

## NRC Regulatory Criteria Applicable to a Transportation, Aging and Disposal Canister<sup>1</sup>

Regulatory Framework	Transportation 10 CFR Part 71	Interim Storage 10 CFR Part 72	Disposal 10 CFR Part 63 <sup>1</sup>
What may be approved or reviewed	Transportation package design - usually consisting of transportation overpack and contents (e.g., canistered fuel, bare fuel)	Independent spent fuel storage installation (ISFSI) under site specific or general license (dry cask storage systems typically comprised of storage overpack, transfer cask and canister)	High-level waste geologic repository at Yucca Mountain <sup>2</sup>
Applicability	Use of NRC-certified packages on public highways, rail, and waterways	At power reactors or at away from reactor ISFSIs	High-level waste geologic repository at Yucca Mountain
Regulatory Process	Technical certification of transportation package design; use of certified package design authorized under NRC general license or DOT regulations	<p>Technical certification of dry cask storage system design via rulemaking; use of cask storage system design at reactor sites authorized by general license</p> <p>Specific license to construct/operate ISFSI at reactor or away from reactor site granted/denied through public licensing process</p>	Licensing (including construction authorization) of DOE to receive and possess source, special nuclear, and byproduct material at a geologic repository operations area at Yucca Mountain in accordance with NWSA, AEA and Energy Reorganization Act.
Main Objectives	<p>Limit dose (shielding)</p> <p>Limit releases (containment)</p> <p>Prevent criticality</p>	<p>Limit dose (shielding)</p> <p>Limit releases (confinement)</p> <p>Prevent criticality</p> <p>Maintain spent fuel in a retrievable state for further processing or disposal</p>	<p>Limit dose and release</p> <p>Protect groundwater resource</p> <p>Provide multiple barriers</p>

<sup>1</sup> Proposed legislation for 10 CFR Part 63 may impact portions of this listing of regulatory criteria.

<sup>2</sup> Aging at proposed Yucca Mountain Repository will be governed by 10 CFR Part 63.

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Importance of canister or canister internals	Criticality control, heat transfer	Confinement, criticality control, heat transfer	Determined by DOE based on pre-closure safety analysis and total system performance assessment
Design parameters; conditions or hazards for which package or SSCs are designed or evaluated	Test conditions for normal transport and hypothetical accident conditions prescribed in rule	Design basis events consistent with site and operations, some prescribed in rule	DOE determines based on credible hazards or events
	Normal Conditions of Transport - includes 0.3m free drop, 0.3m corner drop, compression, penetration	Site characteristics and environmental conditions associated with normal operations	Preclosure - Category 1 events sequences, expected to occur 1 or more times before permanent closure
	Hypothetical Accident Conditions - 9m drop, 1m puncture, 30-min 800°C fire, 0.9m immersion damaged package, 15m immersion undamaged package	Design basis events reflecting characteristics of site and surrounding area (e.g., earthquake, tornado, lightning, flood, man-made hazards)	Preclosure - Category 2 event sequences, have at least 1 chance in 10,000 or occurring before permanent closure
			Postclosure - events that have at least 1 chance in 10,000 of occurring over 10,000 years

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Dose and Release Criteria	<p>Normal Conditions of Transport</p> <p>Direct radiation limit</p> <ul style="list-style-type: none"> <li>• Non-exclusive use: <ul style="list-style-type: none"> <li>≤ 200 mrem/hr at cask surface</li> <li>≤ 10 mrem/hr at 1m from cask surface</li> </ul> </li> <li>• Exclusive use: <ul style="list-style-type: none"> <li>≤ 1000 mrem/hr at cask surface</li> <li>≤ 200 mrem/hr at outer surface of vehicle</li> <li>≤ 10mrem/hr at 2 meters from outer surface of vehicle</li> <li>≤ 2 mrem/hr in occupied space of vehicle</li> </ul> </li> </ul> <p>Release limit:  ≤ 10<sup>-6</sup> A<sub>2</sub>/hr; release based on 200 mrem/yr effective dose</p>	<p>Normal Operations</p> <p>Annual dose to individual beyond controlled area due to planned discharges, direct radiation from ISFSI and radiation from uranium fuel cycle operations within the region:</p> <ul style="list-style-type: none"> <li>≤ 25 mrem to whole body,</li> <li>≤ 75 mrem to thyroid, and</li> <li>≤ 25 mrem other critical organ</li> </ul>	<p>Normal Operations and Category 1 Event Sequences</p> <ul style="list-style-type: none"> <li>≤ 15 mrem TEDE per year to member of the public beyond site boundary</li> <li>≤ 5 rem/year to worker</li> </ul>
	<p>Hypothetical Accident Conditions</p> <p>Direct radiation limit  ≤ 1000 mrem/hr, at 1 meter from package surface</p> <p>Release limit:  ≤ A<sub>2</sub>/week; release based on limiting dose from damaged package to:  ≤ 5 rem CEDE to whole body  ≤ 50 rem CEDE to individual organs  ≤ 15 rem CEDE to lens of the eye.</p>	<p>Design Basis Accidents</p> <p>Dose to individual on or beyond nearest site boundary:</p> <ul style="list-style-type: none"> <li>≤ 5 rem to whole body</li> <li>≤ 15 mrem lens dose equivalent</li> <li>≤ 50 rem shallow dose equivalent to skin or any extremity</li> </ul>	<p>Category 2 Event Sequences</p> <p>Dose to individual on or beyond site boundary due to single Category 2 event sequence</p> <ul style="list-style-type: none"> <li>≤ 5 rem TEDE</li> <li>≤ 15 mrem lens dose equivalent</li> <li>≤ 50 rem shallow dose equivalent to skin</li> </ul>

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			Post-closure Performance Standards for 10,000 years <sup>3</sup>  $\leq 15$ mrem/yr to RMEI for 10,000 yrs  $\leq 4$ mrem/yr groundwater dose and radionuclide concentration limits of 5 pCi/L combined Ra-226 and Ra-228, 15 pCi/L gross alpha excluding Ra and U
Subcriticality Criteria	Subcritical if water were to leak into containment system      $k_{\text{eff}} \leq 0.95^{4,5}$ Burnup credit for actinides only <sup>4</sup>	At least 2 unlikely, independent and concurrent or sequential events before criticality is possible      $k_{\text{eff}} \leq 0.95^{4,5}$ Burnup credit for actinides only <sup>4</sup>	Preclosure safety analysis includes consideration of means to prevent and control criticality  Postclosure performance assessment identifies features, events and processes (FEPs) that could affect disposal system and estimates dose incurred from included FEPs (criticality is an excluded FEP in DOE's current approach)  DOE provides criteria and basis for $k_{\text{eff}}$ and modeling assumptions
Minimum spent fuel cool time	Applicant provides limit and basis	1 year for power reactor fuel	DOE provides criteria and basis based on maintaining barrier capability of the cladding as represented in its performance assessment (DOE's current approach)

<sup>3</sup> Changes to Standards and Regulations for period after 10,000 years have not been finalized.

<sup>4</sup> Based on current NRC practice.

<sup>5</sup> Different values of  $k_{\text{eff}}$  may be used if justified on a case-by-case basis.

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Clad temperature	For Zircalloy: 380°C (5 yr old), 340°C (10 yr old), 570°C for short-term accidents or fuel transfer <sup>4</sup>  Temperature limits may be lower for high burnup fuels <sup>4</sup>  Temperature limits established on case-by-case basis for advanced cladding materials <sup>4</sup>  (Currently based on ability to retrieve fuel intact)	For Zircalloy: 380°C (5 yr old), 340°C (10 yr old), 570°C for short-term accidents or fuel transfer <sup>4</sup>  Temperature limits may be lower for high burnup fuels <sup>4</sup>  Temperature limits established on case-by-case basis for advanced cladding materials <sup>4</sup>  (Currently based on ability to retrieve fuel intact)	DOE provides criteria and basis for barrier capability of the cladding as represented in its performance assessment (DOE's current approach)
Cask internal pressure	Applicant provides limit and basis; pressure limit not to be exceeded during 800°C, 30-min fire	Current practice: maintain pressure within design limit for normal, off-normal, and accident conditions assuming 1%, 10%, and 100% ruptured fuel rods, respectively <sup>4</sup>	
Cask surface temperature	185°F, still air, 100°F ambient temperature, shade, exclusive use shipment	Applicant provides limit and basis	DOE provides criteria and basis
Material specification, fabrication, and welding	Numerous, mostly qualitative, criteria in SFPO Interim Staff Guidance 15 <sup>4</sup>	Numerous, mostly qualitative, criteria in SFPO Interim Staff Guidance 15 <sup>4</sup>	DOE determines importance of structures, system, and components (SSCs) or engineered barriers (i.e., if important-to-safety or important-to-waste-isolation), and provides criteria and basis accordingly
Lifting attachments	Safety factor of three against yielding	Lifting trunnion testing at 150% or 300% of service load	DOE determines if important-to-safety SSC, provides criteria and basis accordingly
Tie-down devices	Must be capable of withstanding forces of 2X, 5X, or 10X the weight of the package with its contents	Storage system specific based on seismic considerations	
Quality Assurance	Design/fabrication/use 10 CFR Part 71, Subpart H	Design/fabrication/use 10 CFR Part 72, Subpart G	Design/construction/operation 10 CFR Part 63, Subpart G
Review Plans	NUREG-1617, multiple SFPO ISGs	NUREG-1567, NUREG-1536, multiple SFPO ISGs	NUREG-1804