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Fuel Cycle Technologies Program
Transportation R&D

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Initial Transportation Objectives

- new FY11 Program -

- **Identify and prioritize technical issues associated with the transport of high burnup used fuel**
- **Identify the technical issues associated with establishing the integrity of used fuel for retrievability and transportation after long term storage**
- **Identify the technical issues associated with transporting fuel in casks designed for storage and transport, but which have only received licensing for storage**
- **Support American Society of Mechanical Engineers Code for radioactive material packages**

Six national laboratories on Transportation Team

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Transportation Priorities Identified

- **Near term: address technical issues for possible transport of selected fuel rods to support possible off-site testing.**

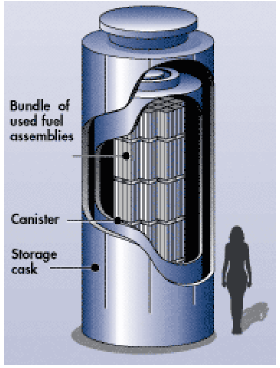
- **Medium term: possible transport of UNF from Independent Spent Fuel Storage Installations to a consolidated interim storage facilities.**
  - **Key transportation emphasis:**
    - ***Inventory of UNF in dry storage and transfer / transport systems available.***
    - ***Logistical issues: E.g.: Are storage canisters currently transportable? Are transfer systems / transport casks available? Dual-purpose casks.***
    - ***Decommissioned sites “first”.***

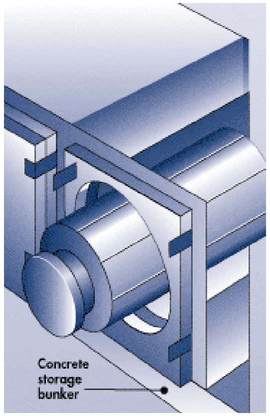
- **Very-long term: transport of used nuclear fuel after extended storage**
  - **Key transportation assumptions for R&D emphasis:**
    - ***UNF may be degraded after extended storage.***
    - ***Canisters may be degraded.***
    - ***Retrievability and criticality issues must be addressed.***

Dry Storage Systems

Courtesy NRC

Some canisters are designed to be placed vertically in robust above-ground concrete or steel structures.



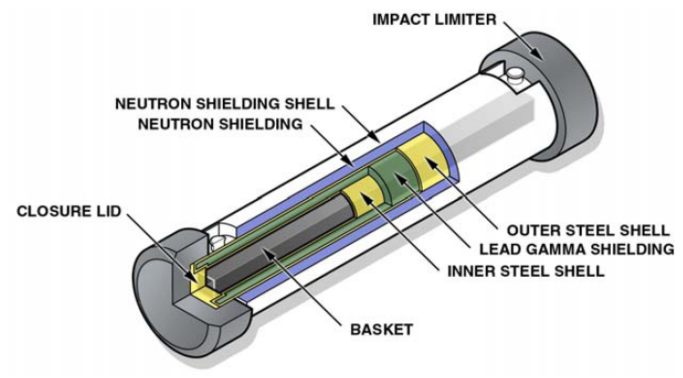


Some canisters are designed to be stored horizontally in above-ground concrete bunkers, each of which is about the size of a one-car garage.

Transportation Casks

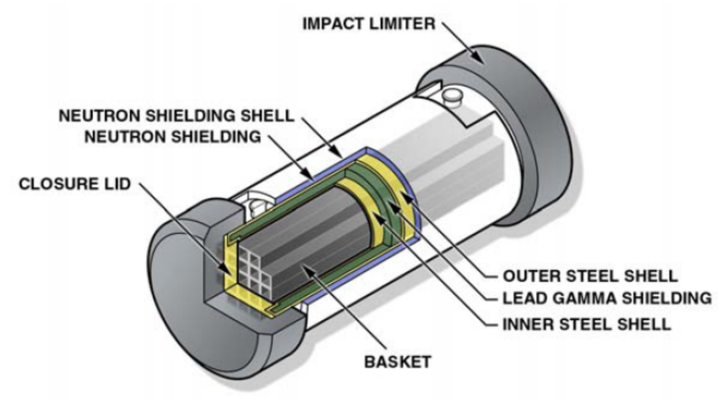
Courtesy NRC

TYPICAL SPENT FUEL TRANSPORTATION CASKS



Generic Truck Cask for Spent Fuel

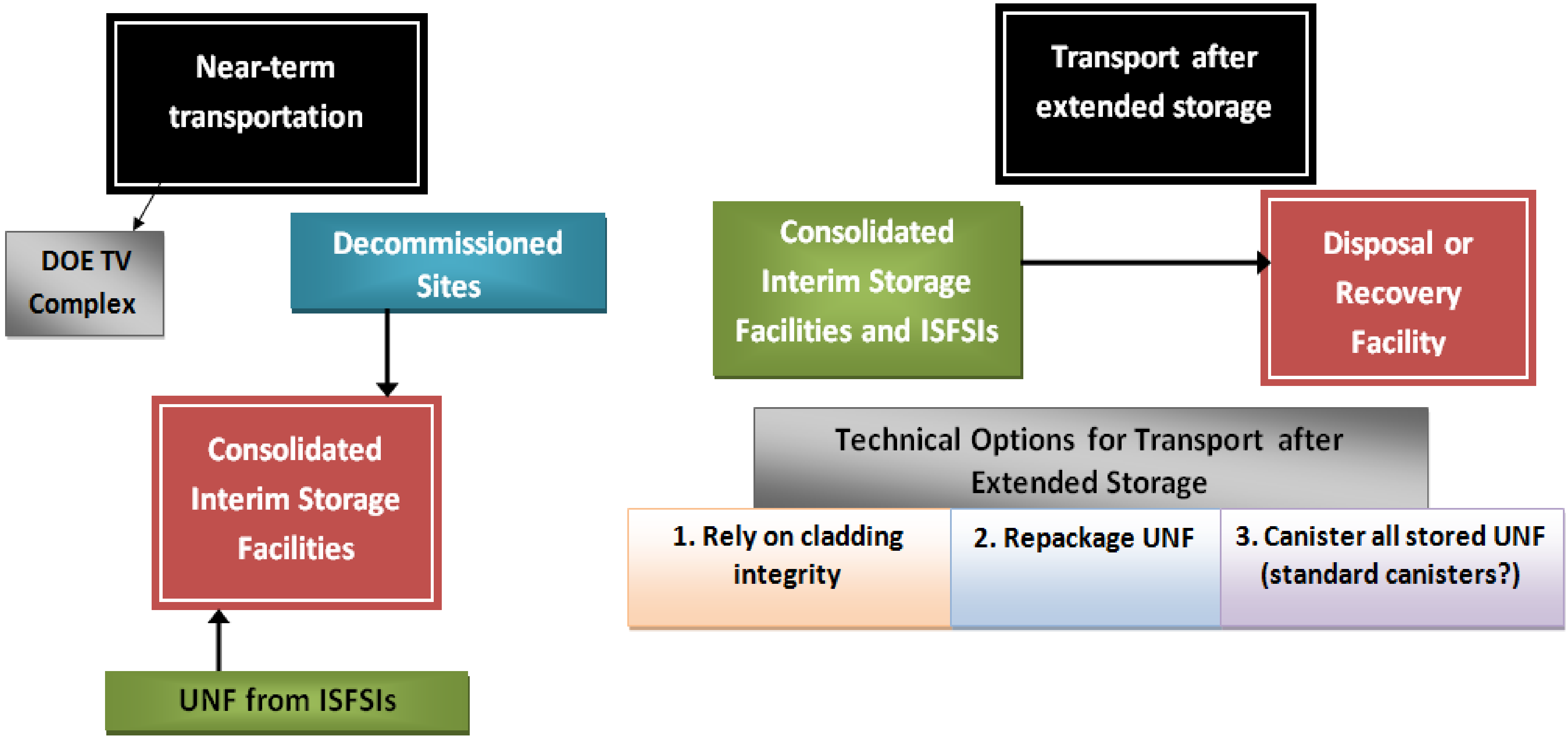
Typical Specifications
Gross Weight (including fuel): 50,000 pounds (25 tons)
Cask Diameter: 4 feet
Overall Diameter (including Impact Limiters): 6 feet
Overall Length (including Impact Limiters): 20 feet
Capacity: Up to 4 PWR or 9 BWR fuel assemblies



Generic Rail Cask for Spent Fuel

Typical Specifications
Gross Weight (including fuel): 250,000 pounds (125 tons)
Cask Diameter: 8 feet
Overall Diameter (including Impact Limiters): 11 feet
Overall Length (including Impact Limiters): 25 feet
Capacity: Up to 26 PWR or 61 BWR fuel assemblies

Possible Transportation Campaigns



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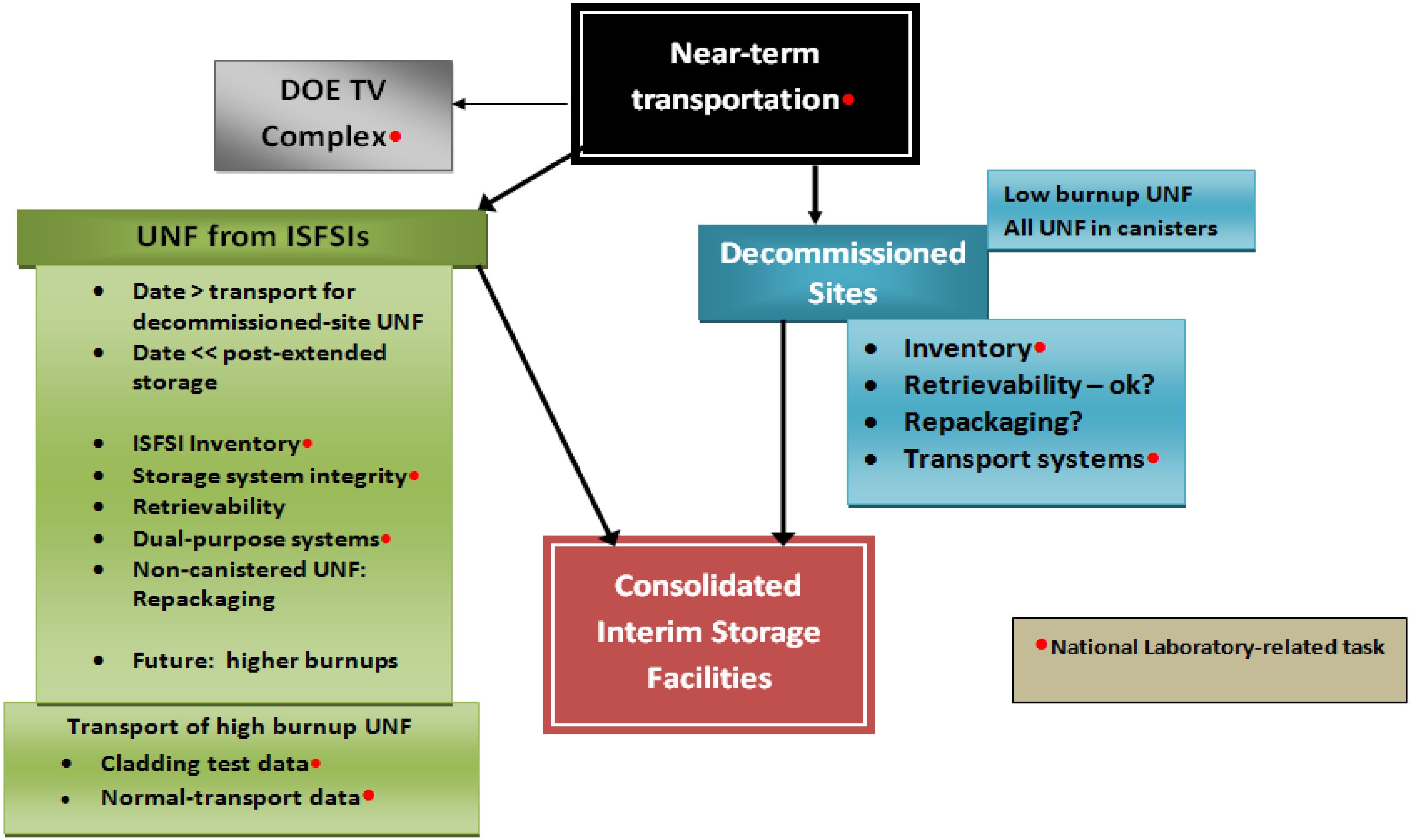
Possible "near-term" transportation campaigns and issues

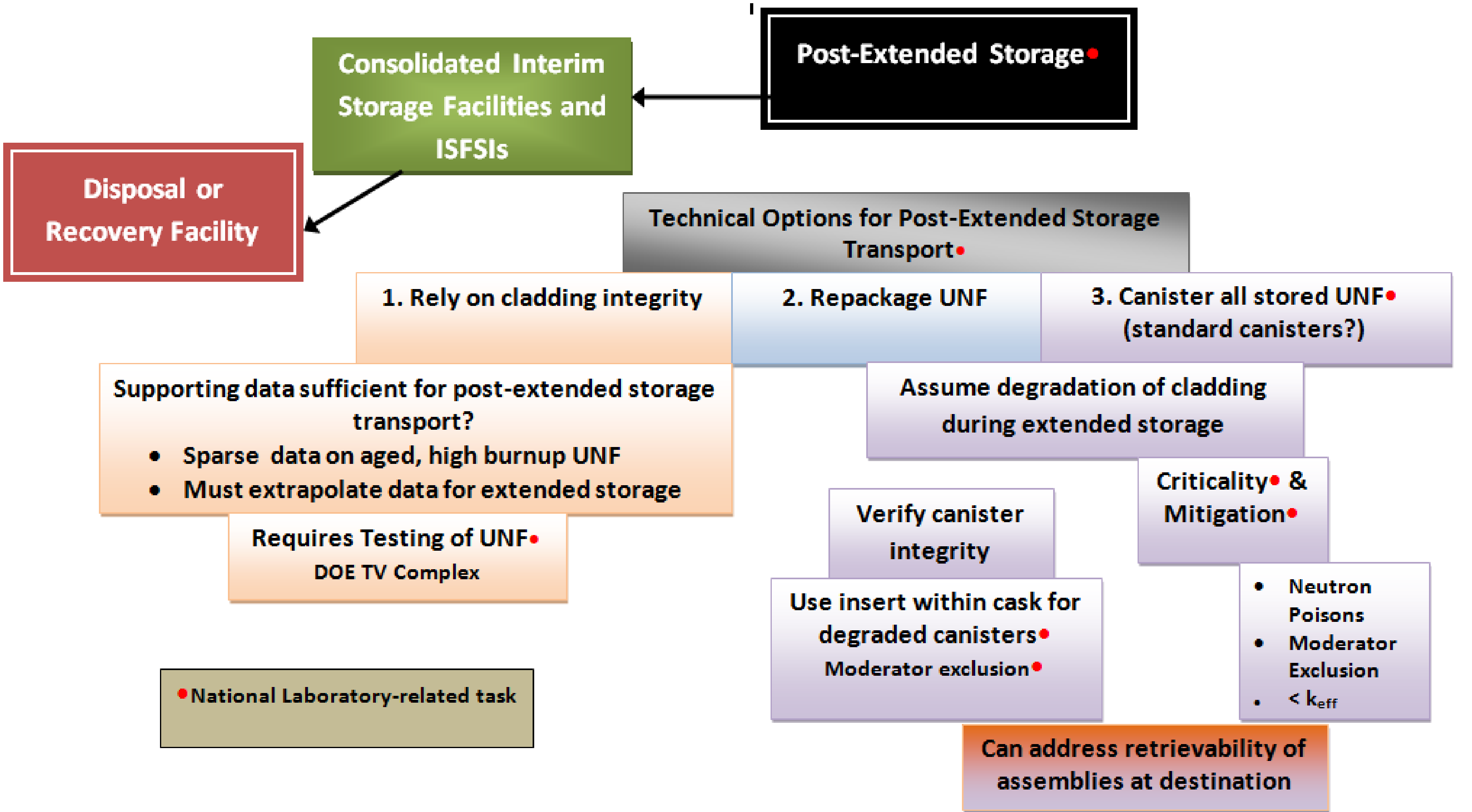


One potential scenario requiring near-term transport of UNF

Regional / centralized storage

- Decommissioned UNF first -

Post-extended storage transportation: issues and options



Options for post-extended storage transportation

Identify advantages and disadvantages of the following options for the post-storage handling of UNF assemblies prior to transport.

1. **Develop the technical bases for the assertion that UNF *cladding and canisters* shall be *intact* after extended storage:**
   - Thermal performance
   - Radiological performance
   - Confinement
   - Sub-criticality
   - Retrievability

Technical Bases for Post-Extended Storage Transport OPTIONS

1. Cladding / canister integrity	2. Repackage	3. Canister all stored UNF

2. ***Repackage* UNF assemblies prior to transport into new canisters.**
3. ***Canister* all future UNF assemblies prior to storage in transportable canisters.**
   - **Provide criticality mitigations within canisters (assume UNF will degrade).**
   - **“Canister” canisters if they are degraded after extended storage.**

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FY11 Transportation activities (1)

Developed database of UNF currently dry stored

- Exactly how much fuel is stored at each ISFSI and at the decommissioned sites?
- How is the fuel packaged – bare within dual-purpose casks; canisters, etc?
- What UNF would require repackaging prior to transport? Are the canisters transportable?
- What transfer systems and transport casks would be used to transport UNF?
- Inventory existing dual-purpose casks being used for dry storage that may be used for transportation in the future – which d-p casks do we need to assess for degradation mechanisms should they ever be used for transport?

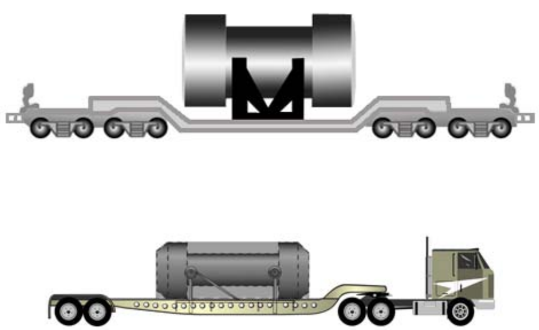
SRNL SAVANNAH RIVER NATIONAL LABORATORY

FY11 Transportation activities (2)

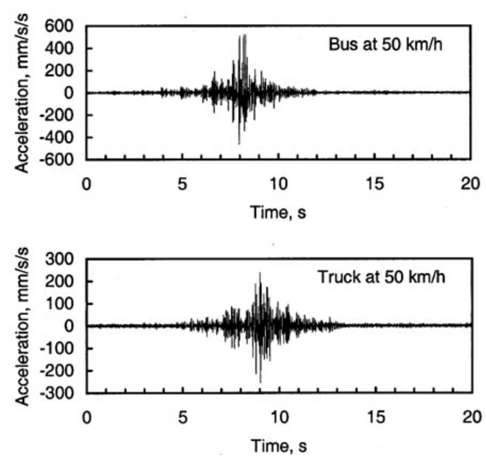
Test plan for obtaining energy input to cask internals during normal transport.

UNF may degrade during very long term storage or high burnup. It is important to know what forces cladding is subjected to under* <u>normal</u> transport conditions *to justify transport after extended storage.

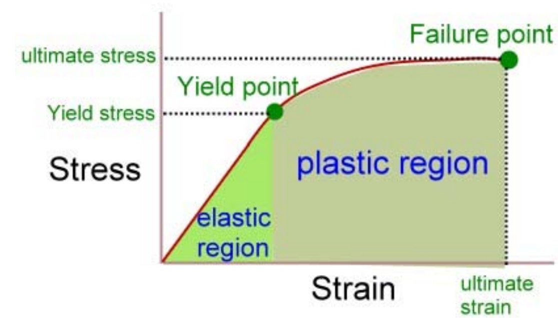
Compare applied loads and cladding material properties



vibrations



cladding properties



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FY11 Transportation activities (3)

Generated a set of Features, Events, and Processes tables that apply to transportation.

The Storage Work Package prepared a report that listed Features, Events, & Processes for very long-term stored used nuclear fuel.

The *Importance of R&D* for some FEPs is higher for Transportation than for Storage, e.g., canister weld integrity.

Pacific Northwest NATIONAL LABORATORY

FY11 Transportation activities (4a)
Criticality analyses

- **Relevant observations and points**
  - **Most UNF is, and will be, stored in multi-assembly canisters.**
  - **There is no assurance (data) that UNF and baskets will not be degraded after very long term storage.**
  - **This lack of assurance exists regardless of aging-study R&D conducted on UNF, including high burnup UNF, in the near future due to uncertainty in extrapolating test results to long periods of storage.**

- **If it can be assured that UNF within canisters will remain subcritical under all credible conditions after extended storage, there would be no need to open the canisters after extended storage prior to transportation.**

Degradation of UNF during extended storage may not preclude transportation.

FY11 Transportation activities (4b)
Criticality analyses

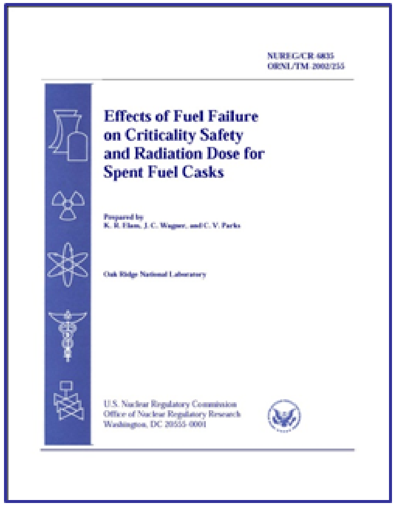
Analyses performed to quantify the increase in reactivity associated with fuel reconfiguration in multi-assembly canisters.

The condition of the UNF for these analyses encompasses a range of damaged conditions.

Options for mitigating the increase in reactivity due to fuel reconfiguration will be investigated.

Mitigation options include:

- **Safety analyses performed for a $k_{eff} \leq 0.95 - \Delta k_{reconfig}$**
  - **where $\Delta k_{reconfig}$ = the maximum possible reactivity increase**
  - **due to fuel reconfiguration.**
- **Package design modifications.**
- **Use of control rods or burnable poison rod assemblies in the fuel assemblies.**
- **Crediting inherent margins /conservatisms, including credit for burnup and cooling time in the safety analyses, perhaps moderator exclusion.**


Effects of Fuel Failure on Criticality Safety and Radiation Dose for Spent Fuel Casks

Prepared by

Oak Ridge National Laboratory

U.S. Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington, DC 20555-0001

FY11 Transportation activities (5)

Moderator exclusion: document the technical basis and process for transport.

This is an alternative to trying to justify the integrity of cladding after very long-term storage or implementing criticality control mitigations.

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FY12 Transportation Priorities

Proceed with a test program to measure the response of UNF cladding to actual loadings imposed during normal conditions of transport.

Identify criticality mitigation measures for degraded fuel rods contained within storage canisters.

Continue moderator exclusion efforts – engage the NRC.

Thermal analyses of degraded used nuclear fuel in canisters.

Identify issues related to dry repackaging of bare UNF at ISFSIs into canisters or transportation containers.

Maintain database of UNF in dry storage. Include dry transfer concepts for canistered fuel with emphasis on decommissioned sites.

ASME and IAEA collaborations.

Transportation: Collaborative Activities and Interactions

- **Industry**

- **Government organizations and advisory groups**

DOE NRC NWTRB NEAC

- **International**