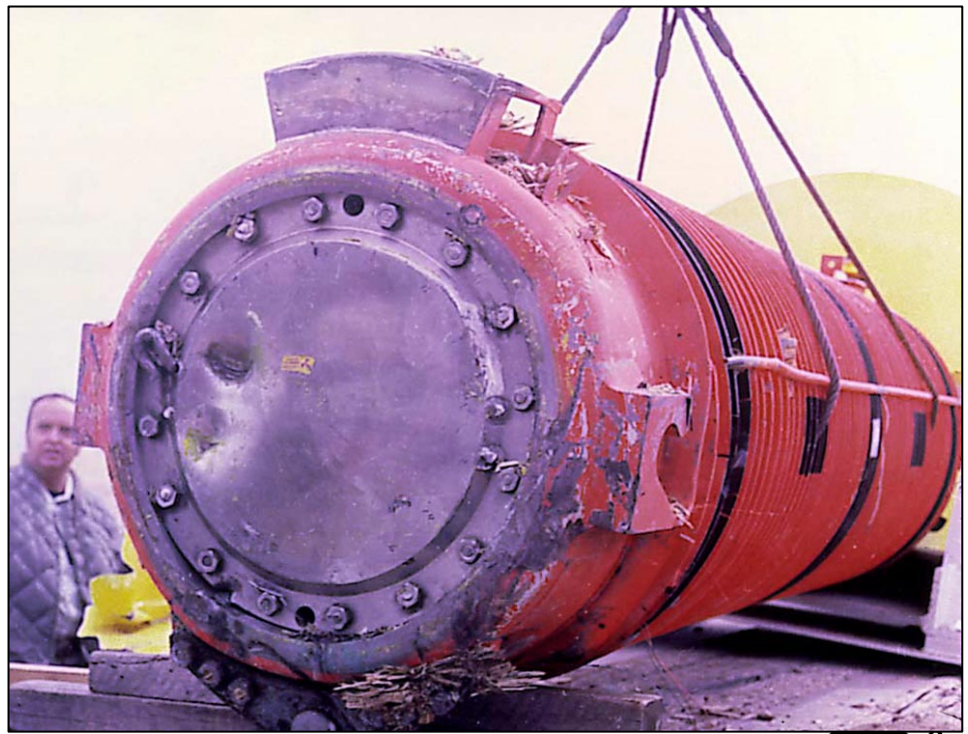
# Extra-Regulatory Testing

- **Full-Scale Truck Testing at SNL**
  - **A 22-ton package on a flatbed semi-trailer crashed into a 690-ton concrete block at 135 kph (84 mph)**
  - **~120 g loading**



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