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Office of Civilian Radioactive Waste Management

Civilian Radioactive Waste Management System

Transportation, Aging and Disposal Canister System Performance Specification Requirements Rationale

Revision 1 / ICN 1

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Preparer: M. Popa — 28 MAR 2008 Date

Approval: D. K. Zabransky
Acting Director
Waste Management Office — 28 Mar 2008 Date

REVISION HISTORY

Revision	Change
A	Initial Issue
B	For requirement number (5) and (6) in Section 3.1.1 changed "... or less then 5 years out-of-reactor..." to "...**and no** less than 5 years out-of-reactor..."
0	Initial issue of Final TAD Performance Specification. Incorporated comments on the Preliminary TAD Performance Specification, Rev. B
1	Revised Sections 3.3.2(7), 3.3.6(1) and 3.3.6(2). Fixed numbering issue in Section 3.3.2. Address CR 10743 Modify Section 3.1.5(2) to change the minimum neutron absorber thickness from 0.433 in. to 0.4375 in.
REV 1 ICN 1	No changes were made due to the ICN

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ACRONYMS

ALARA	as low as is reasonably achievable
BSC	Bechtel SAIC Company, LLC
BWR	boiling water reactor
CFR	Code of Federal Regulation
CSNF	commercial spent nuclear fuel
DCRA	disposal control rod assembly
DOE	U.S. Department of Energy
GROA	geologic repository operations area
HLW	high-level radioactive waste
HVAC	heating, ventilation and air-conditioning
ICRP	International Commission on Radiological Protection
ISFSI	independent spent fuel storage installation
ITS	important to safety
MTU	metric tons of uranium
NRC	U.S. Nuclear Regulatory Commission
NWPA	Nuclear Waste Policy Act
OCRWM	Office of Civilian Radioactive Waste Management
PWR	pressurized water reactor
SNF	spent nuclear fuel
SSC	structures, systems and components
STC	shielded transfer cask
TAD	transportation, aging and disposal
TEDE	total effective dose equivalent
TWPS	TAD waste package spacer
USL	upper subcritical limit
YMP	Yucca Mountain Project

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ABBREVIATIONS

° C	degrees Centigrade
° F	degrees Fahrenheit
BTU	International Table British thermal unit
BTU/hr-ft^2	British thermal unit per hour-square foot
Bq	becquerel
cm	centimeter
cm^2	square centimeter
dpm	disintegrations per minute
ft	feet
ft/s	feet per second
g	acceleration due to gravity
g/cm^2	grams per square centimeter
GWd	gigawatt-day
h or hr	hour
in.	inches
k_{eff}	effective neutron multiplication factor
kg	kilogram
km	kilometer
km/hr	kilometer/hour
kPa	kilopascal
kW	kilowatt
kW/m^2	kilowatt per square meter
lb	pound(s) (weight; unless otherwise specified)
lb/ft^2	pounds per square foot
lb/in^2	pounds per square inch
lb/in^2/sec	pounds per square inch per second
m	meter
m/s	meter per second
m^2	square meter(s)
mho	Conductance in mho being the reciprocal of resistance in ohms
mm	millimeter
MPa	megapascal
mph	miles per hour

mrem	milli roentgen equivalent man
MT	metric tons
pH	potential of hydrogen
ppm	parts per million
psi, lb/in^2	pounds per square inch
s or sec	second
ton	short ton (2,000 lb weight)
torr	pressure that causes the Hg column to rise 1 millimeter
yr	year

1.0 INTRODUCTION

1.1 Purpose

The purpose of this document is to provide the requirements rationale for the current version of the *Transportation, Aging and Disposal Canister System Performance Specification*; WMO-TADCS-000001.

1.2 Definitions

Accident- An undesirable event; especially one that could potentially do damage or harm to a cask or its contents.

Approved Contents- Used in the context of this requirements rationale and the current version of the *Transportation, Aging and Disposal Canister System Performance Specification*; WMO-TADCS-000001, the term "approved contents" means one of the following:

Transportation Overpack: The contents of Type B packaging as discussed in Section 1.3.3 "Package Description" of *The Standard Review Plan for Transportation Packages for Spent Nuclear Fuel* (NUREG-1617) and listed in section 5b "Contents of Packaging" of a Certificates of Compliance issued under 10 CFR part 71.

Storage Overpack: The materials to be stored as discussed in Section 4.4.1 of *Standard Review Plan for Spent Fuel Dry Storage Facilities* (NUREG-1567) and listed in Section 6 "Approved Contents" of Certificates of Compliance issued under 10 CFR part 72.

Normal- A term used to define expected radioactive wastes, operations and/or processes.

Off-normal- A term used to define any combination of radioactive waste, operations or processes that are not expected during normal activities; usually associated with damaged or failed materials, equipment or processes.

Purchaser- Any person, other than a Federal agency, who is licensed by the Nuclear Regulatory Commission to use a utilization or production facility under the authority of sections 103 or 104 of the Atomic Energy Act of 1954 (42 U.S.C. 2133, 2134) or who has title to spent nuclear fuel or high level radioactive waste and who has executed a contract with DOE.

2.0 REFERENCE DOCUMENTATION

Transportation, Aging and Disposal Canister System Performance Specification; WMO-TADCS-000001.

3.0 REQUIREMENTS ANALYSIS RATIONALE

3.1 TAD Canister Requirements Rationale

3.1.1 General

(1) The TAD canister shall be a right circular cylinder with a diameter of 66.5 in. $\left(\frac{+0.0 \text{ in.}}{-0.5 \text{ in.}}\right)$. The TAD canister height shall not be less than 186.0 in. and not greater than 212.0 in. including the lifting feature shown in Attachment C considering all relevant factors (e.g., tolerance stack-up, thermal expansion, internal pressure)

a. For a TAD canister with a height less than the maximum, a TAD waste package spacer (TWPS) meeting requirements in Section 3.1.1(17-20) shall be included. If required, the TWPS shall have a diameter of 66.5 in. $\left(\frac{+0.0 \text{ in.}}{-0.5 \text{ in.}}\right)$ and length such that the combined height of the TWPS and TAD canister shall be 212.0 in. $\left(\frac{+0.0 \text{ in.}}{-0.5 \text{ in.}}\right)$ considering all relevant factors (e.g., tolerance stack-up, thermal expansion, internal pressure)

b. If required, the TWPS shall be placed in a waste package prior to loading of the TAD canister for disposal. The TWPS function is to restrict lateral motion of the TAD canister within the waste package after emplacement.

Rationale: Allowing the variations in the length allow the vendors to develop TAD canisters that interface properly with utility sites. Use of the TWPS in the disposal configuration maintains the capability to use the "Navy Long" waste package. This specification is based on current operational concepts and technical baseline in *Requirements for the Site-Specific Canister/Basket;* 000-30R-HA00-00400-000-000 Revision 0. This cited source was not developed under the OCRWM QA program. Qualification is not required due to the associated values representing a bounding MGDS operational concept; not a calculations or analyses that need to be preformed under the QARD.

(2) The TAD canister loaded weight shall be consistent with the height determined in accordance with specification. The combined weight of the loaded canister and the TWPS shall not exceed 54.25 tons.

Rationale: Limiting the combined loaded TAD canister and TWPS weight to a maximum of 54.25 tons provides confidence in predicting waste package structural behavior during dynamic event sequences. This predicted behavior is in a manner that meets current repository preclosure and postclosure performance requirements. This specification is based on current operational concepts and

technical baseline in *Requirements for the Site-Specific Canister/Basket;* 000-30R-HA00-00400-000-000 Revision 0. This cited source was not developed under the OCRWM QA program. Qualification is not required due to the associated values representing a bounding MGDS operational concept; not a calculations or analyses that need to be preformed under the QARD.

(3) The capacity of the TAD canister shall be either 21 pressurized water reactor (PWR) spent fuel assemblies or 44 boiling water reactor (BWR) spent fuel assemblies.

Rationale: The loaded TAD canister shall be required to meet the approved technical baseline total system performance assessment for source term for waste package loadings. This specification is based on current operational concepts and technical baseline in *Requirements for the Site-Specific Canister/Basket;* 000-30R-HA00-00400-000-000 Revision 0. This cited source was not developed under the OCRWM QA program. Qualification is not required due to the associated values representing a bounding MGDS operational concept; not a calculations or analyses that need to be preformed under the QARD.

(4) The loaded and closed TAD canister shall be capable of being reopened while submerged in a borated or unborated pool.

Rationale: Initial analyses indicate the Wet Handling Building fuel pool will require boron to assure reactivity remains below specified limits. If TAD canister operations do not require borated water, there will be an inherent flexibility in recovering from off-normal and emergency events.

(5) A TAD canister for PWR assemblies shall be limited to accepting CSNF with characteristics less than 5% initial enrichment, less than 80 GWd/MTU burn up and no less than 5 years out-of-reactor cooling time.

Rationale: The maximum design basis source term and heat load for a PWR spent fuel assembly is 5% initial enrichment, 80 GWd/MTU burn up and no less than 5 years out-of-reactor cooling time. See *PWR Source Term Generation and Evaluation*, 000-00C-MGR0-00100-000-00B Revision 00B.

(6) A TAD canister for BWR assemblies shall be limited to accepting CSNF with characteristics less than 5% initial enrichment, less than 75 GWd/MTU burnup and no less than 5 years out-of-reactor cooling time.

Rationale: The maximum design basis source term and heat load for a BWR spent fuel assembly is 5% initial enrichment, 75 GWd/MTU burn up and no less than 5 years out-of-reactor cooling time. See *BWR Source Term Generation and Evaluation*, 000-00C-MGR0-00200-000-00A Revision 00A.

(7) A TAD canister shall be capable of being loaded with CSNF from one or more facilities that are licensed by the NRC and hold one or more contracts with the DOE for disposal of CSNF.

Rationale: Allowing the contents of a TAD canister to be CSNF generated purchasers will encourage broad use of TAD canisters by reactor operators. See *Civilian Radioactive Waste Management System Requirements Document,* DOE/RW-0406 Revision 007.

(8) All external edges of the TAD canister shall have a minimum radius of curvature of 0.25 in.

Rationale: This requirement helps protect the inner surface of the inner vessel of the waste package will not be gouged or otherwise damaged that could adversely affect the performance of the corrosion barrier.

(9) To the extent practicable, projections or protuberances from reasonably smooth adjacent surfaces shall be avoided or smoothly blended into the adjacent smooth surfaces.

Rationale: This requirement ensures minimization of stress risers and line-stress loads on the inner surface of the inner vessel of the waste package of the outer corrosion barrier.

(10) The TAD canister shall be designed to store vendor defined design basis CSNF at a purchaser site in accordance with 10 CFR part 72 in either a horizontal or vertical orientation.

Rationale: Purchaser engineering, design and operational decisions are to be determined solely by the purchasers.

(11) A TAD canister shall be designed to transport vendor defined design basis CSNF to the GROA in a horizontal configuration.

Rationale: This requirement is 1) in accordance with standard industry practice for the movement of spent nuclear fuel; and, 2) to meet requirements of the OCRWM Transportation Project.

(12) A TAD canister shall be designed to dispose of vendor defined design basis CSNF in waste package in a horizontal configuration.

Rationale: The current technical baseline (and supporting analyses) assumes the disposition of CSNF in a horizontal orientation in a waste package. See *Project Design Criteria Document*; 000-3DR-MGR0-00100-000 Revision 006.

(13) A TAD canister shall be designed to be handled at the GROA loaded with vendor defined design basis CSNF in a vertical configuration.

Rationale: The current technical baseline and concept of operations assumes handling TAD canisters in a vertical configuration. See *Project Design Criteria Document*; 000-3DR-MGR0-00100-000 Revision 006.

(14) A TAD canister shall be designed to age vendor defined design basis CSNF in a vertical configuration.

Rationale: The current technical baseline and concept of operations excludes the ability to transfer TAD canisters outside licensed structures (i.e., buildings) at the GROA. The conceptual design of the site transporter only allows for handling in a vertical configuration. See *Project Design Criteria Document*; 000-3DR-MGR0-00100-000 Revision 006.

(15) At the time of delivery to the repository, a loaded TAD canister shall have a remaining service lifetime for aging of 50 years without maintenance. Prior to delivery to the repository, a loaded TAD canister may have been stored at a reactor site for up to 60 years.

Rationale: This requirement is based on engineering judgment intended to envelope storage and aging requirements (purchaser and GROA sites, respectively) prior to emplacement.

(16) The service lifetime environmental conditions shall be appropriate to the site for the period of deployment at reactors. Yucca Mountain environmental conditions apply for repository aging service.

Rationale: This is intended to allow for storage at purchaser locations that have wide ranging environmental and operational conditions.

(17) TWPS shall be constructed of materials specified in the Performance Specification.

Rationale: Use of approved material is required to meet preclosure and post-closure requirements.

(18) TWPS shall be a right circular cylinder, either solid or hollow with sides and ends formed from plates at least 2 inches thick.

Rationale: Per discussion with DOE OCRWM Office of Chief Scientist it is the judgment that specifying a solid or hollow TWPS formed from 2 inch thick plates, the TWPS will perform for seismic purposes equal to or better than the current stainless steel lid on the top of the WP inner vessel.

(19) The TWPS shall have an average mass density equal to or greater than that of the loaded TAD canister.

Rationale: "Equal to or greater" density of the TWPS to that of the loaded TAD canister provides assurance that the seismic response of a loaded waste package will be similar to that of the previously analyzed Navy Long waste package.

(20) The TWPS shall include four (4) threaded holes in its top for the purpose of attaching temporary rigging meeting requirements of NUREG-0612, *Control of*

Heavy Loads at Nuclear Power Plants to be used when inserting the TWPS into an otherwise empty waste package.

Rationale: Four (4) threaded holes, of sufficient load carrying capability, will provide means of lowering the TWPS into the waste package.

3.1.2 Structural

(1) For each of the following design basis seismic events and configurations, the TAD canister shall meet the performance specifications.

a. Following a 2,000-year seismic return period event, a TAD canister shall maintain a maximum leakage rate of 1.5×10^{-12} fraction of canister free volume per second (normal), maximum cladding temperature of 752° F (normal) and remain within design codes while in the configurations described below.

- While suspended by a crane inside an ASTM A-36 cylindrical steel cavity with an inner diameter of 72.5 inches with 12 inch thick wall.
- While contained in a vendor defined transportation overpack (with impact limiters).
- While contained in a vendor defined transportation overpack (without impact limiters) constrained in an upright position.
- While contained in a vendor defined aging overpack.

b. Following a 10,000-year seismic return period event, a TAD canister shall maintain a maximum leakage rate of 1.5×10^{-12} fraction of canister free volume per second (normal), cladding temperature limit of 1,058° F (off-normal) and remain within design codes while in the configurations described below.

- While suspended by a crane inside an ASTM A-36 cylindrical steel cavity with an inner diameter of 72.5 inches with 12 inch thick wall.
- While contained in a vendor defined transportation overpack (with impact limiters).
- While contained in a vendor defined transportation overpack (without impact limiters) constrained in an upright position.
- While contained in a vendor defined aging overpack.

c. Following a seismic event characterized by horizontal and vertical peak ground accelerations of 96.52 ft/s^2 (3g) a TAD canister shall maintain a maximum leakage rate of 1.5×10^{-12} fraction of canister free volume per second (normal) while in the configurations described below. For this initiating event, canister design codes may be exceeded (i.e., vendor may rely on capacity in excess of code allowances).

- A TAD canister in a vendor defined transportation cask described in Section 3.2 that is dropped from a height of 10 feet to an unyielding surface in the most damaging orientation. The transportation cask configuration shall be with or without impact limiters.

- While contained in a vendor defined transportation overpack (without impact limiters) described in Section 3.2 of this performance specification that is constrained in an upright position.
- While contained in a vendor defined aging overpack as described in Section 3.3 of this performance specification

Rationale: 10 CFR part 63 provides repository performance objectives in terms of annual dose limits for workers and public and requires that 10 CFR part 20 be met. An acceptable leakage rate was established to meet both the acceptance criterion of 10% of the annual TEDE (per *Project Design Criteria Document*, 000-3DR-MGR0-00100-000 Revision 006) and the acceptance criterion that ensures that oxygen concentration inside the TAD canister remains below 0.25% by volume to preclude fuel oxidation. Because a seismic event would affect all TADs located on the surface of the GROA, the TAD system must maintain confinement within the normal acceptance leakage rate during and after the seismic event. The TAD can be in any configuration, including on a site transporter. .

The defined configurations and all requirements related to the 96.52 ft/s^2 (3g) event are based on an e-mail to DOE sent on May 25, 2007 with subject line "*FW: TAD spec comments.*"

(2) A TAD canister in a vendor defined aging overpack shall maintain a maximum leakage rate of 1.5×10^{-12} fraction of canister free volume per second and the specified cladding temperature limits during and following exposure to the environmental conditions listed below

a. These environmental conditions are not cumulative but occur independently:

- Outdoor average daily temperature range of 2° F to 116° F with insolation as specified in 10 CFR part 71 (normal)
- Extreme wind gust of 120 mph for 3-sec (normal)
- Tornado wind speed of 189 mph with a corresponding pressure drop of 0.81 lb/in^2 and a rate of pressure drop of 0.30 lb/in^2/sec (off-normal) with the listed spectrum of missiles (off-normal).

b. Annual precipitation of 20 inches/year (normal) and the specified spectrum of rainfall.

c. Maximum daily snowfall of 6.0 in. (normal)

d. Maximum monthly snowfall of 6.6 in. (normal)

e. A lightning strike with a peak current of 250 kiloamps over a period of 260 microseconds and continuous current of 2 kiloamps for 2 seconds (off-normal).

Rationale: This requirement is consistent with specifications in *Project Design Criteria Document*, 000-3DR-MGR0-00100-000 Revision 006.

(3) A TAD canister in a vendor defined transportation overpack (with impact limiters) shall maintain a maximum leakage rate of 1.5×10^{-12} fraction of canister free volume per second and the specified cladding temperature limits during and following exposure to the environmental conditions listed below

a. These environmental conditions are not cumulative but occur independently:

- Outdoor average daily temperature range of 2° F to 116° F with insolation as specified in 10 CFR part 71 (normal)
- Extreme wind gust of 120 mph for 3-sec (normal)
- Tornado wind speed of 189 mph with a corresponding pressure drop of 0.81 lb/in^2 and a rate of pressure drop of 0.30 $lb/in^2/sec$ (off-normal) with the listed spectrum of missiles (off-normal).

b. Annual precipitation of 20 inches/year (normal) and the specified spectrum of rainfall.

c. Maximum daily snowfall of 6.0 in. (normal)

d. Maximum monthly snowfall of 6.6 in. (normal)

e. A lightning strike with a peak current of 250 kiloamps over a period of 260 microseconds and continuous current of 2 kiloamps for 2 seconds (off-normal).

Rationale: Per e-mail to DOE sent on May 25, 2007 with subject line "*FW: TAD spec comments*" shown in Attachment A.

(4) The TAD canister shall have a flat bottom.

Rationale: OCRWM requirement to ensure the empty or loaded TAD canister will remain upright and freestanding.

3.1.3 Thermal

(1) Except as noted in 3.1.3 (2), CSNF cladding temperature in TAD canisters shall not exceed 752° F during normal operations. Normal operations include storage at purchaser sites, transportation from purchasers to the GROA and handling at the GROA (e.g., aging, storage, onsite transfer, etc).

Rationale: NRC Interim Staff Guidance (ISG-11) for storage and transport of CSNF. However, short transients beyond the 752° F limit are acceptable.

(2) CSNF cladding temperature shall not exceed 1,058° F during draining, drying and backfill operations following TAD canister loading.

Rationale: Short-term accident temperature of 570° C (1,058° F) for zircaloy-clad fuel is currently accepted as a suitable criterion for fuel transfer operations per NUREG-1536, *Standard Review Plan for Dry Cask Storage Systems Final Report, USNRC,* January 1997

(3) The maximum leakage rate of a TAD canister shall be 1.5×10^{-12} fraction of canister free volume per second (off-normal) after a fully-engulfing fire characterized by an average flame temperature of 1,720 °F and lasting 30 minutes. During this event the TAD canister is in either a closed vendor defined transportation overpack (with or without impact limiters) or an open vendor defined transportation overpack without impact limiters. For this event, canister design codes may be exceeded (i.e., vendor may rely on capacity in excess of code allowances).

Rationale: Per e-mail to DOE sent on May 25, 2007 with subject line "*FW: TAD spec comments*" shown in Attachment A.

(4) TAD canister cooling features and mechanisms shall be passive.

Rationale: OCRWM requirement that will simplify the GROA design, license application and future maintenance.

(5) To ensure adequate thermal performance of the TAD canister when emplaced in the waste package, the peak cladding temperature shall be less than 662° F for each set of conditions in the table below.

Table 3.1-3 Thermal Conditions for Cladding Temperature Determination

Thermal Output (kW)	Canister Surface Temperature Boundary Conditions (°F)
11.8	525
18	450
25	358

Rationale: The 662° F limit during emplacement is imposed per DOE direction.

3.1.4 Dose and Shielding

(1) For GROA operations, the combined neutron and gamma integrated average dose rate over the top surface of a loaded TAD canister shall not exceed 800 mrem/hr on contact.

Rationale: This requirement allows for TAD operations in GROA facilities which have limited shielding and access capability.

(2) For GROA operations, the combined contact neutron and gamma maximum dose rate at any point on the top surface of the TAD canister shall not exceed 1,000 mrem/hr.

Rationale: This requirement allows for TAD operations in GROA facilities which have limited shielding and access capability.

(3) The TAD canister shall be designed such that accessible external surfaces contamination shall be removable to:

a. 1,000 dpm/100 cm^2 - beta-gamma with a wipe efficiency of 0.1.

b. 20 dpm/100 cm^2 - alpha with a wipe efficiency of 0.1.

Rationale: Control of surface contamination on the TAD canister supports the design of a radiologically clean facility. Such controls mitigate the potential for onsite and offsite releases of radioactive material. See "*Control of Radioactively Contaminated Material,*" IE Circular No. 81-07.

3.1.5 Criticality

(1) No specific requirements beyond those of 10 CFR part 71, subpart E, paragraph 55(b).

Rationale: These criticality requirements will be sufficient to significantly reduce the possibility of a criticality event in the TAD canister in any configuration prior to disposal.

(2) Postclosure Criticality control shall be maintained by employing either the items in (a) or the analysis in (b), as follows:

a. Include the following features in the TAD internals:

- Neutron absorber plates or tubes made from borated stainless steel produced by powder metallurgy and meeting ASTM A887-89, Standard Specification for Borated Stainless Steel Plate, Sheet, and Strip for Nuclear Application, Grade "A" alloys.
- Minimum thickness of neutron absorber plates shall be 0.4375 inches. Maximum and nominal thickness may be based on structural requirements. Multiple plates may be used if corrosion assumptions (250 nm/year) are taken into for all surfaces such that 6 mm remains after 10,000 years.
- The neutron absorber plate shall have a boron content of 1.1 wt % to 1.2 wt %, a range that falls within the specification for 304B4 UNS S30464 as described in ASTM A887-89, Standard Specification for Borated Stainless Steel Plate, Sheet, and Strip for Nuclear Application.
- Neutron absorber plates or tubes shall extend the full length of the active fuel region inclusive of any axial shifting with the TAD canister.
- Neutron absorber plates or tubes must cover all four longitudinal sides of each fuel assembly.
- TAD canister designs for PWR fuel assemblies shall accommodate assemblies loaded with a disposal control rod assembly (DCRA). A DCRA is intended for acceptance of PWR CSNF with characteristics outside limits set in the postclosure criticality loading curves. Current postclosure criticality loading curves are shown in Attachment B of this performance specification. Updated postclosure criticality loading curves that represent a PWR TAD canister with features described in items 1 through 5 of this subsection may be provided at a later date.

b. Perform analyses of TAD canister-based systems to ensure the maximum calculated effective neutron multiplication factor (k_{eff}[1]) for a TAD canister

[1] The maximum k_{eff} for a configuration is the value at the upper limit of a two-sided 95% confidence interval.

containing the most reactive CSNF for which the design is approved shall not exceed the critical limit[2] for four postclosure archetypical proxy configurations.[3,4]

Rationale: These features will ensure postclosure criticality control to extent reasonably possible without a fully detailed postclosure criticality evaluation of a specific design using the methods described in the topical report and Input document. See *Criticality Input to Canister Based System Performance Specification for Disposal,* TDR-DS0-NU-000002 Revision 1.

3.1.6 Containment

(1) The TAD canister design shall meet either of the requirements below.

a. The qualification of the TAD canister final closure welds shall meet SFPO-ISG-18, *Design/Qualification of Final Closure Welds on Austenitic Stainless Steel Canisters as Confinement Boundary for Spent Fuel Storage and Containment Boundary for Spent Fuel Transportation,* for assuring no credible leakage for containment and confinement.

b. The TAD canister shall be designed to facilitate helium leak testing of closure features using methods that can demonstrate the defined leak-tight requirements have been met. Leak testing shall be performed in accordance with ANSI N14.5-97, *American National Standard for Radioactive Materials - Leakage Tests on Packages for Shipment.*

Rationale: NUREG-1536, Section 8.0, Item V, ("Filling and Pressurization") leak testing should be in accordance with ANSI N 14.5-97. However, if the welds meet the requirements of SFPO-ISG-18, the welds are considered sufficient to meet the leak tight requirements for storage and transportation. The requirement provides the vendor flexibility in selecting an appropriate verification method.

(2) Helium shall be the only gas used for final backfill operations.

Rationale: Helium is the assumed inert gas in the Total System Performance Assessment (TSPA).

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[2] The critical limit is the value of k_{eff} at which a configuration is considered potentially critical including biases and uncertainties *Criticality Model.* CAL-DS0-NU-000003 REV 00A (BSC 2004, Section 6.3.1).

[3] The *Criticality Input to Canister Based System Performance Specification for Disposal* (SNL 2007, Section 3.1) provides a set of considerations for determining the proxy configurations based upon analyses of different, but similar, waste package designs. A list of the four proxy configuration cases are:

a. Nominal case, basket assembly degraded, CSNF intact.

b. Seismic case-I, basket assembly intact, CSNF degraded.

c. Seismic case-II, basket assembly degraded, CSNF degraded.

d. Igneous intrusion case, basket assembly degraded, CSNF degraded, waste package and TAD structural deformation.

[4] A system performance assessment is a comprehensive analysis estimating dose incurred by reasonably maximally exposed individual, including associated uncertainties, as a result of repository releases caused by all significant features, events, processes, and sequences of events and processes, weighted by their probability of occurrence. Disposal Criticality Analysis Methodology Topical Report (YMP 2003, Appendix B).

(3) TAD canister shell and lid shall be designed and fabricated in accordance with *ASME Boiler and Pressure Vessel Code*, Section III, Division 1, Sub-section NB (for Class 1 Components). Vendor shall identify applicable exceptions, clarifications, interpretations, and code cases

Rationale: Requirement obviates the need for active leak monitoring during aging.

By adopting a nationally recognized code for design and construction of pressure vessels, such as *2004 ASME Boiler and Pressure Vessel Code*, acknowledges the guidance provided by NRC in NUREG-1804, *Yucca Mountain Review Plan, Final Report.*

(4) In accordance with industry standards and regulatory guidance, the TAD canister shall be designed to facilitate the following:

a. Draining and drying to remove water vapor and oxidizing material shall be carried out in accordance with NUREG-1536, *Standard Review Plan for Dry Cask Storage Systems Final Report, USNRC,* January 1997.

b. Filling with helium to atmospheric pressure or greater as required to meet leak test procedural requirements.

c. Sampling of the gas space to verify helium purity.

d. Limiting maximum allowable oxidizing gas concentration within the loaded and sealed TAD canister to 0.20% of the free volume in the TAD canister at atmospheric pressure.

Rationale: Complies with guidance in NUREG-1536 (NRC 1997) related to limits on oxidizing agents and inerting medium for interior environment. The sealed TAD canister must provide conditions necessary to maintain physical integrity and chemical stability of waste form and maintain waste form characteristics that restrict transport of radionuclides to the accessible environment. This requirement maintains consistency with licensing precedents established for commercial canisters that have been previously reviewed and accepted under title 10 CFR part 72.

(5) A loaded TAD canister shall maintain a leakage rate of 1.5×10^{-12} fraction of canister free volume per second (normal) and cladding temperature below 752° F (normal) following a 12 inch vertical flat-bottom drop. The impacted surface is equivalent to a solid carbon steel plate, simply supported. The material should be assumed to conform to ASTM A36/A36M, *Standard Specification for Carbon Structural Steel.* It should be assumed that the centerline of the TAD canister may be offset from the centerline of the plate by as much as three inches.

Rationale: Current GROA concepts of operation allow a potential failure during the transfer of a loaded TAD canister on to the transfer bell door.

3.1.7 Operations

(1) The TAD canister lid shall be designed for handling underwater with the TAD in a vertical orientation.

Rationale: GROA handling concepts are based on a vertical orientation of the TAD canister for fuel assembly loading. See *Project Design Criteria Document*; 000-3DR-MGR0-00100-000 Revision 006.

(2) The TAD canister body and lid shall have features to center and seat the lid during submerged installation. The maximum off-center value is ½ in.

Rationale: Industry standard cranes have a positional repeatability of ±¼ in. See *Project Design Criteria Document*; 000-3DR-MGR0-00100-000 Revision 006.

(3) A feature for lifting a vertically oriented, loaded TAD from the lid shall be provided. The lifting feature may be integral with the lid or mechanically attached. The lifting feature shall be in place and ready for service prior to transport to the repository.

Rationale: To facilitate operational, dose and throughput requirements, TAD canisters shall have a common integral lifting feature. See *ALARA Management Commitment and Policy.*

(4) An open, empty and vertically oriented TAD canister shall have integral lifting feature(s) provided to allow lifting by an overhead handling system.

Rationale: To facilitate repository handling of an empty TAD canister body (without lid), integral lifting feature or features are required. See *Project Design Criteria Document,* 000-3DR-MGR0-00100-000 Revision 006.

(5) The TAD canister shall be designed with features such that draining, drying and backfill operations take advantage of "as low as reasonably achievable" (ALARA) principles.

Rationale: To facilitate operational, dose and throughput requirements, TAD canisters shall have a common integral lifting feature. See *ALARA Management Commitment and Policy.*

3.1.8 Materials

(1) Required Materials- Except for thermal shunts and criticality control materials, the TAD canister and structural internals (i.e., basket) shall be constructed of a Type 300-series stainless steel (UNS S3XXXX, such as UNS S31603, which may also be designated as type 316L) as listed in ASTM A-276-06, *Standard Specification for Stainless Steel Bars and Shapes.*

Rationale: Degradation of TAD canister materials via corrosion needs to have a minimal impact on the pH of the aqueous solution(s) contacting the TAD canister and waste form after TAD canister is breached. This requirement is consistent with the In-Package Chemistry Abstraction AMR.

(2) The TAD and its basket materials shall be designed to be compatible with either borated or unborated repository pool water as defined in *Transportation, Aging and Disposal Canister System Performance Specification*; WMO-TADCS-000001.

Rationale: TAD canister materials must not be adversely affected by pool water chemistry. Pool water chemistry must not be adversely affected by TAD canister materials. See *Behavior of Spent Nuclear Fuel in Water Pool Storage,* BNWL-2256.

(3) Prohibited or Restricted Materials

a. The TAD canister shall not have organic, hydrocarbon-based materials of construction.

b. All metal surfaces shall meet surface cleanliness classification C requirement defined in ASME NQA-1-2000 Edition, Subpart 2.1 *Quality Assurance Requirements for Cleaning of Fluid Systems and Associated Components for Nuclear Power Plants.*

c. The TAD canister shall not be constructed of pyrophoric materials.

d. The TAD canister, including steel matrix, gaskets, seals, adhesives and solder, shall not be constructed with materials regulated as hazardous wastes under the Resource Conservation and Recovery Act (RCRA) and prohibited from land disposal under RCRA if declared to be waste.

Rationale: The extremely low organic carbon supply in the repository will limit heterotrophic microbial activity, which could otherwise accentuate corrosion or radionuclide transport. See *Evaluation of Potential Impacts of Microbial Activities on Drift Chemistry*; ANL-EBS-MD-000038 Revision 001.

A pyrophoric event is defined as ignition, followed by rapid chemical oxidation or self-sustained burning. A constraint on availability of pyrophoric materials for exothermic reaction is used to Exothermic Reactions in the EBS. See *Waste Form Features, Events, and Processes*; ANL-WIS-MD-000009 Revision 002.

To avoid the generation, storage, or disposal of hazardous or mixed waste that could subject the CRWMS facility to State of Nevada RCRA permitting requirements and NRC or DOE regulation. See *Civilian Radioactive Waste Management System Requirements Document;* DOE/RW-0406 Revision 007.

(4) Markings

a. The TAD canister shall be capable of being marked on the lid and body with an identical unique identifier prior to delivery for loading.

b. The unique identifier space shall be of suitable length and height to contain nine (9) alphanumeric and two (2) special characters (e.g., -, /, "space", etc.) to be specified by the DOE.

c. Alphanumeric characters shall have a minimum height of 6 in.

d. The markings shall remain legible without intervention or maintenance during/after any of the following events:

- The entire service life defined in the current version of the *Transportation, Aging and Disposal Canister System Performance Specification*; WMO-TADCS-000001.
- Normal operations to include loading, closure, storage, transportation, aging and disposal.
- Dose, heat and irradiation associated with the vendor defined design basis PWR or BWR, as applicable.

Rationale: This provides capability to implement requirement for material control and accountability. See *Material Control and Accounting of Special Nuclear Material*; 10 CFR part 74.

3.2 Transportation Overpack

3.2.1 General

(1) The transportation overpack cavity shall accommodate a TAD canister formed as a right-circular cylinder with a length including the lifting feature as specified by the vendor in accordance with 3.1.1(1) and a diameter of 66.5 in.; and Attachment C of the *Transportation, Aging and Disposal Canister System Performance Specification*; WMO-TADCS-000001.

Rationale: The transportation overpack must be capable of containing a loaded TAD canister.

(2) The transportation overpack shall function with a vendor defined TAD canister that meets the requirements of *Transportation, Aging and Disposal Canister System Performance Specification*; WMO-TADCS-000001.

Rationale: The transportation overpack must be capable of containing a loaded TAD canister.

(3) The loaded transportation overpack (without impact limiters) shall be designed to be lifted in a vertical orientation by an overhead crane.

Rationale: Current GROA facility operations require handling transportation overpacks in a vertical orientation. It is consistent with common industry cask and overpack designs and handling practices.

(4) The loaded transportation overpack (without impact limiters) shall be able to stand upright when set down upon a flat horizontal surface without requiring the use of auxiliary supports.

Rationale: Requiring the transportation overpack stand upright in a vertical orientation facilitates simplified operations and preparations for TAD transfers. It is

consistent with common industry cask and overpack designs and handling practices.

(5) The size and weight of the loaded transportation overpack shall be limited to the values listed in the current version of the *Transportation, Aging and Disposal Canister System Performance Specification*; WMO-TADCS-000001.

Rationale: To establish reasonable interface parameters for repository surface facility interfaces such as trolley widths, sizes of shielded canister transfer area openings, crane heights, and crane capacities.

(6) Lifting attachments and appurtenances on transportation overpacks, overpack lids and impact limiters shall be designed, documented and fabricated in accordance with NUREG-0612 *Control of Heavy Loads at Nuclear Power Plants.*

Rationale: Heavy items, as defined in NUREG-0612, need to be safely and securely lifted and moved to handle TAD canisters.

3.2.2 Structural

(1) A loaded TAD canister contained within a transportation overpack assembled with any other components included in the packaging, as defined in 10 CFR part 71, shall meet requirements for a Type B cask as specified in 10 CFR part 71, as evidenced by a valid Certificate of Compliance.

Rationale: Transportation of CSNF in a NRC certified cask is required under the Nuclear Waste Policy Act, Subtitle H Section 180(a).

3.2.3 Thermal

(1) During normal operations, the CSNF cladding temperature in the TAD canister shall not exceed 752° F. Normal operations include transportation from purchaser sites to the GROA and on-site at the GROA.

Rationale: NRC Interim Staff Guidance for storage and transport of CSNF sets guidelines for cladding temperature. See *Cladding Considerations for the Transportation and Storage of Spent Fuel*; Interim Staff Guidance-11.

(2) Supplemental shielding shall not be required in vacant trunnion locations to dose requirements for transporting the TAD canister with vendor defined contents.

Rationale: OCRWM requirement.

(3) Transportation overpack cooling features and mechanisms shall be passive.

Rationale: OCRWM requirement that will simplify GROA design, license application and future maintenance.

3.2.4 Dose and Shielding

(1) The transportation overpack impact limiters shall include design and handling features that use standardized tools and features that simplify removal operations. Standard tools are those that can be found in industrial tool catalogs.

Rationale: Supports DOE ALARA policy and design goals.

(2) Supplemental shielding shall not be required in vacant trunnion locations to meet dose requirements for transporting the TAD canister with vendor defined contents

Rationale: Supports DOE ALARA policy and design goals.

(3) Transportation overpack shall be designed such that accessible external surfaces contamination shall be removable to:

a. 1,000 dpm/100 cm^2 - beta-gamma with a wipe efficiency of 0.1.
b. 20 dpm/100 cm^2 - alpha with a wipe efficiency of 0.1.

Rationale: Control of surface contamination on transportation overpacks supports the design of a radiologically clean facility. Such controls mitigate the potential for onsite and offsite releases of radioactive material. See "*Control of Radioactively Contaminated Material,*" IE Circular No. 81-07.

3.2.5 Criticality

No specific requirements beyond those of 10 CFR part 71.

Rationale: Transportation overpack must be transportable with a TAD canister loaded with vendor defined CSNF.

3.2.6 Containment

The loaded transportation overpack shall have a tamper indicting device (TID) that meets requirements of 10 CFR part 73 *Physical Protection of Plants and Materials.*

Rationale: Transportation overpack must be transportable with a TAD canister loaded with vendor defined CSNF.

3.2.7 Operations

(1) Normal operational procedures shall **not** require submergence of transportation overpack into CSNF pool at repository or loading site. Transportation overpacks may be submerged in pool in unusual or off-normal circumstances.

Rationale: This specification is intended to mitigate spread of radioactive contamination of the exterior surfaces of the transportation overpack and mitigating potential for decontamination upon receipt. See "*Control of Radioactively Contaminated Material,*" IE Circular No. 81-07.

(2) Transportation overpacks shall have closures that can be bolted and unbolted using standard tools. Standard tools are those that can be found in industrial tool catalogs.

Rationale: Use of standard tools simplifies operations to prepare overpacks for unloading.

(3) The transportation overpack shall have trunnions that meet the following requirements.

a. There shall be two (2) upper (lifting) trunnions with the centerline located between 8 and 24 inches from the top of the vendor defined transportation overpack.

b. There shall be two (2) lower (rotation) trunnions with the centerline located less than 36 inches from the bottom of the vendor defined transportation overpack.

c. The centerline of each trunnion set shall be outside the area of the spent fuel region to provide maximum ALARA benefits.

Rationale: The requirement allows use of a standard yoke for all transportation overpacks and allows for proper clearance to interface with GROA facilities.

(4) The transportation overpack shall have upper lifting trunnions with dual seats.

a. The smaller seat (lifting yoke interface) shall have a diameter of 6.75 ±0.25 inches and an axial width of no less than 2.50 inches.

b. The diameter of the end caps shall not exceed 8.75 inches.

Rationale: Provides proper size to meet repository lifting and rigging requirements and interfaces as provided to DOE via RW-05 comment #35.

(5) The transportation skid shall be designed to permit the transportation overpack, without impact limiters, to be upended by rotation about its lower trunnions and removed from the transportation skid in a vertical orientation via overhead crane.

Rationale: Current GROA operation concepts remove the loaded transportation overpack from its conveyance by lifting with the upper trunnions and rotating about its lower trunnions.

(6) The lower turning trunnions shall be pocket trunnions and recessed into the cask body.

Rationale: Facilitates preparation of the transportation overpack to remove a TAD canister. Ensures the transportation overpack will not require removal from conveyance in a horizontal orientation prior to upending.

(7) The upper trunnions shall:

a. Be mechanically fastened to the cask body.

b. Incorporate features for installation and removal that maximize ALARA principles. Repository goal is to limit total dose for installing or removing the trunnions to less then 40 millirem per pair.

Rationale: Removable trunnions ease cask maintenance activities and allow for a more robust cask from a hypothetical accident condition impact.

(8) The upper trunnions shall be removed and stowed during transport.

Rationale: Per discussions consultation with the Office of Chief Engineer and Office of Logistics Management. This action was agreed upon based on resolution of conflicting Comment Sheet requests (see RW-05 Comment #35 and RW-10 Comment #5) on the review of the initial draft.

(9) The transportation overpack lid shall have a lifting ring that is:

a. Identical to that of the TAD canister as shown in Attachment C.

b. Is removable from the transportation overpack lid.

c. Capable of handling the unencumbered transportation overpack lid.

Rationale: Current GROA design concepts require removal of the loaded transportation cask lid using remote systems. In order to facilitate safer and more efficient unloading of transportation overpacks a common lifting tool concept is being required.

While having it in place on arrival may reduce doses to repository workers, the lift ring may complicate impact limiter design and become a stress point during accident conditions.

(10) The transportation skid to be used with the TAD canister-based system shall have the following characteristics:

a. Secures the transportation overpack during normal conditions of transport in accordance with requirements of 10 CFR part 71.45.

b. Secures to the railcar in accordance with requirements of AAR Interchange Rule 88, A.15.c.3. (AAR Field Manual 2006)

c. Design shall facilitate lifting of the loaded package in its transportation configuration, including the skid and impact limiters, and transfer of the package from one conveyance to another.

d. The footprint of the transportation skid shall not exceed 124 inches wide by 360 inches long.

e. Vendor skid design shall be compatible with all variations of their TAD canister-based system in a transportation configuration (e.g., PWR and BWR variants).

f. Shall be designed to permit the loaded vendor defined transportation overpack, without impact limiters, to be upended by rotation about its lower trunnions and removed in a vertical orientation via overhead crane.

g. Skid shall be designed such that the bottom of loaded vendor defined transportation overpack (in a vertical orientation) shall not be required to be lifted more than 12'-3" above grade elevation (top of rail). The conveyance deck height will not be greater than 54" above grade elevation.

Rationale: A standard railcar interface incorporated into each vendor's transportation skid design would be preferred, but is currently not available. In order to proceed with TAD procurement, each vendor will be permitted to design a skid/rail car attachment. This attachment system design, engineering and analyses are needed to show compliance with 10 CFR part 71 requirements.

If a universal attachment system is deployed, OCRWM may request or independently perform a design analysis to comply with new interface and applicable regulations.

Identified limitations (i.e., items d and g) are based upon information provided by OCRWM contractor personnel as shown in Attachment A.

3.2.8 Materials

Materials selections shall be as required to meet requirements of 10 CFR part 71 and other requirements of this specification.

Rationale: Transportation overpack requires certification under 10 CFR part 71.

3.3 Aging Overpack

3.3.1 General

(1) The aging overpack cavity shall accommodate a TAD canister formed as a right-circular cylinder with a length including the lifting feature as specified by the vendor in accordance with 3.1.1 and a diameter of 66.5 in.; and Attachment C *Transportation, Aging and Disposal Canister System Performance Specification*; WMO-TADCS-000001.

Rationale: The aging overpack shall be capable of containing a loaded TAD canister.

(2) The aging overpack shall function with a TAD canister that has a loaded weight consistent with vendor specified dimensions in accordance with the current version of the *Transportation, Aging and Disposal Canister System Performance Specification*; WMO-TADCS-000001.

Rationale: The aging overpack shall be capable of containing a loaded TAD canister.

(3) The combined size and weight of the loaded TAD aging overpack shall be limited to the values listed the current version of the *Transportation, Aging and Disposal Canister System Performance Specification*; WMO-TADCS-000001.

Rationale: To establish reasonable interface parameters for GROA facility interfaces such as trolley widths, sizes of transfer area openings, crane heights and capacities.

Diameter and weight limits are based on e-mail to DOE sent on May 25, 2007 with subject line "*FW: TAD spec comments*" shown in Attachment A.

(4) The loaded aging overpack shall meet the operational requirements detailed in sketch presented in Attachment D of the current version of the *Transportation, Aging and Disposal Canister System Performance Specification*; WMO-TADCS-000001.

Rationale: To establish reasonable interface parameters for GROA facility interfaces such as trolley widths, sizes of transfer area openings, crane heights and capacities.

(5) The aging overpack shall be designed to be moved in a vertical orientation.

Rationale: Repository handling concepts are based on handling transportable aging overpacks with both an overhead crane and site transporter. This specification is based on current operational concepts and technical baseline in the *Yucca Mountain Project Conceptual Design Report,* TDR-MGR-MD-000014 Revision 005. This cited source was not developed under the OCRWM QA program. Qualification is not required due to the associated values representing a bounding MGDS operational concept; not a calculations or analyses that need to be preformed under the QARD.

(6) The aging overpack lid shall have a lifting ring that is:

a. Identical to that of the TAD canister as shown in Attachment C.

b. Capable of handling the unencumbered aging overpack lid.

Rationale: OCRWM requirement.

(7) The designed maintainable service lifetime of the aging overpack shall be a minimum of 100 years.

Rationale: Doubling the anticipated time frame design margin.

3.3.2 Structural

(1) For each design basis seismic events below, the TAD canister in an aging configuration shall meet the following performance specifications.

a. Following a 2,000-year seismic return period event:

- TAD canister in an aging overpack, shall maintain a maximum leakage rate of 1.5×10^{-12} fraction of canister free volume per second (normal)
- Maintain a maximum cladding temperature of 752° F (normal)
- Canister design codes shall not be exceeded.
- The aging overpack shall remain upright and free standing.

b. Following a 10,000-year seismic return period event:

- TAD canister in an aging overpack, shall maintain a maximum leakage rate of 1.5×10^{-12} fraction of canister free volume per second (normal)

- Maintain a maximum cladding temperature of 1,058° F (off-normal)
- Canister design codes shall not be exceeded.
- The aging overpack shall remain upright and free standing.

c. Following a seismic event characterized by horizontal and vertical peak ground accelerations of 96.52 ft/s^2 (3g):

- TAD canister in an aging overpack, shall maintain a maximum leakage rate of 1.5×10^{-12} fraction of canister free volume per second (normal)
- Canister design codes may be exceeded (i.e., vendor may rely on capacity in excess of code allowances).
- The aging overpack shall remain upright and free standing during and following the event.

Rationale: 10 CFR part 63 provides repository performance objectives in terms of annual dose limits for workers and public and requires that 10 CFR part 20 be met. An acceptable leakage rate was established to meet both the acceptance criterion of 10% of the annual TEDE (per *Project Design Criteria Document*, 000-3DR-MGR0-00100-000 Revision 006) and the acceptance criterion that ensures that oxygen concentration inside the TAD canister remains below 0.25% by volume to preclude fuel oxidation. Because a seismic event would affect all TADs located on the surface of the GROA, the TAD system must maintain confinement within the normal acceptance leakage rate during and after the seismic event. The TAD can be in any configuration, including on a site transporter.

The defined configurations and all requirements related to the 96.52 ft/s^2 (3g) event are based on e-mail to DOE sent on May 25, 2007 with subject line "*FW: TAD spec comments*" shown in Attachment A.

(2) During GROA operations, aging overpack shall be designed to maintain a maximum TAD canister leakage rate of 1.5×10^{-12} fraction of free volume per second (normal) and cladding temperature limits (see inset) during and following exposure to the environmental conditions listed below.

a. These environmental conditions are not cumulative but occur independently:

- Outdoor average daily temperature range of 2° F to 116° F with insolation as specified in 10 CFR part 71 (normal)
- Extreme wind gust of 120 mph for 3-sec (normal)
- Tornado wind speed of 189 mph with a corresponding pressure drop of 0.81 lb/in^2 and a rate of pressure drop of 0.30 lb/in^2/sec (off-normal) with the listed spectrum of missiles (off-normal).

b. Annual precipitation of 20 inches/year (normal) and the specified spectrum of rainfall.

c. Maximum daily snowfall of 6.0 in. (normal)

d. Maximum monthly snowfall of 6.6 in. (normal)

e. A lightning strike with a peak current of 250 kiloamps over a period of 260 microseconds and continuous current of 2 kiloamps for 2 seconds (off-normal).

Rationale: This requirement is consistent with specifications in *Project Design Criteria Document*, 000-3DR-MGR0-00100-000 Revision 006.

(3) Following an impact (with resultant fire) from an F-15 military aircraft into an aging overpack, the TAD canister shall maintain a maximum leak rate of 9.3×10^{-10} fraction of canister free volume per second (off-normal) and maximum cladding temperature 1,058° F (off-normal). The analysis shall assume the following:

a. The crash speed is assumed to be 500 ft/sec.

b. Impact orientation analyzed shall be that which results in maximum damage.

c. 12,000 lbs of JP-8 fuel.

d. F-15 airframe.

e. Two engine components of 3,740 lbs. and dimensions of 46.5 inches D x 191 inches each spaced 96 inches apart.

f. One (1) M61A1 20-mm cannon mounted internally just off center of axis.

g. 1,000 lbs of inert armaments (i.e., dummy bombs) located between the engines.

Rationale: Maintain TEDE limits and cladding integrity following the unlikely event of an impact of an F-15 with the aging overpack on the aging pad.

(4) The TAD canister in an aging overpack shall be designed to a maximum leakage rate of 1.5×10^{-12} fraction of canister free volume per second (normal) and maximum cladding temperature of 1,058° F (off-normal) following 4 in. of volcanic ash accumulation. The aging overpack may be on a site transporter. The ash fall loads are estimated at 21 lb/ft^2 with a thermal conductivity of 0.11 BTU/hr-ft-° F.

Rationale: This requirement is consistent with specifications in *Project Design Criteria Document*, 000-3DR-MGR0-00100-000 Revision 006.

(5) The aging overpack shall retain the TAD canister following a drop and/or tip-over event.

Rationale: A loaded, unshielded and unprotected TAD canister would make recovery from off-normal events laborious and hazardous. If the TAD canister remains within the aging overpack, recovery operations will be simplified and safer.

(6) The aging overpack top shall have one (1) lift feature in each quadrant to allow for lifting using temporary rigging and portable crane. The lifting features shall be of sufficient size to allow any two (2) to upright and lift a loaded aging overpack.

Rationale: Lift and upright capabilities and locations will facilitate alternate transfer process in event of emergency and recovery from an off-normal event.

(7) For analysis purposes, the aging pad shall be assumed to have the following characteristics:

a. 5,000 PSI concrete with a minimum thickness of three feet and a maximum thickness of seven feet.

b. Concrete surface is a light broom finish.

c. Reinforcing steel shall be #11's on 8 in. centers, each direction, top and bottom, standard cover top and bottom, with #5 ties spaced at 2'-0". On the perimeter there are #5 ties spaced at 8" with 2 #11's spaced at 10" on the vertical face of the foundation..

d. Soil data is in Attachment E.

Rationale: Not applicable. This is for information only and is required for vendors to complete design of aging overpack.

3.3.3 Thermal

(1) Aging overpack cooling features and mechanisms shall be passive.

Rationale: OCRWM requirement that will simplify the GROA design, license application and future maintenance.

(2) A loaded aging overpack shall be capable of withstanding a fully engulfing fire without the TAD canister exceeding a leakage rate of 9.3×10^{-10} fraction of canister free volume per second (off-normal) and maximum fuel cladding temperature of 1,058° F (off-normal) under the conditions below.

a. The resulting fire described by an aircraft impact.

b. The fire described in 10 CFR 71.73.c (4) *Hypothetical Accident Condition* requirements as modified below.

- The 30-minute period shall be replaced by a period to be determined by calculation of a pool spill fire formed by 100 gallons of diesel fuel.
- Additionally, a surrogate fully engulfing fire of duration twice the duration of the pool fire which starts simultaneously with the pool fire and with a steady-state heat release rate of 10 MW shall be used to model the burning rate of all other solid and liquid combustible materials. For this purpose, assume the heat transfer conditions specified in 10 CFR 71.73.c (4). Temperature conditions from this fire shall be consistent with a totally engulfing black body emitting from the 10 MW requirement.

c. A loaded aging overpack shall withstand a deflagration blast wave, fuel tank projectiles and incident thermal radiation resulting from the worst case engulfing

fire[5] determined in the previous fire protection requirement without the TAD canister exceeding a leakage rate of 9.3×10^{-10} fraction of canister free volume per second (off-normal) and maximum fuel cladding temperature of 1,058° F (off-normal).

Rationale: This fire protection standard should envelope any possible causality and allow for safe recovery.

3.3.4 Dose and Shielding

When the loading aging overpack is on the aging pad with its vertical axis in its normal orientation, the combined neutron and gamma contact dose rate on any accessible exterior surface (excluding the underside of the aging overpack) shall not exceed 40 mrem per hour at any location. This is inclusive of any air circulation ducts, penetrations and other potential streaming paths where they exit the projected surfaces of the overpack.

Rationale: 40 mrem/hr on contact is approximately 10 mrem/hr at 2 m from overpack surface, which is consistent with OCRWM ALARA program goals. This dose limit is representative of several NRC-issued Certificates of Compliance. E.g., certificate No. 1002, No. 1003 and No. 1005.

3.3.5 Criticality

No criticality requirements beyond those detailed in Section 3.1.5 of this performance specification.

Rationale: Section 3.1.5 provides all requirements related to criticality.

3.3.6 Containment

The aging overpack shall be designed such that following a 3-ft vertical drop or tip over from a 3-ft high site transporter, the TAD canister maximum leak rate is 9.3×10^{-10} fraction of canister free volume per second (off-normal) under applicable repository environmental conditions. The impacted surface characteristics are as follows:

(1) 5,000 PSI concrete with a thickness of three feet with a broom finish.

(2) Reinforcing steel shall be #11's on 8 in. centers, each direction, top and bottom, standard cover top and bottom, with #5 ties spaced at 2'-0". On the perimeter there are #5 ties spaced at 8" with 2 #11's spaced at 10" on the vertical face of the foundation.

(3) Soil data provided.

Rationale: To meet performance objectives for the GROA in terms of dose limits for workers and public. This specification is based on current operational concepts and technical baseline in the *Yucca Mountain Project Conceptual Design Report,* TDR-MGR-MD-000014 Revision 005. This cited source was

[5] For this analysis, assume the total quantity of fuel shall vaporize into an efficient fuel-air mixture producing an explosive event. Effects of heat generation, fuel tank projectiles and blast wave propagation shall be considered.

not developed under the OCRWM QA program. Qualification is not required due to the associated values representing a bounding MGDS operational concept; not a calculations or analyses that need to be preformed under the QARD.

3.3.7 Operations

(1) The aging overpack shall be designed to receive, age and discharge a loaded TAD canister in a vertical orientation.

Rationale: Current GROA concepts of operation allow for the vertical receipt, aging and discharging of a loaded TAD canister. See *Yucca Mountain Project Conceptual Design Report*; TDR-MGR-MD-000014 Revision 005.

(2) The loaded aging overpack shall be transportable on site in a vertical orientation.

Rationale: Current GROA concepts of operation allow for movement of an aging overpack in a vertical orientation. This specification is based on current operational concepts and technical baseline in the *Yucca Mountain Project Conceptual Design Report;* TDR-MGR-MD-000014 Revision 005.

(3) The loaded aging overpack shall be designed to remain in its transport orientation when set down on an essentially flat horizontal surface without use of auxiliary supports.

Rationale: OCRWM requirement for the loaded aging overpack to remain freestanding.

(4) The aging overpack shall have a vendor designed fixture(s) such that the loaded aging overpack can be handled via an overhead crane.

Rationale: Maximizes flexibility for transfer within GROA facilities.

(5) The loaded aging overpack shall be designed to be moved to the aging pad via site transporter using a pair of lift beams (e.g., forklift).

Rationale: Allows for transport via GROA aging overpack transporter.

(6) The aging overpack shall be capable of being transported by air pallet.

Rationale: Maximizes flexibility for transfer within GROA facilities. This specification is based on current operational concepts and technical baseline in the *Yucca Mountain Project Conceptual Design Report;* TDR-MGR-MD-000014 Revision 005.

3.3.8 Materials

No material requirements, prohibitions or restrictions have been identified for the aging overpack.

Rationale: None required.

4.0 GLOSSARY

The following section incorporates the definitions and descriptions of major "terms of art" used throughout this document.

Aging- Safely placing commercial CSNF in a site-specific overpack on an aging pad for a long period of time (years) for radioactive decay. Radioactive decay results in a cooler waste form to ensure thermal limits can be met. Safely aging CSNF is an integral part of GROA operations to ensure material has significantly decayed to meet licensed thermal limitations.

Burnup- A measure of nuclear reactor fuel consumption expressed either as the percentage of fuel atoms that have undergone fission or as the amount of energy produced per initial unit weight of fuel.

Canister- The structure surrounding the waste form that facilitates handling, storage, aging and/or transportation.

1. For CSNF, the canister may provide structural support for intact CSNF, loose rods, non-fuel components and confinement of radionuclides.
2. Canistered waste shall be placed in waste packages prior to emplacement.

Cladding- The metallic outer sheath of a fuel rod generally made of a zirconium alloy. It is intended to isolate the fuel from the external environment.

Design Bases- That information that identifies the specific functions to be performed by a structure, system, or component of a facility and the specific values or ranges of values chosen for controlling parameters as reference bounds for design. These values may be constraints derived from generally accepted "state-of-the-art" practices for achieving functional goals or requirements derived from analysis (based on calculation or experiments) of the effects of a postulated event under which a structure, system, or component must meet its functional goals. The values for controlling parameters for external events include:

1. Estimates of severe natural events to be used for deriving design bases that will be based on consideration of historical data on the associated parameters, physical data, or analysis of upper limits of the physical processes involved; and,
2. Estimates of severe external human-induced events to be used for deriving design bases, which will be based on analysis of human activity in the region, taking into account the site characteristics and the risks associated with the event. (10 CFR 63.2)

Event Sequence- A series of actions and/or occurrences within the natural and engineered components of a GROA that could potentially lead to exposure of individuals to radiation. An event sequence includes one or more initiating events and associated combinations of repository system component failures, including those produced by the action or inaction of operating personnel. Those event sequences that are expected to occur one or more times before permanent closure of the geologic repository operations area are referred to as Category 1 event sequences. Other event sequences that have at

least one chance in 10,000 of occurring before permanent closure are referred to as Category 2 event sequences.

Fuel assembly- A number of fuel rods held together by plates and separated by spacers used in a reactor. This assembly is sometimes called a fuel bundle or fuel element.

Geologic Repository Operations Area (GROA)- A high-level radioactive waste facility that is part of a geologic repository, including both surface and subsurface areas, where wet handling activities are conducted. (10 CFR 63.2)

Hypothetical Accident Conditions- The sequential conditions and tests defined in 10 CFR part 71 subpart E (Package Approval Standards) and subpart F (Package, Special Form and LSA-III Tests) that a package (or array of packages) must be evaluated against.

High-Level Radioactive Waste (HLW)- (1) The highly radioactive material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentrations; (2) Irradiated reactor fuel; and (3) Other highly radioactive material that the Commission, consistent with existing law, determines by rule requires permanent isolation. (10 CFR 63.2)

Important to Safety- In reference to structures, systems and components, means those engineered features of the GROA whose function is:

1. To provide reasonable assurance that high-level waste can be received, handled, packaged, stored, emplaced, and retrieved without exceeding the requirements of §63.111(b)(1) for Category 1 event sequences; or
2. To prevent or mitigate Category 2 event sequences that could result in radiological exposures exceeding the values specified at §63.111(b)(2) to any individual located on or beyond any point on the boundary of the site.

Important to Waste Isolation- With reference to design of the engineered barrier system and characterization of natural barriers, means those engineered and natural barriers whose function is to provide a reasonable expectation that high-level waste can be disposed of without exceeding the requirements of 10 CFR 63.113(b) and (c). (10 CFR part 63.2)

Neutron Absorber- A material (e.g., boron) that absorbs neutrons used in nuclear reactors, transportation overpacks and waste packages to control neutron multiplication.

Normal Conditions of Transport- The conditions and tests defined in 10 CFR part 71 subpart E (Package Approval Standards) and subpart F (Package, Special Form and LSA-III Tests) that all packages must be evaluated against.

Postclosure- The period of time after closure of the geologic repository.

Preclosure- The period of time before and during closure of the GROA disposal system.

Site- An area surrounding the GROA for which the DOE exercises authority over its use in accordance with the provisions of 10 CFR part 63.

Site Transporter- A self-powered vehicle designed to haul the TAD canister and contents while within either a shielded transfer cask or aging overpack between GROA surface facilities.

Shielded Transfer Cask (STC)- A cask that meets applicable requirements for safe transfer of a TAD canister and its contents between various surface facilities.

Spent Nuclear Fuel (SNF)- Fuel withdrawn from a nuclear reactor following irradiation, the constituent elements of which have not been separated by reprocessing.

Storage– For the purposes of this specification, the placement, by a licensees and/or purchasers, of spent nuclear fuel in independent spent fuel storage installations (ISFSI) certified under title 10 CFR part 72.

TAD System- The set of components consisting of one or more TAD canisters, transportation overpacks, transportation skids, ancillary equipments, shielded transfer casks, aging overpacks and site transporters used to facilitate handling of CSNF.

Total Effective Dose Equivalent- For purposes of assessing doses to workers, the sum of the deep-dose equivalent (for external exposures) and committed effective dose equivalent (for internal exposures).

Transportation Overpack- The assembly of components of the packaging intended to retain the radioactive material during transport.

Trunnion- Cylindrical protuberance for supporting and/or lifting located on the outside of a container or cask (e.g., waste package, aging overpack, etc.)

Waste package- The waste form and any containers, shielding, packing and other absorbent materials immediately surrounding an individual waste container.

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Attachment A
E-Mail Correspondence

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Christopher White
05/24/2007 09:00 PM

To: Markus Popa/HQ/RWDOE@CRWMS
cc: Paul Harrington/YD/RWDOE@CRWMS, Kirk Lachman/YD/RWDOE@CRWMS, Dave
Zabransky/HQ/RWDOE@CRWMS, Kurt Espiritu/HQ/RWDOE@CRWMS, Stephen
Woodberry/HQ/RWDOE@CRWMS, Robert Slovic/YM/RWDOE@CRWMS
Subject: Re: TAD issues.... D3D4A02A81365382852572E2005B9F0D
LSN: Not Relevant - Not Privileged
User Filed as: Excl/Procedures-21-10-a/QA:N/A

Markus,
Please use the attached for the unresolved issues.

Thank you.

Chris

(See attached file: Unresolved TAD Spec Issues.doc)

Markus Popa
05/21/2007 09:42 AM

To: Christopher White/YD/RWDOE
cc: Dave Zabransky/HQ/RWDOE@CRWMS, Kurt Espiritu/HQ/RWDOE@CRWMS, Stephen
Woodberry/HQ/RWDOE@CRWMS
Subject: TAD issues....
LSN: Not Relevant - Not Privileged
User Filed as: Excl/Procedures-21-10-a/QA:N/A

6. Manager of Reviewing Organization (Print Name): Paul Harrington			7. Org./Discipline: RW-05
3.	General	Footnotes in the Specification (e.g., Section 3.1.6 and Attachment A) refer to certain references that are needed by the specification user (e.g. BSC 2004, Section 6.3.1; BSC 2006, Section 3.1; YMP 2003, Appendix B; BSC 2002 Figure 1, BSC 2004, Figure 1, etc.) Provide document identifiers for these references in the specification.	Comment can be incorporate if document identifiers are provided. **The documents referenced in the footnotes are there for transparency and traceability. They are not needed by the potential vendors to understand and meet the specification requirements.**
11.	2.4, page 6	Add "ANSI/ANS-57.9-1992, *Design Criteria for an Independent Spent Fuel Storage Installation (dry type)*. La Grange Park, Illinois: American Nuclear Society." This is a design criteria source for NUREG-1536.	Comment incorporated. TIC Number needed. **The TIC Number for ANSI/ANS 57.9-1992 is 3043.**

6. Manager of Reviewing Organization (Print Name): Paul Harrington			7. Org./Discipline: RW-05
35.	3.2.7(3), page 19	Change this requirement to: "The transportation overpack shall have two (2) upper and two (2) lower trunnions. The centerline of the upper (lifting) trunnions shall be located between 8 inches and 24 inches from the top of the overpack. The centerline of the lower (rotation) trunnions shall be located less than 36 in. from the bottom of the overpack." This change is expected to result in lower worker dose to install lifting trunnions at the repository.	OLM recommends the dimensional specification for the trunnions be deleted since the size design and size of the shield plug will change from vendor and the dimensions may not minimize exposure. OLM recommends the upper trunnion location be specified as outside of the area of the spent fuel and in an area of the shield plug that provides maximum ALARA benefits. The location of the lower trunnions should be outside of the spent fuel and in an area providing maximum ALARA benefits. If the dimensional specifications are critical to the repository for other reasons OLM has no objection to this comment. **Recommend adding the OLM proposed wording to the requirement as follows:** ***The transportation overpack shall have two (2) upper and two (2) lower trunnions. The centerline of the upper (lifting) trunnions shall be located between 8 inches and 24 inches from the top of the overpack such that the upper trunnion location is outside of the area of the spent fuel and in an area of the shield plug that provides maximum ALARA benefits. The centerline of the lower (rotation) trunnions shall be located less than 36 inches from the bottom of the overpack such that the location of the lower trunnions is outside of the area of the spent fuel and in an area providing maximum ALARA benefits.***

6. Manager of Reviewing Organization (Print Name): Paul Harrington			7. Org./Discipline: RW-05
49.	3.3.2(8) NEW	Add the following: "Aging overpacks containing a loaded TAD canister shall be required to remain upright during and after the 10,000-year design basis seismic event without the use of hold down devices between the aging overpack and the aging pads."	**Now proposed as 3.3.2(1)c "Following a seismic event characterized by peak ground vertical and horizontal accelerations of 3 g, a TAD canister in an aging overpack shall be demonstrated to maintain a maximum leakage rate of 1.5×10^{-12} fraction of canister free volume per second, without the need to meet code requirements. The aging overpack shall remain upright on an aging pad (i.e., no tip-over) without the use of hold down devices between the aging overpacks and the aging pads."**
53.	Attachment C	Change "Lifting Ring" to "TAD Lifting Feature"	Attachment C cover sheet changed. Modification of drawing required by drafting. **The change to the Appendix cover sheet was suggested to make the name on the cover sheet match the name (lifting feature) on the drawing. No change to the drawing is required.**

6. Manager of Reviewing Organization (Print Name): Gary Lanthrum		7. Org./Discipline: RW-10	
7.	3.2.7(8)	Change to read: "The TAD transportation skid shall have the following characteristics: a. Provide for cask-to-skid securement that secures the cask during normal conditions of transportation in accordance with the requirements of 10 CFR part 71.45. b. Skid-to-railcar securement system shall meet requirements of AAR Interchange Rule 88, A.16.c.3. (AAR Field Manual 2006). c. Design shall facilitate lifting of the loaded package in its transportation configuration, including the skid and impact limiters, and transfer of the package from one conveyance to another. d. The footprint of the transportation skid shall not exceed 124 inches wide by 360 inches long. e. Vendor skid design shall be compatible with all variations of their TAD transportation overpack designs (i.e., PWR and BWR variants). f. The transportation skid shall be designed to permit the transportation overpack, without impact limiters, to be upended by rotation about its lower trunnions and removed in a vertical orientation via overhead crane having a maximum hook lift height of 42 feet above the rail." (BSC)	Characteristic (a) incorporated with editorial modification. Characteristic (b) incorporated with editorial modification Characteristic (e) changes not incorporated. E.g., is appropriate because there may be several variations of the PWR TAD canister-based system. Characteristic (f) changes not incorporated due to redundancy with 3.2.7(4). Added height limitation to 3.2.7(6). New requirement reads: The maximum hook lift height for the upended transportation overpack on the transportation skid is 42 feet above the rail. **NOTE: Is the height limit above the rail, rail bed or railcar? If it is above the railcar, there are no issues – if it is anything else, vendors will need more details – height of railcar, rail description, etc.** **Change 3.2.7(8)f to "The transportation skid shall be designed to permit the transportation overpack, without impact limiters, to be upended by rotation about its lower trunnions and removed in a vertical orientation via overhead crane. The skid shall be designed such that the bottom of the Transportation Overpack (in the vertical orientation) shall not be required to be lifted more than 12'-3" above grade elevation (top of rail). The conveyance deck height will not be greater than 54" above the rail."**

6. Manager of Reviewing Organization (Print Name): Christopher Kouts			7. Org./Discipline: RW-09
18.	Table 3.1-4	The water chemistry specifications for the borated pool appear to be inconsistent or incomplete. The large swing in pH for the borated water chemistry cannot be achieved with boric acid alone. Other agents used to control water chemistry should be identified. Also, the conductivity appears to be low for a system with multiple dissolved species. The listed values should be confirmed.	**The water chemistry ranges have been confirmed.**
19.	3.1.8(3)b.	Delete this item. It's adequately covered by item c., which it refers to.	**No Comment.**
34.	Attachment C Drawing	Note 6 should be revised to read: "The lifting feature may be integral (as shown) or mechanically attached to the TAD Canister lid per the designer concept. For TAD Canisters loaded at reactors, the fixture must be attached to the lid prior to delivery to the repository. For canisters loaded at the repository, the fixture must be attached to the lid prior to its delivery to the WHF."	Modification of drawing required by drafting. **Do not modify the drawing.** **The current Note 6 "The lifting feature may be integral (as shown) or mechanically attached to the TAD Canister lid (per TAD designer concept) and must be in place upon arrival at the repository." is sufficient for the vendors.**

Also there are these:

6. Manager of Reviewing Organization (Print Name): Larry Newman			7. Org./Discipline: RW-03
8. CODE	9. SECT./PARA.	10. COMMENT/SUGGESTED RESOLUTION	11. RESPONSE
9.	Matrix – general	Suggest adding the revisions of parent documents	Revision numbers excluded to keep documents compliant – i.e., no formal review needed due to change in document revision that does not affect TAD.

6. Manager of Reviewing Organization (Print Name): Larry Newman		7. Org./Discipline: RW-03	
8. CODE	9. SECT./PARA.	10. COMMENT/SUGGESTED RESOLUTION	11. RESPONSE
11.	Matrix 3.1.2 (1)	The document Determination of Leakage Rate Requirements for Transportation, Aging and Disposal (TAD) Canisters and Transportation and Aging Casks is not available directly from the CDIS, but the entry seems to indicate that the document was not developed under the QARD. While this might not be a concern for the matrix itself, the document is also referenced in the RAS with no discussion of why the document is suitable for use as input.	**The subject document was developed in accordance with applicable procedures as a QA:N/A document. The document is in CDIS as 000-30R-WHS0-00600-000-000. The matrix should be updated.**
12.	Matrix 3.1.5	Rev. 0 of the document Criticality input to Canister Based System Performance Specification for Disposal. Has been superseded. This also impacts the RAS.	**The document revision changed the neutron absorber material to borated stainless steel, which is reflected in the current TAD specification. The matrix should be updated.**
13.	Matrix 3.1.7	The document ALARA MANAGEMENT COMMITMENT AND POLICY is listed in the CDIS as being superseded	**The document has been superseded by RP-POL-01, Revision 000. The matrix should be updated.**
14.	Matrix 3.2.4 and other entries	The IICD volume II is a draft document – see comment 6	**The matrix should be updated to reflect that the requirements associated with the IICD volume II draft document need to be validated once the IICD volume II is issued.**

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Sent by: Patricia Freeman

To: Markus Popa/HQ/RWDOE@CRWMS, Kurt Espiritu/HQ/RWDOE@CRWMS
cc:
Subject: TAD spec comments (Document link: Markus Popa)
LSN: Not Relevant - Not Privileged
User Filed as: Excl/AdminMgmt-14-4/QA:N/A

Gentlemen,

Per Dave Zabransky's request.

Rick

Mark Wisenburg
05/24/2007 05:02 PM

To: Richard Profant/MV/RWDOE@CRWMS, David Siefken/MV/RWDOE@CRWMS, Marshall Weaver/YM/RWDOE@CRWMS
cc: Richard Kacich/YM/RWDOE@CRWMS
Subject: Fw: TAD spec comments
LSN: Not Relevant - Not Privileged
User Filed as: Excl/AdminMgmt-14-4/QA:N/A

See the string of e-mail below regarding the TAD spec comments delivered to the Chief Engineer this afternoon.
---- Forwarded by Mark Wisenburg/YM/RWDOE on 05/24/2007 05:03 PM ----

Kirk Lachman
05/24/2007 04:56 PM
To: Christopher Kouts/HQ/RWDOE@CRWMS, Dave Zabransky/HQ/RWDOE@CRWMS
cc: paul_harrington@ymp.gov, Christopher White/YD/RWDOE, barbara_rusinko@ymp.gov, Mark_Wisenburg@ymp.gov, Bill Spezialetti/YD/RWDOE@CRWMS
Subject: Fw: TAD spec comments
LSN: Not Relevant - Not Privileged
User Filed as: Excl/AdminMgmt-14-4/QA:N/A

Chris/Dave,

I forgot to include the thickness of the canister transfer machine walls in the comments. The walls are 12 inches thick. This would apply to this comment (multiple occurrences): TAD canister suspended by a crane, swinging and striking inside an ASTM A-36 cylindrical steel cavity with an inner diameter equal to 72.5 inches with a wall thickness of 12 inches.

Sorry for the omission.

Kirk
----Forwarded by Kirk Lachman/YD/RWDOE on 05/24/2007 04:51 PM ----

To: Christopher Kouts/HQ/RWDOE@CRWMS, Dave Zabransky/HQ/RWDOE@CRWMS
cc: paul_harrington@ymp.gov, Christopher White/YD/RWDOE, barbara_rusinko@ymp.gov, Mark_Wisenburg@ymp.gov, Bill Spezialetti/YD/RWDOE@CRWMS

Subject: TAD spec comments
LSN: Not Relevant - Not Privileged
User Filed as: Excl/AdminMgmt-14-4/QA:N/A

The attached files contain an explanation of the reasons behind the revised TAD specification sections, the revised sections, and the 3 g peak ground acceleration earthquake uniform hazard spectra.

Please note that 3 g peak ground acceleration earthquake, along with all the seismic information in the current Attachment A of the draft TAD specification, are preliminary and subject to change based on the ongoing seismic work.

Requirement Number	Original Requirement text	Disposition/Action	Proposed Wording
3.1.2 (1)	"The TAD canister shall be required to meet temperature and leak tight standards for 2,000-year and 10,000-year design basis seismic events. The seismic return vertical and horizontal accelerations are defined in Attachment A of this performance specification."	This requirement, which is an overview of the specific requirements 3.1.2 (1) a and 3.1.2 (1) b, is reworded to account for a new requirement (3.1.2 (1) c) mandating no tipover of the aging overpack and leak tightness of the TAD canister in an aging overpack after a 3 g peak ground acceleration earthquake.	"The TAD canister shall be required to meet temperature and leak tightness standards for 2,000-year and 10,000-year return period seismic events in accordance with the canister design code. In addition, the TAD canister shall be required to demonstrate the same leak tightness standard for the 3 g peak ground acceleration earthquake without the need to meet code requirements. The seismic vertical and horizontal accelerations are defined in Attachment A of this performance specification"
3.1.2 (1) a	"Following a 2,000-year seismic return period event, a TAD canister in an aging overpack shall maintain a maximum leakage rate of 1.5 x 10^{-12} fraction of canister free volume per second (normal) and maximum cladding temperature of 752□F (normal)."	Rewording to account for other configurations.	"Following a 2,000-year design-basis seismic event, a maximum leakage rate of 1.5 x 10^{-12} fraction of canister free volume per second (normal) and maximum cladding temperature of 752□F (normal) shall be maintained for the TAD canister in the following configurations: - TAD canister in an aging overpack. The aging overpack shall remain upright (i.e., no tip-over) without the use of hold down devices between the aging overpacks and the aging pads - TAD canister in a transportation overpack with impact limiters - TAD canister in a transportation overpack without impact limiters, constrained in an upright position - TAD canister suspended by a crane, swinging and striking inside an ASTM A-36 cylindrical steel cavity with an inner diameter equal to 72.5 inches."

Requirement Number	Original Requirement text	Disposition/Action	Proposed Wording
3.1.2 (1) b	"Following a 10,000-year seismic return period event, a TAD canister in an aging overpack shall maintain a maximum leakage rate of 1.5 x 10^{-12} fraction of canister free volume per second (normal) and cladding temperature limit of 1,058□F (off-normal) following a seismic event defined by the 10,000-year seismic return period."	Rewording to account for other configurations.	"Following a 10,000-year design-basis seismic event, a maximum leakage rate of 1.5 x 10^{-12} fraction of canister free volume per second (normal) and maximum cladding temperature of 1,058□F (off-normal) shall be maintained for the TAD canister in the following configurations: - TAD canister in an aging overpack. The aging overpack shall remain upright (i.e., no tip-over) without the use of hold down devices between the aging overpacks and the aging pads - TAD canister in a transportation overpack with impact limiters - TAD canister in a transportation overpack without impact limiters, constrained in an upright position - TAD canister suspended by a crane, swinging and striking inside an ASTM A-36 cylindrical steel cavity with an inner diameter equal to 72.5 inches."
3.1.2 (1) c		New requirement to account for 3 g peak ground acceleration seismic event, a credible earthquake (over 50 years of operation), whose severity could lead to events not considered in Requirements 3.1.2 (1) (a) and (b).	Following a seismic event characterized by peak ground vertical and horizontal accelerations of 3 g, a TAD canister shall be demonstrated to maintain a maximum leakage rate of 1.5 x 10^{-12} fraction of canister free volume per second, without the need to meet code requirements, in the following configurations: - TAD canister in an aging overpack. The aging overpack shall remain upright (i.e., no tip over) without the use of tie-downs. - TAD canister in a transportation cask with or without impact limiters, dropped onto an unyielding surface from a railcar, representing a 10-ft drop in the most damaging orientation. - TAD canister in a transportation cask without impact limiters, constrained in an upright position."

Requirement Number	Original Requirement text	Disposition/Action	Proposed Wording
3.1.2 (2) a	"A TAD canister in an aging overpack shall maintain a maximum leakage rate of 1.5×10^{-12} fraction of canister free volume per second (normal) and cladding temperature limits (see inset) during and following exposure to the environmental conditions listed below. These environmental conditions are not cumulative but occur independently: ..Outdoor average daily temperature range of 2° F to 116° F with insolation as specified in 10 CFR part 71 (normal) ..An extreme wind gust of 90 mph for 3-sec (normal) ..Maximum tornado wind speed of 189 mph with a corresponding pressure drop of 0.81 lb/in2 and a rate of pressure drop of 0.30 $lb/in^2/sec$ (off-normal). The spectrum of missiles from the maximum tornado is provided in Table 3.1-1 (off-normal):" Table 3.1-1 (Spectrum of Missiles) [not shown here] considers the following missiles: wood plank, 6" schedule 40 pipe, 1" steel rod, utility pole, 12" schedule 40 pipe, and automobile.	Reword the requirement in order to: * include 10 CFR 71 configuration * include higher extreme wind gust speed. * delete "automobile" as a missile from Table 3.1-1	Change "A TAD canister in an aging overpack shall maintain..." to "A TAD canister in an aging overpack or in a transportation overpack with impact limiters shall maintain..." Change "An extreme wind gust of 90 mph for 3-sec (normal)" to "An extreme wind gust of 120 mph for 3-sec (normal)" In Table 3.1-1, delete "automobile" from the list of potential missiles.

Requirement Number	Original Requirement text	Disposition/Action	Proposed Wording
3.1.3 (4)		New requirement to account for fire inside a facility.	"A TAD canister in a closed transportation cask with or without impact limiters or a TAD canister in an open transportation cask without impact limiters shall maintain a maximum leakage rate of 1.5×10^{-12} fraction of canister free volume per second after a fully-engulfing fire characterized by an average flame temperature of 1720^0F and lasting 30 minutes without the need to meet code requirements."
3.3.1 (3)	Original text includes Table 3.3-1, not shown here.	Change characteristics of aging overpack to accommodate "no tipover" requirement.	In Table 3.3-1, change: - maximum overpack diameter from 139 in to 144 in. - maximum overpack weight (loaded) from 200 tons to 250 tons
3.3.2 (1)	"The TAD canister in an aging overpack shall be required to meet temperature and leak tightness standards for 2,000-year and 10,000-year design basis seismic events. The seismic return vertical and horizontal accelerations are defined in Attachment A of this performance specification."	This requirement, which is an overview of the specific requirements 3.3.2 (1) a and 3.3.2 (1) b, is reworded to account for a new requirement (3.3.2.(1) c) mandating no tipover of the aging overpack and leak tightness of the TAD canister in an aging overpack after a 3 g peak ground acceleration earthquake.	"The TAD canister in an aging overpack shall be required to meet temperature and leak tightness standards for 2,000-year and 10,000-year return period seismic events in accordance with the canister design code. In addition, the TAD canister shall be required to demonstrate the same leak tightness standard for the 3 g peak ground acceleration earthquake without the need to meet code requirements. The seismic vertical and horizontal accelerations are defined in Attachment A of this performance specification"
3.3.2 (1) c		New requirement to accommodate no tipover of the aging overpack and no TAD leak after a 3 g peak ground acceleration earthquake.	"Following a seismic event characterized by peak ground vertical and horizontal accelerations of 3 g, a TAD canister in an aging overpack shall be demonstrated to maintain a maximum leakage rate of 1.5×10^{-12} fraction of canister free volume per second, without the need to meet code requirements. The aging overpack shall remain upright on an aging pad (i.e., no tip-over) without the use of hold down devices between the aging overpacks and the aging pads."

Requirement Number	Original Requirement text	Disposition/Action	Proposed Wording
3.3.2 (2) a	These environmental conditions are not cumulative but occur independently: ..Outdoor average daily temperature range of 2° F to 116° F with insolation as specified in 10 CFR part 71 (normal) ..An extreme wind gust of 90 mph for 3-sec (normal) ..Maximum tornado wind speed of 189 mph with a corresponding pressure drop of 0.81 lb/in2 and a rate of pressure drop of 0.30 $lb/in^2/sec$ (off-normal). The spectrum of missiles from the maximum tornado is provided in Table 3.3-2 (off-normal):" Table 3.3-2 (Spectrum of Missiles) [not shown here] considers the following missiles: wood plank, 6" schedule 40 pipe, 1" steel rod, utility pole, 12" schedule 40 pipe, and automobile.	Reword the requirement in order to: * include higher extreme wind gust speed. * delete "automobile" as a missile from Table 3.3-2	 Change "An extreme wind gust of 90 mph for 3-sec (normal)" to "An extreme wind gust of 120 mph for 3-sec (normal)" In Table 3.3-2, delete "automobile" from the list of potential missiles.
3.3.2 (5)	"The aging overpack shall retain the TAD canister following a drop and/or tip-over event."	Rewording to remove references to tipover	"The aging overpack shall retain the TAD canister following a drop event."
3.3.2 (6)	"The aging overpack top shall have four (4) lifting features, one in each quadrant, to permit up-righting following a tip over using temporary rigging and a portable crane. The lifting features shall be sized to allow any pair to be used to upright the overpack."	Rewording to remove references to tipover	"The aging overpack top shall have four (4) lifting features, one in each quadrant of the top of the aging overpack, to permit lifting of the loaded aging overpack using temporary rigging and a portable crane. The lifting features shall be sized to allow any pair to be used to lift the loaded aging overpack."

Requirement Number	Original Requirement text	Disposition/Action	Proposed Wording
3.3.2 (7)	"For purposes of analyzing tip-over and drop events, the aging pad shall be assumed to have the following characteristics:"	Reword for clarity	"For purposes of demonstrating no tip-over and compliance following a drop event, the aging pad shall be assumed to have the following characteristics:"
3.3.2 (7) d		New requirement to include coefficient of friction of aging overpack on aging pad	"A coefficient of friction associated with a light broom concrete finish."