



# **NRC Perspective on a National Program to Transport Spent Nuclear Fuel and Radioactive Materials**

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# Outline

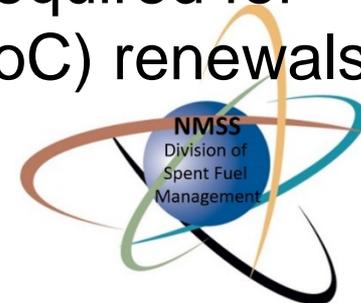
- Independent Spent Fuel Storage Installations (ISFSIs)
- Consolidated Interim Storage Facility (CISF)
- Questions on a Large Scale Transportation Program
  - Storage-Transportation-Storage Guidance (72-71-72)
  - Demonstrating that the condition of the spent nuclear fuel (SNF) has not changed substantially during storage
  - Storage and transportation application reviews
  - Multiple storage and transportation application reviews
  - NRC involvement in SNF or HLW shipments in a transportation cask system with a Certificate of Compliance (CoC)



# Independent Spent Fuel Storage Installations (ISFSIs)



- More than 2700 dry storage systems as of May 2018
- Most are dual purpose systems which are designed to be transported after storage
- Aging management programs (AMPs) required for license and certificate of compliance (CoC) renewals



# Consolidated Interim Storage Facilities (CISFs)

- NRC has received 2 license applications for Consolidated Interim Storage Facilities (CISFs)
- CISF applications include spent fuel currently in storage canisters at existing independent spent fuel storage installations (ISFSIs) licensed under 10 CFR Part 72
- These canisters are proposed to be transported under 10 CFR Part 71, and subsequently placed into storage at the CISF under Part 72 (72-71-72)

# Specific Questions

1. Explain the NRC guidance development for the transition of commercial SNF from storage to transportation to storage (possibly in repeating cycles).
  - NRC Office of Nuclear Materials Safety and Safeguards Division of Spent Fuel Management (NRC/NMSS/DSFM) has determined that additional guidance would be beneficial for the Storage-Transportation-Storage scenario
  - Additional guidance will likely be added to NUREG-2215 (Draft): Standard Review Plan for Spent Fuel Dry Storage Systems and Facilities (guidance has yet to be developed)
  - Guidance will consider a number of factors including
    - Status of storage systems (initial period or renewal)
    - Requirements for transport (canister integrity for moderator exclusion)
    - Acceptance testing at the second or subsequent storage site

# Transportation after Storage

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## Regulatory requirements of 10 CFR Part 71

- Transportation packaging provides containment
- Canister integrity may be necessary for moderator exclusion (e.g., transportation of high-burnup fuel)
  - Testing and nondestructive examination (NDE) to demonstrate an adequate margin of safety
  - Initial storage period
  - Renewed storage license or CoC with aging management programs (AMPs)

# Returning Canisters to Storage after Transportation

## Regulatory requirements of 10 CFR Part 72

- Possible Variations
  - Initial storage period
  - Renewed storage license or CoC with AMPs
  - Examinations to verify canister condition prior to transport (e.g., high-burnup fuel)
- Testing and NDE
  - Canister helium leak rate test
  - Visual Examination
  - Surface/Volumetric NDE

# Testing and Nondestructive Evaluation Methods

- Canister helium leak rate test
  - Conducted inside the transportation package
  - Verify no canister breaches prior to and/or after transportation
- Visual Examination
  - Performed using remote methods while canister is in storage or during transfer operations
  - Detection of aging effects and handling defects
- Surface/Volumetric NDE
  - Performed using remote methods while canister is in storage or during transfer operations
  - Eddy current and ultrasonic testing are potential methods
  - Characterize aging and handling effects



# Contingency Planning

- The number of canisters that are found to have indications of aging are anticipated to be limited
- An acceptable plan for addressing canisters with aging effects is expected to be provided in the CISF application
  - Procedures and controls to limit occupational exposures and site boundary dose limits
  - Corrective actions necessary to return to normal operations
  - Necessary to meet the requirements of 10 CFR 72.24(c)(3), 72.24(d), 72.24(e), 72.104 and 72.106



# Specific Questions (cont.)

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2. What steps can the licensee take to demonstrate to the NRC that the condition of the SNF has not changed substantially during storage (>20 years) and conforms to the licensing requirements, thereby ensuring that the SNF is safe for transportation?
  - Low-Burnup fuel: ISG-11 Rev. 3
  - High Burnup Fuel: NUREG-2224 (Draft) Chapter 4
  - Compatibility of storage system design and loading parameters with transportation
  - Relevant Interim Staff Guidance (ISG): ISG-1, ISG-11, ISG-22, ISG-24, and ISG-25

# ISG-11 Revision 3

- Maximum calculated fuel cladding temperature should not exceed 400°C (752°F) for normal conditions of storage
- For low burnup fuel, a higher short-term temperature limit may be used, if the cladding hoop stress is equal to or less than 90 MPa (13,053 psi) for the temperature limit proposed
- Repeated thermal cycling (repeated heatup/cooldown cycles) should be limited to less than 10 cycles, with cladding temperature variations that are less than 65°C (117°F) each
- Off-normal and accident conditions, the maximum cladding temperature should not exceed 570°C (1058°F)



# High-Burnup Fuel NUREG-2224 (Draft) Chapter 4

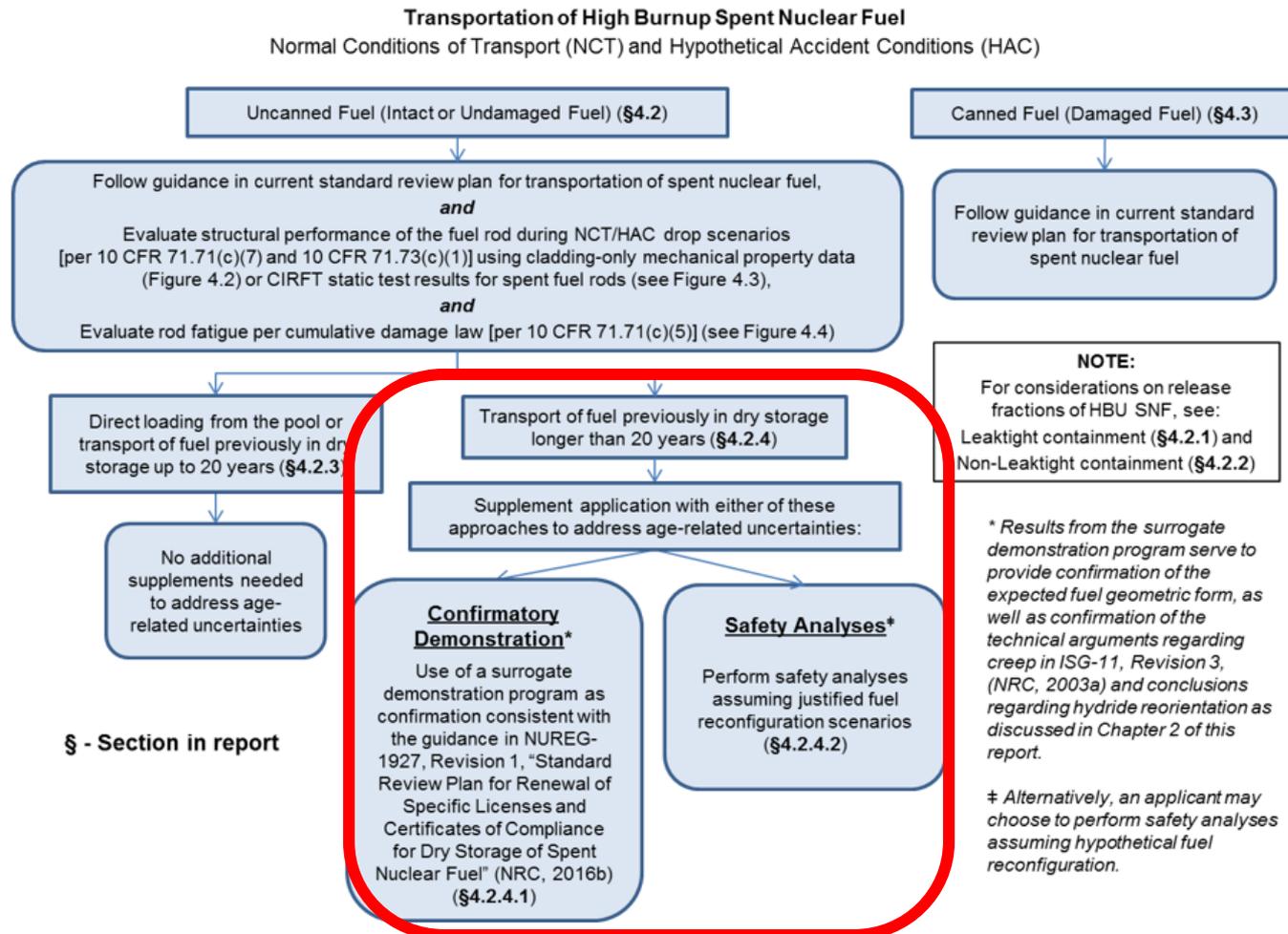


Figure 4-1 Example approaches for approval of transportation packages with high burnup spent nuclear fuel

# Supplemental Data From Confirmatory Demonstration

- Supplementing the application with results from a surrogate demonstration program
  - Such a program could provide field obtained confirmation that the fuel configuration has been maintained before transport.
  - The applicant may refer to Appendices B and D to NUREG-1927, Revision 1 (NRC, 2016b), which describe attributes and acceptance criteria of an acceptable surrogate demonstration program.



# Supplemental Safety Analyses

- Demonstrate that a transportation package can still meet the pertinent regulatory requirements by assuming hypothetical reconfiguration of the fuel contents into justified geometric forms
- Demonstration that the HBU SNF contents, even if reconfigured, can still meet the pertinent 10 CFR Part 71 regulations for containment, thermal performance, criticality safety and shielding after the required tests for normal conditions of transport (NCT) and hypothetical accident conditions (HAC)



# Specific Questions (cont.)

3. In planning for transporting all domestic SNF and HLW DOE will develop and submit several new applications for those SNF and HLW containers. What is the typically time for the NRC to review and approve a license application for storage or transportation?
- Storage Metric: 80% in 13 months; >90% in 2 years
    - Includes ~ 5 months for NRC Rulemaking
    - Does not include response time from the applicant
  - Transportation Metric: 80% in 8 months; >90% in 2 years
    - Does not include response time from the applicant
  - RIS 2007-09: Recurring Requests for Additional Information (RAIs) for 10 CFR Part 71 and 72 Applications
  - Examples of Recent Reviews
    - TN Americas EOS (CoC 72-1042) Application: 6/16/2015 CoC: 6/7/2017
    - Holtec HI-STAR 190 (CoC 71-9373) Application: 8/7/2015 CoC: 8/8/2017



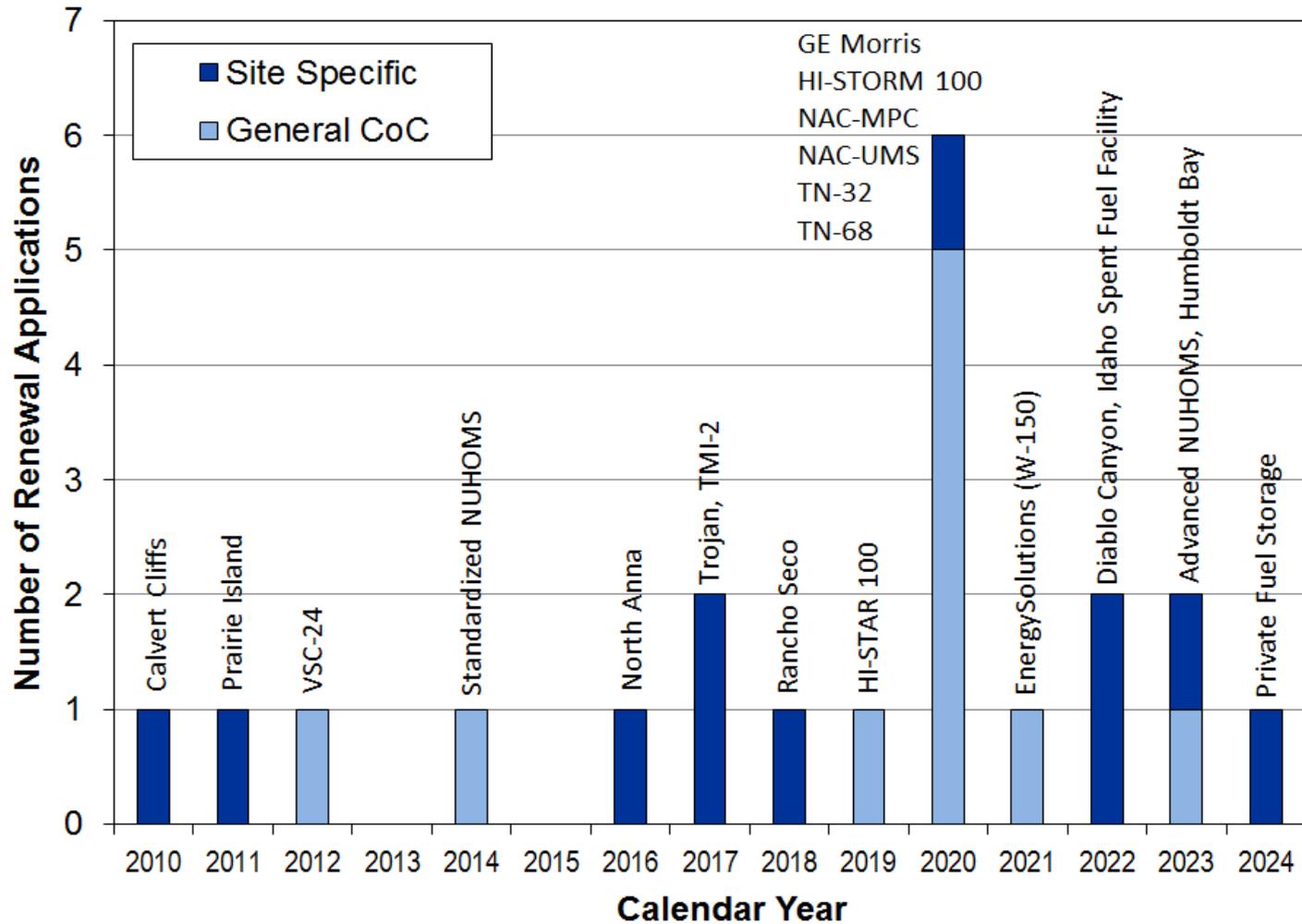
# Specific Questions (cont.)

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4. How much notice does the NRC recommend that DOE provide to the NRC if, for example, DOE wants to have four new licenses for SNF or HLW containers approved in the same timeframe? How does that change if DOE needs to have six or eight licenses approved?
- RIS 2004-20: Lessons Learned from Review of 10 CFR Parts 71 and 72 Applications
    - Pre-application Meetings
    - Processing of Concurrent Reviews
  - 2005-27, Rev. 1: NRC Timeliness Goals, Prioritization of Incoming License Applications and Voluntary Submittal of Schedule for Future Actions for NRC Review
    - Informing NRC of Future Licensing and Certification Actions
    - Prioritization of SFPO Workload



# Part 72 Renewals



# Specific Questions (cont.)

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5. What involvement does NRC have in approving individual SNF or HLW shipments in a transportation cask system that has a Certificate of Compliance?
- Regulations concerning the transportation of radioactive materials are published by four agencies:
    - Department of Transportation (DOT)
    - Nuclear Regulatory Commission (NRC)
    - Transportation Security Administration (TSA)
    - United States Postal Service (USPS)
  - NRC approved Transportation CoC specifies contents
  - Transportation routes approved by NRC per 10 CFR 73.37(b)(vi)
  - ISG-20: Transportation Package Design Changes Authorized Under 10 CFR Part 71 Without Prior NRC Approval



# Interim Staff Guidance

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- ISG-1, Rev. 2: Classifying the Condition of Spent Nuclear Fuel for Interim Storage and Transportation Based on Function
- ISG-11, Rev 3: Cladding Considerations for the Transportation and Storage of Spent Fuel
- ISG-19: Moderator Exclusion under Hypothetical Accident Conditions and Demonstrating Subcriticality of Spent Fuel per 10 CFR 71.55(e)
- ISG-20: Transportation Package Design Changes Authorized Under 10 CFR Part 71 Without Prior NRC Approval
- ISG-22: Potential Rod Splitting due to Exposure to an Oxidizing Atmosphere During Short-Term Cask Loading Operations in LWR or Other Uranium Oxide Based Fuel
- ISG-24: The Use of a Demonstration Program as a Surveillance Tool for Confirmation of Integrity for Continued Storage of High Burnup Fuel Beyond 20 Years
- ISG-25: Pressure and Helium Leakage Testing of the Confinement Boundary of Spent Fuel Dry Storage Systems



# NUREG (Draft Reports)

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- NUREG-2215: Standard Review Plan for Spent Fuel Dry Storage Systems and Facilities
- NUREG-2216: Standard Review Plan for Transportation Package Approval
- NUREG-2224: Dry Storage and Transportation of High Burnup Spent Nuclear Fuel



# Backup

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# Spent Fuel Storage System Design Review: 10 CFR Part 72

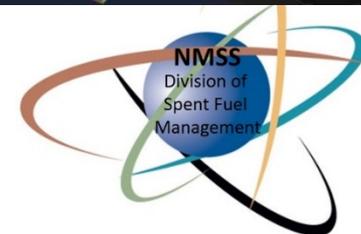
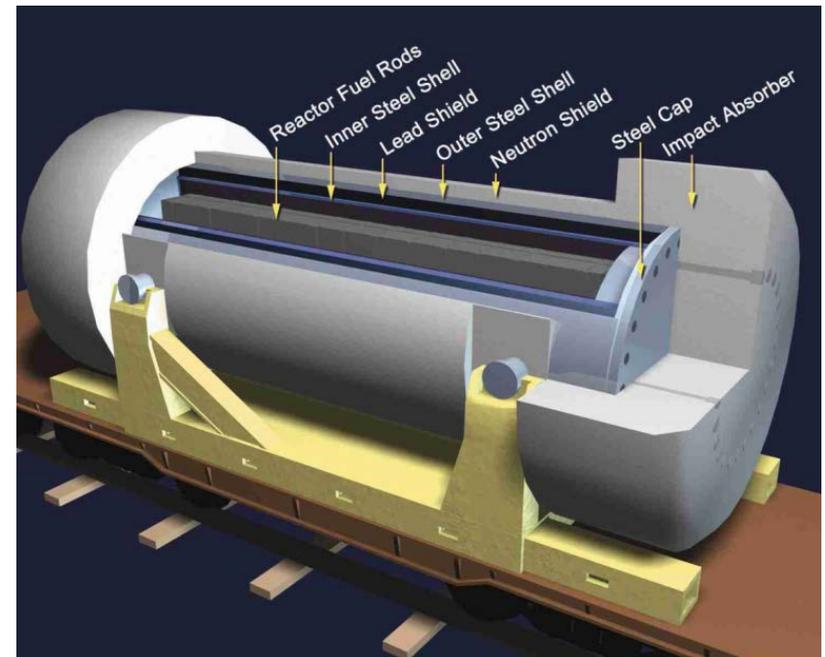
- Normal and Off-Normal Conditions
- Accident Conditions and Natural Phenomena
- General design criteria
  - Provide reasonable assurance that spent fuel can be received, handled, packaged, stored, and retrieved without undue risk to the health and safety of the public
  - Protection against environmental conditions and natural phenomena (earthquakes, tornadoes, lightning, hurricanes, floods, tsunami, and seiches)
  - Protection against fires and explosions
  - Protection against external man-induced events
- Acceptance criteria
  - Nuclear criticality safety – maintained subcritical
  - Radiological protection – dose limits to individual worker and to individual located beyond the controlled area boundary ( $\leq 25$  mrem annual dose)

# Aging Management Review for Spent Fuel Storage Renewals

- Considers Materials + Environment + Time and the intended function of the systems, structures, and components (SSCs)
- Identification of relevant aging mechanisms:
  - Review of site maintenance records
  - Results of inspections
  - Maintenance and inspection records from ISFSI sites with similar SSC materials and operating environments
  - Review of industry records and operational experience
  - Applicable consensus codes and standards
  - NUREG-2214 Managing Aging Processes in Storage (Draft Report for Public Comment: ML17289A237)

# Transportation System Review: 10 CFR Part 71

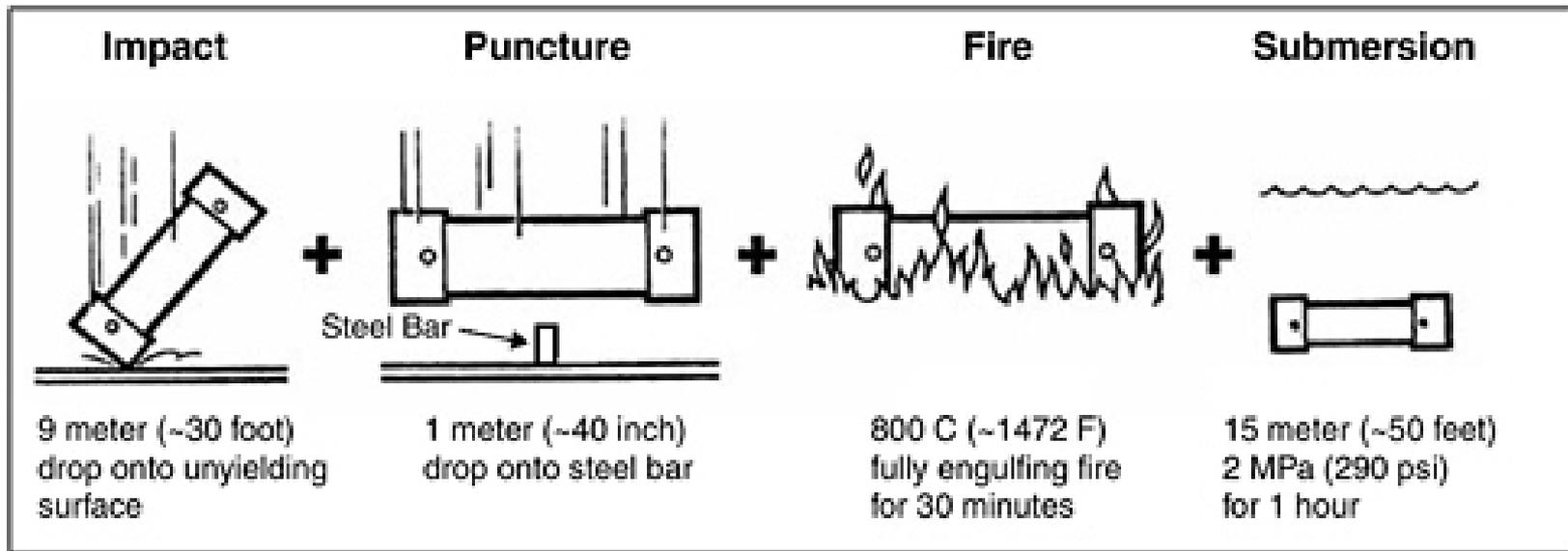
- Type B Fissile packaging required for transportation of spent fuel
  - External dose rate limits
  - Contents remain subcritical
  - Containment is maintained
- Normal transport
  - Vibration
  - Drops and impacts
  - Heat and cold



# Transportation System Reviews

## 10 CFR Part 71

### Hypothetical Accident Conditions (HAC)



### Acceptance criteria after the accident conditions tests

- Limits for release of krypton-85 and other radioactive material
- Contents remain subcritical
- Radiation dose rate limits at 1 m (40 in) from the external surface of the package

# Scenario Variations

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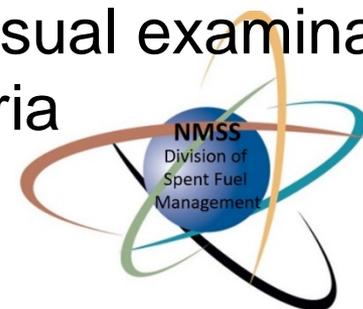
- Dual purpose storage and transportation canister based systems in CISF applications
- Systems designed only for storage
- Part 72
  - Initial license/Certificate of Compliance (CoC) period
  - Period of Extended Operation (PEO) with AMPs
- Part 71
  - No credit for canister boundary integrity
  - Credit for canister boundary integrity



# Example 1

## CoC/License with no credit for canister boundary integrity for Part 71

- Part 71 Pre-transport
  - No canister leak test unless CISF receipt testing results do not meet acceptance criteria
  - No visual examination unless initial CISF receipt visual examination results do not meet acceptance criteria
  - No surface/volumetric NDE unless visual examination results do not meet acceptance criteria



# Example 1 (cont.)

## CoC/License with no credit for canister boundary integrity for Part 71

- Part 72 CISF Receipt
  - 100% canister leak test
  - Visual examination - minimum of 2 from each originating site (most susceptible)
    - Credit for AMP examinations permitted
  - No surface/volumetric NDE unless visual examination results do not meet acceptance criteria



## Example 2

### CoC/License with credit for canister boundary integrity for Part 71

- Part 71 Pre-transport
  - 100% canister leak test
  - Visual examination - minimum of 2 from each originating site (most susceptible)
    - Credit for AMP examinations permitted
  - No surface/volumetric NDE unless visual examination results do not meet acceptance criteria



## Example 2 (cont.)

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### CoC/License with credit for canister boundary integrity for Part 71

- Part 72 CISF Receipt
  - 100% canister leak test
  - No visual examination
  - No surface/volumetric NDE

