Topical Report Outline and Associated Criteria

Note: Grey shaded cells indicate entries where sections of the document denoted by the column are either not present and/or are not applicable to the scope of the topical report.

Topical Report Section	Topical Report Content Summary	Reg Guide 7.9 Section (Format and Content Guidance)	NUREG 1617 Section (Standard Review Plan)	10CFR71 Section #s (Requirements)
Revision Log	A brief history of any revisions to the topical report			
Abstract	A brief overview of the report background, objectives, and content			
Acronyms	Alphabetical list of acronyms			
1. General Information	An overview of the report's purpose … • To confirm that DOE SNFs to be repackaged into DOE standardized SNF canisters will be acceptable for transportation • To provide a starting point for a future applicant to prepare an application for (or an amendment to) a certificate of compliance for a package to transport DOE SNF …and content • demonstration of canister performance and identification of transportation requirements that can be satisfied and/or simplified by relying on performance of the canister This section will include a discussion of how a future applicant may use the information in the topical report.	1. General	1.5 Review Procedures	
1.1 Introduction	Section header only			
1.1.1 Background and Objectives	A summary of the proposed role of the canister in the transportation package, the basis for crediting canister leaktightness in demonstrating compliance with transportation safety requirements, and a clear statement of the objectives of the topical report. The primary objectives are • To demonstrate that leakage into or out of the DOE Standardized SNF canister during normal transport and hypothetical accident conditions is not credible (see sections 2 and 3) • To demonstrate that criticality safety is assured in the absence of moderator intrusion (see section 6) • To identify any fuel-specific data needed to demonstrate compliance with transportation requirements and to	1.1 Introduction	1.5.2.1 Purpose of Application	

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	confirm that this data may be acquired prior to permanent closure of canisters • To specify the performance requirements that must be met by the transportation cask in order to preserve the conclusions of the canister analyses and tests cited in this report			
1.1.2 Scope	A description of the future transportation package, a Type B(U) package consisting of a traditional transportation cask containing an array of up to 9 sealed DOE standardized SNF canisters A description of the fuel/canister configurations included within the scope of the report (i.e. type 1a basket loadings), and a reference to the tabular listing in appendix 1.3.2 for canister specific weights, heat loads, etc. An explanation of how the report, which addresses only a component of the transportation package (i.e. the canister and its contents), may be utilized in future applications for a C of C for packages that will transport DOE SNFs. Specifically, this section will delineate the roles of both the cask and the canister and will specify the performance and quality assurance requirements that must be satisfied by the transportation cask and the DOE standardized SNF canisters within the cask[1] • Performance requirements for canisters will assure that canisters meet the design specification and are loaded, handled, and stored in a manner that does not impair their physical condition and preserves the analytical bases for the conclusions of this report (and records provide sufficient evidence to confirm it). • Performance requirements for casks will ensure that they protect the canisters in order to preserve the conclusions of the canister structural, thermal, and criticality analyses. to preserve the bases for the structural and thermal analyses	1.1 Introduction	1.5.2.2 QA Program 1.5.2.3 Proposed Use/General Contents 1.5.2.4 Package Type and model # 1.5.2.5 Package Category and Maximum Activity 1.5.2.7 Transport Index and Maximum # of packages	71.1 71.33(a)(1) 71.33(a)(4) 71.37(a) 71.87(b) 71.91(b-d) 71.93, 71.95 71.101 thru 71.137

[1] Requirements upon the canister contents are summarized in section 1.2.2

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	A discussion of how NRC regulatory interests will be addressed during canister fabrication, loading, and storage prior to transportation and disposal under NRC jurisdiction[2]			
1.1.3 Approach	An explanation that, although the requirements of 10CFR71 apply to the transportation package, canister leaktightness may be credited for satisfying many of the requirements A discussion of how the requirements of 10CFR71 may be allocated between the transport cask and/or the DOE SNF standardized canister and a reference to appendix 1.3.3 for a crosswalk from each applicable 10CFR71 requirement to the corresponding section of the topical report An explanation of the use of conservative and/or bounding parameters to represent groups of fuels (and a reference to 1.2.2 for a discussion of the diversity of DOE SNFs) An explanation that, because the final transport configuration will not be available until one or more casks are selected and a loading configuration is identified, the topical report will provide the basis for criticality safety for a single canister. And, to illustrate that criticality safety for an array of these canisters in a cask is achievable, the topical report will also include criticality analyses	1.1 Introduction	1.5.1 General SAR Format 1.5.4 Compliance with 10CFR71	

[2] The DOE standardized SNF canister design will be made available to DOE SNF sites for their use when repackaging SNFs for interim storage and/or preparing them for repository disposition. The standardized canister will be loaded and stored in DOE facilities prior to transportation and disposal under NRC regulatory authority. Handling and storage of canisters within DOE facilities will be conducted in accordance with the governing procedures and DOE Orders. Because the NRC has a regulatory interest in canister fabrication and operations that may affect the canister's ability to perform its credited safety function, the topical report will propose the following:

1) Records possessed by NSNFP that are required to support the topical report are maintained in accordance with DOE/RW-0333P QA requirements. Ultimately, these records will be turned over to OCRWM for retention.

2) NRC will be notified and invited to observe canister fabrication and loading activities.

3) Any instances of safety significant defects or other occurrences (during canister fabrication, loading, or subsequent storage) that may jeopardize the ability of the canister to meet its performance requirements will be documented in accordance with the governing QA program (e.g. 10CFR72 Subpart G, 10CFR71 Supbart H, and/or DOE/RW-0333P).

4) Records that demonstrate that canister fabrication, handling, loading, and storage meet the conditions prescribed by the topical report will be maintained by the SNF storage site in accordance with the governing QA program and made available to the licensee (OCRWM) to furnish evidence of the quality of the packaging and to demonstrate compliance with applicable acceptance requirements.

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	for an array of up to nine canisters in a typical transportation cask. Criticality analyses associated with the complete transportation package will be submitted by the applicant for a Certificate of Compliance for the future transportation package. An explanation of how criticality safety will be demonstrated for each canister loading via a combination of bounding criticality analyses for 1) its as-loaded condition with the assumption of nonmechanistic flooding, and 2) a fully degraded and optimally reconfigured condition with credit for canister leaktightness An overview of the format and content of the topical report along with a crosswalk (appendix 1.3.4) between the each section of the topical report and the applicable guidance in Regulatory Guide 7.9 and NUREG 1617 and the applicable 10CFR71 requirement(s) A discussion of how the scope of the report may be expanded to accommodate other standardized canister loadings (i.e. fuels and baskets outside the scope of the present report)			
1.2 Package Description	NA – section header only	1.2 Package Description		
1.2.1 DOE Standardized SNF Canister	A description of the DOE standardized SNF canister and the type 1a baskets, including their service life, material specifications, internal and external dimensions, performance requirements and associated features, and a reference to 2.1.3 for canister , minimum and maximum weights A reference to section 2.3 for specifications and criteria for fabrication, welding, and examination processes; to section 1.3.5 for drawings; and to 2.1.2 for canister labeling requirements A brief summary of applicable codes with a reference to section 2.1.4 for a complete discussion	1.2.1 Packaging	1.5.3.1 Packaging	71.33(a)(5) 71.43(a)
1.2.2 Contents	An overview of the diversity of DOE SNFs within the scope of the report (range of enrichments, burnups, fuel matrices, etc.) and a reference to the tables in section 1.3.2 for fuel-specific information An overview of canister contents (i.e. radioactivity, mass, chemical and physical form, fissile and nonfissile materials, neutron poisons, moderator materials, materials interactions, decay heat, etc.) and a discussion of their significance given that they will be permanently sealed in a leaktight canister	1.2.2 Contents	1.5.3.3 Contents	71.33(b)(3) 71.87(a)

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	Any loading constraints (i.e. on fuel contents) needed to preserve the safety envelope with respect to structural, thermal, and criticality safety are summarized along with references to sections 2, 3, and 6, as appropriate Section 1.2.2 will also identify the data needed to demonstrate compliance with the certificate of compliance and will clearly state that this data will be based on data available at the time of loading.			
1.2.3 Special Requirements for Plutonium	An explanation that this requirement is implicitly satisfied because all SNF within the scope of this report will be fully contained within a DOE Standardized SNF canister (i.e. separate inner container that meets the requirements of 10CFR71.51(a)(1) and (2) for normal and accident conditions, respectively)	1.2.3 Special Requirements for Plutonium		71.63
1.2.4 Operational Features	An explanation that all safety features of canister are passive	1.2.4 Operational Features	1.5.3.2 Operational Features	
1.3 Appendix	NA – section header only	1.3 Appendix	1.5.5 Appendix	
1.3.1 References	An itemized list of documents referenced in Section 1			
1.3.2 DOE Spent Nuclear Fuel Types	A tabular list of DOE spent nuclear fuels within the scope of the report along with data relevant to the content of the report (i.e. loading configuration, total and fissile mass per canister, heat load per canister, etc.)			71.33(a)(2)
1.3.3 Cross-Reference Matrix -- 10CFR71 Requirements to Topical Report	An itemized list of 10CFR71 requirements and a reference to the applicable section of the topical report for those that can be satisfied, in whole or in part, by crediting the performance of the canister			
1.3.4 Cross-Reference Matrix – topical report section to Regulatory Guide 7.9 NUREG 1617 to 10CFR71	An itemized list of each of the sections prescribed by Regulatory Guide 7.9 along with a cross-walk to the applicable section of the topical report and the associated review criteria from NUREG 1617 (i.e. this table without this column)			
1.3.5 Drawings	Copies of drawings referenced in Section 1 and/or references to drawings already docketed			
2. Standardized Canister Structural Evaluation.	Background on the canister design and a brief summary of the analyses, testing (including puncture drops) and results	2. Structural Evaluation	2.5 Review Procedures	
2.1 Description of Canister Structural Design	NA – section headers	2.1 Description of Structural Design	2.5.1 Description of Structural Design	
2.1.1 Discussion	An overview of various canister configurations (and a reference to section 1.2.1 for canister lengths, diameters, basket configurations,	2.1.1 Discussion	2.5.1.1 Descriptive Information	

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Topical Report Section	Topical Report Content Summary	Reg Guide 7.9 Section (Format and Content Guidance)	NUREG 1617 Section (Standard Review Plan)	10CFR71 Section #s (Requirements)
	etc.) along with a discussion of the key structural design and performance features and a reference to the applicable drawings in section 1.3.5			
2.1.2 Canister Design Criteria	A summary of the canister design criteria (i.e. load combinations, allowable stresses and strains, labeling requirements, etc.) and the associated bases, a reference to section 2.1.4 for the associated codes and standards, and a reference to the design criteria document	2.1.2 Design Criteria	2.5.1.1 Descriptive Information	71.33(a)(3) 71.87(a) 71.85(c)
2.1.3 Canister Weights and Centers of Gravity	A table showing the minimum and maximum gross canister weights and centers of gravity used in the analyses along with an explanation of the basis for concluding that they adequately bound the canister configurations within the scope of the report (and a reference to the table in section 1.3.2 for an estimate of the loaded weight of each canister configuration)	2.1.3 Weights and Centers of Gravity	2.5.1.1 Descriptive Information	71.33(a)(2) 71.33(a)(5) 71.33(b)(6)
2.1.4 Identification of Codes and Standards for Canister Design	A discussion of the codes and standards that apply to design, analyses, testing, and fabrication of the DOE standardized SNF canister along with justification for any alternatives employed	2.1.4 Identification of Codes and Standards for Package Design	2.5.1.2 Codes and Standards 3.5.1.2 Codes and Standards 1.5.2.6 Material Specifications, Fabrication, and Welding Criteria 8.2.4 Review Procedures 8.3.4 Review Procedures	71.31(c)
2.2 Canister Materials	A brief summary of the basis for materials selection	2.2 Materials		
2.2.1 Material Properties and Specifications	A discussion of the materials used in the canister and the type 1a basket along with the material specifications and the associated mechanical properties used in the analyses (and their bases)	2.2.1 Material Properties and Specifications	2.5.2.1 Materials and material Specifications	71.33(a)(5) 71.87(a)
2.2.2 Chemical, Galvanic, or Other Reactions	Identification and assessment of the material interactions that could potentially jeopardize the ability of the canister to meet its performance requirements along with any associated controls	2.2.2 Chemical, Galvanic, or Other Reactions	2.5.2.2 Prevention of Chemical, Galvanic, or Other Reactions	71.43(d) 71.87(a)
2.2.3 Effects of Radiation on Materials	An assessment of the potential for radiation damage to jeopardize the ability of the canister to meet its performance requirements	2.2.3 Effects of Radiation on Materials	2.5.2.3 Effects of Radiation on Materials	71.43(d) 71.87(a)
2.3 Canister Fabrication and Examination	A description of the canister fabrication and examination processes (including leak-check), applicable codes, associated QA requirements (including records requirements), and references to sections 1.1.2, 7, 8, and 2.1.4 as appropriate	2.3 Fabrication and Examination	1.5.2.6 Materials Specifications, Fabrication, and Welding Criteria	71.1, 71.33(a)(5) 71.37(b) 71.91(b-d), 71.135
	Addressed in section 2.3 above	2.3.1 Fabrication		
		2.3.2 Examination		

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2.4 General Requirements for All Packages	NA – these requirements apply to the transportation cask not the canisters within the transportation cask	2.4 General Requirements for All Packages 2.4.1 Minimum Package Size 2.4.2 Tamper-Indicating Feature 2.4.3 Positive Closure		
2.5 Lifting and Tie-Down Standards for All Packages	NA – these requirements apply to the transportation cask not the canisters within the transportation cask This section will nonetheless provide a summary of the handling features of the canister and also of the requirements imposed upon the cask to ensure that canisters are constrained sufficiently to preserve the bases for the structural analyses (see 1.1.2)	2.5 Lifting and Tie-Down Standards for All Packages 2.5.1 Lifting Devices 2.5.2 Tie-Down Devices	2.5.3 Lifting and Tie-Down Standards for All Packages	
2.6 Normal Conditions of Transport	An explanation as to why the hypothetical accident conditions addressed in section 2.7 bound each of normal transport conditions with respect to challenging the integrity of the canister boundary (and thus the applicable requirements of 10CFR71.71 are satisfied by the tests summarized in section 2.7.8). The discussion will address the sensitivity of the results given in section 2.7 to the range of temperatures and pressures (see section 3) and other loads prescribed by 10CFR71.71 for normal conditions of transport An explanation that canisters are not breached and are not substantially deformed[3] even under the more severe 10CFR71.73 drop test requirements and without the protection of the cask Canister response to vibration loads is also addressed	2.6 Normal Conditions of Transport 2.6.5 Vibration	2.5.4 General Considerations for Structural Evaluation of Packaging 2.5.5 Normal Conditions of Transport 2.5.5.5 Vibration	71.55(d)(1) 71.55(d)(2) 71.71(c)(5) 71.71(c)(7)
	NA – bounded by the hypothetical accident conditions addressed in section 2.7 (see explanation above)	2.6.1 Heat 2.6.1.1 Summary of Pressures and Temperatures 2.6.1.2 differential Thermal Expansion 2.6.1.3 Stress Calculations 2.6.1.4 Comparison with Allowable stresses	2.5.5.1 Heat	

[3] 71.55(d)(2) also requires that the form of the package contents not be substantially altered. Data to determine the mechanical response of the canister contents is not available in many cases. However, because the canister remains leaktight, criticality safety is independent of the geometric form of the canister contents, as illustrated in section 6.1.2.

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	NA – bounded by the hypothetical accident conditions addressed in section 2.7 (see explanation above)	2.6.2 Cold	2.5.5.2 Cold	
		2.6.3 Reduced External Pressure	2.5.5.3 Reduced External Pressure	
		2.6.4 Increased External Pressure	2.5.5.4 Increased External pressure	
		2.6.6 Water Spray	2.5.5.6 Water Spray	
		2.6.7 Free Drop	2.5.5.7 Free Drop	
		2.6.8 Corner Drop	2.5.5.8 Corner Drop	
		2.6.9 Compression	2.5.5.9 Compression	
		2.6.10 Penetration	2.5.5.10 Penetration	
2.7 Hypothetical Accident Conditions	A description of the analytical modeling capability and the drop testing that has been completed to validate the analytical models and to that the canister remains leaktight following the prescribed tests A discussion of how the series of "sequential" tests are addressed for the canister by the free drop and the immersion tests over the temperature range of -20F to 600F	2.7 Hypothetical Accident Conditions	2.5.4 General Considerations for Structural Evaluation of Packaging 2.5.5 Normal Conditions of Transport 2.5.6 Hypothetical Accident Conditions	71.73(a)
2.7.1 Free Drop	A summary of the testing and analytical effort to confirm that the 10CFR71.73 drop requirements have been satisfied for end drops, side drops, and combinations thereof, which cover loads on the canisters for all cask drop orientations – over the entire range of temperatures and canister configurations within the scope of the topical report[4] A discussion of the applicable failure criteria and the material impact testing being done to help quantify margin to failure	2.7.1 Free Drop	2.5.6.1 Free Drop	71.73(c)(1)
2.7.1.1 End Drop	Description of end drop tests and discussion of results	2.7.1.1 End Drop		
2.7.1.2 Side Drop	Description of side drop tests and discussion of results	2.7.1.2 Side Drop		
2.7.1.3 Corner Drop	NA – cask cavity restricts canister impacts to its end or side or a combination thereof	2.7.1.3 Corner Drop		

[4] Canisters have been drop tested per 10CFR71.73 requirements (without the additional protection of a cask) to confirm canister performance and to validate analytical models. These tests confirm that a canister will not be breached as long as the cask protects the canister such that this drop is the enveloping design load for the structural response of the canisters. The topical report imposes this requirement on the cask (section 1.1.2).

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2.7.1.4 Oblique Drops	NA – cask cavity restricts canister impacts to its end or side or a combination thereof	2.7.1.4 Oblique Drops		
2.7.1.5 Summary of Results	Summary and conclusions from the drop tests	2.7.1.5 Summary of Results		
2.7.2 Crush	NA – cask and canisters weigh more than 500kg. Further, canisters are protected from crush-type loading by the transportation cask	2.7.2 Crush	2.5.6.2 Crush	
2.7.3 Puncture	NA – canisters are protected from any puncture-type loading by the transportation cask	2.7.3 Puncture	2.5.6.3 Puncture	
2.7.4 Thermal	NA – analyses summarized in section 2.7.1 are valid over the entire range of temperatures and pressures that may be encountered while in the transportation cask (see cask performance requirements in section 1.2.1 and summary table of maximum pressures in section 3)	2.7.4 Thermal 2.7.4.1 Summary of Pressures and Temperatures 2.7.4.2 Differential Thermal Expansion 2.7.4.3 Stress Calculations 2.7.4.4 Comparison with Allowable Stresses	2.5.6.4 Thermal	
2.7.5 Immersion – Fissile Material	A discussion of the applicability of this requirement (i.e. because water leakage is not assumed when demonstrating compliance w/ 71.55 under potentially reconfigured conditions (e.g. hypothetical accident)) A reference to the post-drop leak tests (section 2.7.1.5) and also to the deep-water immersion test (section 2.7.7) for an explanation as to the basis for concluding that this immersion requirement (3' in worst orientation – following the drop scenario) is satisfied by the canister	2.7.5 Immersion – Fissile Material	2.5.6.5 Immersion – Fissile Material	71.73(c)(5)
2.7.6 Immersion – All Packages	An explanation as to why this requirement does not apply to canisters (but is nonetheless satisfied by the deep water immersion test summarized in the following section) A reference to the deep-water immersion test (section 2.7.7) for an explanation as to the basis for concluding that this immersion requirement (50' for a separate undamaged specimen) is satisfied by the canister	2.7.6 Immersion – All Packages	2.5.6.6 Immersion – All Packages	71.73(c)(6)
2.7.7 Deep Water Immersion Test	An explanation that this requirement has been applied to the canister because the cask cavity is conservatively assumed to be flooded in the criticality analyses. Further, this test is invoked by ISG-18 as part of the basis for acceptance of closure welds on austenitic stainless steel canisters.	2.7.7 Deep Water Immersion Test	2.5.7 Special Requirements for Irradiated Nuclear Fuel Shipments	71.61

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	And a summary, of the analyses that demonstrate that the canister will meet this deep water immersion requirement			
	NA – this internal pressure test applies to the containment system (i.e. transportation cask)		2.5.8 Internal Pressure Test	
2.7.8 Summary of Damage	A summary of the damage resulting from the foregoing test sequence and a comparison against applicable acceptance criteria that concludes the canister will remain leaktight in a package subjected to the prescribed 10CFR71.73 tests An estimate of the likelihood of a canister being flooded as a result of a transportation accident	2.7.8 Summary of Damage		71.55(b)(2) 71.55(e)(2) 71.55(d)(1)
2.8 Accident Conditions for Air Transport of Plutonium	NA – DOE standardized SNF canisters will not be transported by air	2.8 Accident Conditions for Air Transport of Plutonium		
2.9 Accident Conditions for Fissile Material Packages for Air Transport	NA – DOE standardized SNF canisters will not be transported by air	2.9 Accident Conditions for Fissile Material Packages for Air Transport		
2.10 Special Form	NA – The DOE standardized SNF canister is not intended to be licensed as special form radioactive material	2.10 Special Form		
2.11 Fuel Rods	NA – Credit is not being sought for the cladding integrity of DOE SNF	2.11 Fuel Rods		
2.12 Appendix	An itemized list of documents referenced in Section 2	2.12 Appendix	2.5.9 Appendix	
3. Thermal Evaluation	An explanation that thermal considerations are addressed by the analyses provided in section 2.7 because… 1) the canister wall is the only credited safety feature of the canister (i.e. safety cannot be compromised by degradation of bolts, gaskets, or seals, canister content, etc) 2) a performance requirement is imposed on the cask (see section 1.1.2 to ensure canister wall temperatures are maintained between -20F and 600F) 3) As demonstrated in section 2.7, the canister will maintain its integrity during normal and hypothetical accident conditions throughout this temperature range The material properties used in the thermal calculations, summary of thermal analyses showing canister wall temperatures as a function of heat generation (in a typical transportation cask), and canister internal pressures as a function of temperature	3. Thermal Evaluation 3.1 Description of Thermal Design 3.1.1 Design Features 3.1.2 Contents' Decay Heat 3.1.3 Summary Tables of Temperatures	3.5.1 Description of Thermal Design 3.5.1.1 Package Design Features 3.5.1.2 Codes and Standards 3.5.1.3 Content Heat load Specification 3.5.1.4 Summary Tables of Temperatures	71.33(a)(5) 71.33(b)(5) 71.33(b)(7) 71.43(c) 71.71(b) 71.73(b) 71.73(c)(4)

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	Identification of the maximum decay heat per canister and the corresponding maximum canister temperature and pressure along with confirmation that design criteria limits (section 2.1.2) are not exceeded References to Appendix 1.3.2 and section 5.2 will be provided for data regarding the decay heat, gross weight, and other properties associated with canister contents and to section 1.2.2 for a discussion of their chemical and physical form An explanation of the basis for neglecting the effects of cask and canister pressure in the structural analyses. A discussion of the potential for a "thermal driven" decomposition of corrosion product for Aluminum based fuels will be provided along with a reference back to section 2.2.2 for further details	3.1.4 Summary Tables of Maximum Pressures 3.2 Material Properties and Component Specifications 3.2.1 Material Properties 3.2.2 Component Specifications	3.5.1.5 Summary Tables of Pressure in the Containment System 3.5.2 Material Properties and Component Specifications 3.5.2.1 Material Properties 3.5.2.2 Technical Specifications of Components 3.5.2.3 Thermal Design Limits of Package Materials and components 3.5.3 General Considerations for Thermal Evaluations	
	NA – applies to transportation package (surfaces of canister are not accessible during transportation)		3.5.4 Evaluation of Accessible Surface Temperatures	
	NA – Cask is required to maintain canister wall temperatures within the analyzed range during both normal and hypothetical accident conditions	3.3 Thermal Evaluation Under Normal Conditions of Transport 3.3.1 Heat and Cold 3.3.2 Maximum Normal Operating Pressure	3.5.5 Thermal Evaluation under Normal Conditions of Transport	

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	NA – Cask is required to maintain canister wall temperatures within the analyzed range during both normal and hypothetical accident conditions	3.4 Thermal Evaluation under Hypothetical Accident Conditions 3.4.1 Initial Conditions 3.4.2 Fire Test Conditions 3.4.3 Maximum Temperatures and Pressure 3.4.4 Maximum Thermal Stress 3.4.5 Accident Conditions for Fissile Material Packages for Air Transport	3.5.6 Thermal Evaluation under Hypothetical Accident Conditions	
	NA – the appendices are related to prescribed analyses and tests associated with the complete transportation package.	3.5 Appendix	3.5.7 Appendix	
4. Containment	An explanation that, although the canister provides an additional leaktight boundary, all containment functions are to be provided by the transportation cask	4. Containment	4.5 Containment Review Procedures	
	An explanation that, for damaged SNFs, the canister will confine fuel materials to a known subcritical volume and will serve as a redundant containment boundary that meets the requirements of ANSI N14.5 under normal conditions of transport and hypothetical accident conditions		4.5.1.3 Special Requirements for Damaged Spent Nuclear Fuel	
	NA – cask provides all containment functions	4.1 Description of the Containment System	4.5.1 Description of the Containment System	
		4.2 Containment under Normal Conditions of transport	4.5.2 Containment under Hypothetical Accident Conditions	
		4.3 Containment under Hypothetical Accident Conditions	4.5.3 Containment under Hypothetical Accident Conditions	
		4.4 Leakage rate Tests for		

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		type B Packages		
		4.5 Appendix	4.5.4 Appendix	
5. Canister Shielding Evaluation	An explanation that the shielding evaluation will be performed by the applicant for a C of C based on the complete transportation package An explanation that limited source term information is provided in sections5.2 in order to assist in understanding DOE SNFs and in evaluating the safety approach proposed in this report	5. Shielding evaluation	5.5 Review Procedures	
5.1 Description of Shielding Design	NA – the canister functions are to standardize handling and to provide a leaktight barrier. Shielding requirements played no part in the establishing the canister performance or design requirements	5.1 Description of Shielding Design	5.5.1 Description of the Shielding Design	
		5.1.1 Design Features	5.5.1.1 Packaging Design Features 5.5.1.2 Codes and Standards	
		5.1.2 Summary table of Maximum Radiation Levels	5.5.1.3 Summary table of Maximum Radiation Levels	
5.2 Source Specification	A reference to 1.2.2 for an overview of canister contents (i.e. radioactivity, mass, chemical and physical form, fissile and nonfissile constituents, neutron poisons, moderator materials, materials interactions, decay heat, etc.) A summary of the methodology used for estimating the radiological inventories, a discussion of the uncertainties and conservatisms associated with the estimates, and a reference to the document containing the estimates An explanation that the radiation levels (i.e. source terms and distribution of source term within the canisters) associated with the cask contents (i.e. 7 to 9 loaded canisters) will be shown to be within the shielding design basis of the cask using either conservative analytical approaches and/or actual radiation measurements	5.2 Source Specification	5.5.2 Source Specification	
5.2.1 Gamma Source	A table summarizing the average gamma source term (Ci/canister for 45 key isotopes and photons per second for 18 energy groups) for canisters within the scope of the report, and a graph showing the distribution of gamma source per canister relative to the	5.2.1 Gamma Source	5.5.2.1 Gamma Source	71.33(b)(1)

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	average A description of how the gamma source was calculated from the estimated radionuclide inventories A reference to section 6.2 for a discussion of fissile material contents			
5.2.2 Neutron Source	A listing of the average neutron source term (i.e. neutrons/sec) as a function of energy, and a graph showing the distribution of neutron source per canister relative to the average A description of how the neutron source was calculated from the estimated radionuclide inventories	5.2.2 Neutron Source	5.5.2.2 Neutron Source	71.33(b)(1)
5.3 Shielding Model	NA -- the shielding evaluation will be performed by the applicant for a C of C based on the complete transportation package	5.3 Shielding Model 5.3.1 Configuration of Source and Shielding 5.3.2 Material Properties	5.5.3 Model Specification 5.5.3.1 Configuration of Source and Shielding 5.5.3.2 Material Properties	
5.4 Shielding Evaluation	NA -- the shielding evaluation will be performed by the applicant for a C of C based on the complete transportation package	5.4 Shielding Evaluation 5.4.1 Methods 5.4.2 Input and Output data 5.4.3 Flux-to-Dose-Rate Conversion 5.4.4 External radiation Levels	5.5.4 Evaluation 5.5.4.1 Methods 5.5.4.2 Key Input and Output Data 5.5.4.3 Flux-to-Dose-Rate Conversion 5.5.4.4 Radiation Levels	
5.5 Appendix	An itemized list of documents referenced in Section 5	5.5 Appendix	5.5.5 Appendix	
6. Canister Criticality Evaluation	A summary of the applicable requirements and the compliance approach proposed within the topical report An explanation that, because the final transport configuration will not be available until one or more casks are selected and a loading configuration is identified, criticality analyses associated with the complete transportation package will be submitted with the application for a C of C for the future transportation package This section of the topical report will illustrate that criticality safety is achievable by providing analyses of a single canister along with	6. Criticality Evaluation		

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	limited criticality analyses for an array of up to nine canisters in a typical transportation cask. Specifically, this section will provide an. 1) analyses for a bounding single canister scenario, assuming nonmechanistic flooding, but with credit for the basket and fuel maintaining their as-loaded configuration 2) analyses for a bounding single canister scenario, with credit for canister remaining leaktight, and with canister contents fully degraded and in their most reactive configuration 3) analyses of arrays of canisters in both of the above configurations in a typical cask. Section 6.3.4 will be referenced for an explanation of how the fuels included in the above-mentioned analyses were selected and how other canister/fuel configurations will be confirmed to be enveloped by the analyzed cases			
6.1 Description of Canister Criticality Design	An overview of canister criticality safety considerations • Leaktight canister for interim storage, transportation, and pre-closure repository safety • Basket grid plates of advanced neutron absorber material for repository post-closure safety[5] A discussion of the basis for canister fissile loading limits A reference to section 6.3.2 for material properties related to criticality design	6.1 Description of Criticality Design	6.5.1. Description of Criticality Design	71.87(g)
6.1.1 Canister Design Features	A discussion of the canister design features credited to ensure transportation criticality safety (i.e. the leaktight barrier for all credible cases, and basket compartments for the intact flooded cases) A discussion of any codes and standards applied to criticality design and/or analysis and a reference to the drawings (Section 1.3.5) for relevant dimensional information	6.1.1 Design Features	6.5.1.1 Packaging Design Features 6.5.1.2 Codes and Standards	71.31(c)
6.1.2 Summary Table of Criticality Evaluation	The topical report demonstrates that the contents of a single canister remain subcritical when • fully degraded and optimally reconfigured (i.e. maximum	6.1.2 Summary Table of Criticality Evaluation	6.5.1.3 Summary Table of Criticality Evaluations	71.55(b) 71.55(d)(1) 71.55(e) 71.55(e)(1)

[5] Neutron absorber material may be added in order to meet requirements for post-closure repository criticality calculations related to fully degraded, flooded conditions. If neutron absorber is added to the caniser, it will provide additional safety margin for transportation criticality scenarios.

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Topical Report Section	Topical Report Content Summary	Reg Guide 7.9 Section (Format and Content Guidance)	NUREG 1617 Section (Standard Review Plan)	10CFR71 Section #s (Requirements)
	reactivity) in a leaktight canister[6] • fully flooded and in the as-loaded configuration, and In order to demonstrate that criticality safety in a cask containing multiple canisters is achievable, the topical report also includes limited analyses of arrays of canisters within a typical transportation cask. Criticality safety for the future transportation package configuration will be demonstrated by the applicant for a C of C. In all cases, water leakage into the containment system (i.e. the cask cavity) is assumed and conditions within the cask cavity (i.e. reflection and moderation) are assumed such that the maximum reactivity of the fissile material is achieved. A table will be provided to summarize the results. The table will demonstrate that, in all cases, criticality safety for a sealed canister can be assured by adhering to identified fissile loading limits.			71.55(e)(3)
6.1.3 Criticality Safety Index	NA – this requirement applies to the transportation cask not the individual canisters within the transportation cask	6.1.3 Criticality Safety Index	6.5.1.4 Transportation Safety Index	
6.2 Canister Fissile Material Contents	Identification of the maximum quantities of fissile constituents and a description of composition and form of the fuel and any credited poison material for the scenarios included in the analyses References to sections 1.2.2 and 5.2 for the composition of other fuels An explanation as to how fissile content was conservatively estimated when necessary to account for uncertainties and/or missing data	6.2 Fissile Material Contents	6.5.2 Spent Nuclear Fuel Contents	71.33(b)(2) 71.83
6.3 General Considerations	A description of the assumptions and conservatisms applied within the criticality analyses	6.3 General Considerations	6.5.3 General Consideration s for Criticality Evaluation	
6.3.1 Model Configuration	A description (and associated figures) of the models employed for the analyses and the bases for their applicability and conservatism (e.g. moderator to fissile ratios, reflectors, etc.)	6.3.1 Model Configuration	6.5.3.1 Model Configuration	71.33(b)(4)
6.3.2 Material Properties	Tables showing the chemical compositions of the canister	6.3.2 Material Properties	6.5.3.2 Material	71.33(b)(4)

[6] Based on the analytical and test results provided in section 2, intrusion of water into the canister is not credible.

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	(including mass and atom densities), basket, fuel, cladding, and poison materials used in the analytical models		Properties	71.33(a)(5)
6.3.3 Computer Codes and Cross Section Libraries	A description of the codes, cross sections and other inputs used to calculate the K_{eff}	6.3.3 Computer Codes and Cross Section Libraries	6.5.3.3 Computer Codes and Cross Section Libraries	
6.3.4 Demonstration of Maximum Reactivity	An explanation of the basis for selecting the bounding scenarios[7] for the flooded as-loaded and the dry degraded cases along with a reference to appendix 6.9 for details of the analyzed fuels and to section 6.1.2 for results A discussion of how other canister/fuel configurations will be confirmed to be enveloped by the analyzed cases included in the topical report	6.3.4 Demonstration of Maximum Reactivity	6.5.3.4 Demonstration of Maximum Reactivity 6.5.3.5 Confirmatory Analyses 6.5.8 Burnup Credit	71.33(b)(2)
6.4 Canister Evaluation	NA – section header only	6.4 Single Package Evaluation	6.5.4 Single Package Evaluation (NA – Section Header Only)	
6.4.1 Configuration	Description and, as appropriate, figures to illustrate each of the canister configurations for the scenarios analyzed are in their most reactive credible condition	6.4.1 Configuration	6.5.4.1 Configuration	71.55(b) 71.55(e)
6.4.2 Results	A reference back to the results previously summarized in section 6.1.2 A reference to section 2.6 where it is shown that the canister remains leaktight and that its geometry is not substantially altered[8]	6.4.2 Results	6.5.4.2 Results	
6.5 Evaluation of Package Arrays under Normal Conditions of Transport	NA – this requirement applies to the transportation cask not the individual canisters within the transportation cask.	6.5 Evaluation of Package Arrays under Normal Conditions of Transport 6.5.1 Configuration 6.5.2 Results	6.5.5 Evaluation of Package Arrays under Normal Conditions of Transport 6.5.5.1 Configuration 6.5.5.2 Results	
6.6 Package Arrays under hypothetical Accident Conditions	NA –applies to the transportation cask	6.6 Package Arrays under hypothetical Accident Conditions 6.6.1 Configuration 6.6.2 Results	6.5.5 Evaluation of Package Arrays under Hypothetical Accident Conditions	

[7] Scenarios provided will be very conservative and are expected to bound the results for all other Type 1a fuels. Actual loaded configurations will be confirmed and documented to be within the analyzed envelope prior to loading.

[8] In a leaktight canister that adheres to the specified fissile loading limits, criticality safety will be shown to be independent of the geometric form of the canister contents.

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Topical Report Section	Topical Report Content Summary	Reg Guide 7.9 Section (Format and Content Guidance)	NUREG 1617 Section (Standard Review Plan)	10CFR71 Section #s (Requirements)
			6.5.5.1 Configuration 6.5.5.2 Results	
6.7 Fissile Material Packages for Air Transport	NA – DOE standardized SNF canister will not be transported by air	6.7 Fissile Material Packages for Air Transport 6.7.1 Configuration 6.7.2 Results		
6.8 Benchmark Evaluation	A description of TSUNAMI and how it was applied for determining applicable benchmarks	6.8 Benchmark Evaluation	6.5.7 Benchmark Evaluations	
6.8.1 Applicability of Benchmark Experiments	A discussion of the TSUNAMI results for the bounding flooded, as-loaded case A discussion of the TSUNAMI results (i.e. 14 potential benchmark cases and their correlation coefficients) for the bounding dry degraded case	6.8.1 Applicability of Benchmark Experiments	6.5.7.1 Experiments and Applicability	
6.8.2 Bias determination	A recommendation for a 5% bias for the flooded, intact cases (i.e. a subcritical limit requiring K_{eff} to be less than 0.95) A recommendation for an appropriate bias (to be determined) for the dry case, taking into consideration the available margins and the limited benchmarks available for dry systems	6.8.2 Bias determination	6.5.7.2 Bias Determination	
6.9 Appendix	NA – section header only	6.9 Appendix	6.5.9 Appendix	
6.9.1 References	An itemized list of documents referenced in Section 6			
6.9.2	Specific descriptions of fuels used in the criticality analyses (e.g. Advanced Test Reactor fuel)			
6.9.3				
6.9.4				
6.9.5				
6.9.7 Criticality Calculation Input and Output Files	Representative input and output files used in the criticality models		6.5.3.3 Computer Codes and Cross Section Libraries	
7. Canister Loading Operations	A summary of the canister life cycle and a discussion of its present state (i.e. designed but not yet fabricated or loaded). Specifically, this section will describe anticipated canister operations (consistent with ALARA principles per 10CFR20.1101(b)) and will specify acceptance criteria associated with any canister operations that are credited in the structural or criticality evaluations. A reference to is also given to section 1.1.2 for a discussion of how NRC regulatory interests will be addressed in DOE packaging and	7. Package Operations		71.91(b-d) 71.93 71.95

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Topical Report Section	Topical Report Content Summary	Reg Guide 7.9 Section (Format and Content Guidance)	NUREG 1617 Section (Standard Review Plan)	10CFR71 Section #s (Requirements)
	storage facilities.			
7.1 Canister Loading	A description of the canister loading, drying, sealing, and inspection process, including any special controls and precautions, and acceptance tests (see section 8.1) that assure the sealed canister meets performance requirements. Applicable codes and standards are discussed in section 2.1.4.		7.5.1 Package Loading (Address 7.5.1.1 and 7.5.1.2 as applicable to canister loading)	71.1, 71.35(c) 71.87(b) 71.91(c) 71.91(d) 71.135
7.2 Interim Storage	A discussion of the interim storage period between canister loading and transportation for final disposition and a reference to 8.2 for a discussion of the monitoring program that will be applied during the interim storage period			
7.3 Cask Loading	NA – the cask loading process will be prescribed by the applicant for a C of C	7.1 Package Loading 7.1.1 Preparation for Loading 7.1.2 Loading of Contents 7.1.3 Preparation for Transport	7.5.1.1 Preparation for Loading 7.5.1.2 Loading of Contents 7.5.1.3 Preparation for Transport	
7.4 Cask Unloading	NA – the cask loading process will be prescribed by the applicant for a C of C	7.2 Package Unloading 7.2.1 Receipt of Package from Carrier 7.2.2 Removal of Contents 7.3 Preparation of Empty Package for Transport 7.4 Other Operations	7.5.2 Package Unloading 7.5.2.1 Receipt of Package from Carrier 7.5.2.2 Preparation for Unloading 7.5.2.3 Removal of Contents 7.5.4 Other Procedures	
7.5 Appendix	An itemized list of documents referenced in Section 7	7.5 Appendix	7.5.5 Appendix	
8. Canister Acceptance Tests and Maintenance Program	A summary of the testing and inspection programs that assure canister integrity is established and maintained and a reference to section 1.1.2 for a discussion of how NRC regulatory interests will be addressed during canister fabrication, loading, and storage prior to transportation and disposal under NRC jurisdiction	8. Acceptance Tests and Maintenance Program		71.93 71.95
8.1 Canister Acceptance tests	A description of the inspections, measurements, weld examinations, and associated acceptance criteria, corrective processes etc. that are associated with canister fabrication, loading, and sealing processes described in section 7.1 and 2.3 A discussion of ISG-18 and its application to the canister final closure welds	8.1 Acceptance Tests 8.1.1 Visual Inspections and Measurements 8.1.2 Weld Examination 8.1.3 Structural and Pressure Tests 8.1.4 Leakage Tests	8.2.4.1 Visual Inspections and Measurements 8.2.4.2 Weld Inspections 8.2.4.3 Structural and Pressure Tests 8.2.4.4 Leakage Tests	71.85(a) 71.85(b)
	NA – canister performance is not credited for shielding or thermal	8.1.5 Component and	8.2.4.5 Component Tests	

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		Material Tests		
		8.1.6 Shielding Tests	8.2.4.6 Shielding Tests	
	performance of the package.		8.2.4.7 Neutron Absorber Tests	
		8.1.7 Thermal Tests	8.2.4.8 Thermal Tests	
		8.1.8 Miscellaneous Tests		
8.2 Canister Maintenance Program	An explanation that the canister materials and closure processes were selected to preclude significant degradation during the period prior to permanent disposal. Criticality and radiological safety rely solely on the passive safety provided by the canister A description of a sampling and inspection program to confirm that there is no unacceptable canister degradation during the interim storage period prior to transport	8.2 Maintenance Program		71.35(c) 71.87(b)
		8.2.1 Structural and Pressure Tests	8.3.4.1 Structural and Pressure Tests	
		8.2.2 Leakage Tests	8.3.4.2 Leakage Tests	
	NA – canisters will not be re-opened or re-used.	8.2.3 Component and Material Tests	8.3.4.3 Component Tests	
			8.3.4.4 Neutron Absorber Tests	
		8.2.4 Thermal Tests	8.3.4.5 Thermal Tests	
		8.2.5 Miscellaneous Tests		
8.3 Appendix	An itemized list of documents referenced in Section 8	8.3 Appendix	8.2.4.9 Appendix 8.3.4.6 Appendix	