**OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT**

**SYSTEM DESCRIPTION DOCUMENT VOLUME I COVER SHEET**

1. QA: QA

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7. Remarks:

The following TBD/TVB are contained in this document:

TBD-161; TBD-179; TBD-293; TBD-234; TBD-235; TBD-241; TBD-276; TBD-3755; TBD-3764

TVB-092; TVB-094; TVB-096; TVB-241; TVB-245; TVB-264; TVB-273; TVB-455; TVB-365

Revision 00 of this System Description Document consists of Volume I, only. Revision 00 of this document supersedes BBA00000-01717-1705-00002 REV 00. Volume II will be presented in a future revision.
<table>
<thead>
<tr>
<th>1. SDD Title</th>
<th>Defense High Level Waste Disposal Container System Description Document</th>
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<tr>
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This document is a complete revision of the superseded BBA000000-01717-1705-00002 REV 00. The document incorporates changes to the "Monitored Geologic Repository Requirements Document," including switching traceability to the "Revised Interim Guidance Pending Issuance of New U.S. Nuclear Regulatory Commission (NRC) Regulations (Revision 01, July 22, 1999), for Yucca Mountain, Nevada." This revision incorporates the "Classification of the MGR Defense High Level Waste Disposal Container System." This revision incorporates the revision to the "MGR Compliance Program Guidance Package for the Defense High-Level Waste (DHLW) Disposal Container." Changes have been included for the system to comply with management direction put into effect via the "Monitored Geologic Repository Project Description Document."
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SUMMARY

The Defense High Level Waste Disposal Container System supports the confinement and isolation of waste within the Engineered Barrier System of the Monitored Geologic Repository (MGR). Disposal containers are loaded and sealed in the surface waste handling facilities, transferred to the underground through the accesses using a rail mounted transporter, and emplaced in emplacement drifts. The defense high level waste (HLW) disposal container provides long-term confinement of the commercial HLW and defense HLW (including immobilized plutonium waste forms [IPWF]) placed within disposable canisters, and withstands the loading, transfer, emplacement, and retrieval loads and environments. U.S. Department of Energy (DOE)-owned spent nuclear fuel (SNF) in disposable canisters may also be placed in a defense HLW disposal container along with commercial HLW waste forms, which is known as "co-disposal."

The Defense High Level Waste Disposal Container System provides containment of waste for a designated period of time, and limits radionuclide release. The disposal container/waste package maintains the waste in a designated configuration, withstands maximum handling and rockfall loads, limits the individual canister temperatures after emplacement, resists corrosion in the expected handling and repository environments, and provides containment of waste in the event of an accident.

Defense HLW disposal containers for HLW disposal will hold up to five HLW canisters. Defense HLW disposal containers for co-disposal will hold up to five HLW canisters arranged in a ring and one DOE SNF canister inserted in the center and/or one or more DOE SNF canisters displacing a HLW canister in the ring. The disposal container will include outer and inner cylinders, outer and inner cylinder lids, and may include a canister guide. An exterior label will provide a means by which to identify the disposal container and its contents.

Different materials will be selected for the disposal container inner and outer cylinders. The two metal cylinders, in combination with the Emplacement Drift System, drip shield, and natural barrier, will support the design philosophy of defense-in-depth. The use of materials with different properties prevents a single mode failure from breaching the waste package. The inner cylinder and inner cylinder lids will be constructed of stainless steel and the outer cylinder and outer cylinder lids will be a barrier made of high-nickel alloy.

The defense HLW disposal container interfaces with the emplacement drift environment and the internal waste by transferring heat from the canisters to the external environment and by protecting the canisters and their contents from damage/degradation by the external environment. The disposal container also interfaces with the canisters by limiting access of moderator and oxidizing agents to the waste. A loaded and sealed disposal container (waste package) interfaces with the Emplacement Drift System’s emplacement drift waste package supports upon which the waste packages are placed. The disposal container interfaces with the Canister Transfer System, Waste Emplacement/Retrieval System, Disposal Container Handling System, and Waste Package Remediation System during loading, handling, transfer, emplacement, and retrieval of the disposal container/waste package.
QUALITY ASSURANCE

The quality assurance program applies to the development of this document. The "SDD Development/Maintenance (Q SDDs) (WP# 16012126M5)" activity evaluation has determined the development of this document to be subject to DOE/RW-0333P, "Quality Assurance Requirements and Description" requirements. This document was developed in accordance with AP-3.11Q, "Technical Reports."
1. FUNCTIONS AND DESIGN CRITERIA

The functions and design criteria for the Defense High Level Waste Disposal Container System are identified in the following sections. Throughout this document the term “disposal container” is used to indicate the Defense High Level Waste Disposal Container System. The system architecture and classification are provided in Appendix B.

The term “disposal container” means the container cylinders and any integral structures (spacers, lifting features, absorbent materials, etc.). The term “waste package” means a disposal container that is loaded with a waste form, sealed by the designed methods, and is tested and accepted.

To address the term “breach” in a quantified manner, threshold limits for failure per American Society of Mechanical Engineers (ASME) code are to be used. Throughout this document when the term “breach” is referred to in a function or criterion, the following apply: During normal handling operations, breach has occurred, analytically, when Subsection NB 3200 limits of stress intensity for the stress categories are exceeded. For accident (design basis event) conditions, breach has occurred, analytically, when 0.9 of the ultimate tensile strength is exceeded.

1.1 SYSTEM FUNCTIONS

1.1.1 The disposal container/waste package contains canistered HLW and canistered DOE SNF within its boundary until it is breached.

1.1.2 The waste package restricts the transport of radionuclides to the outside of the waste package boundary after it is breached.

1.1.3 The disposal container/waste package provides criticality control during loading and after it is loaded with waste.

1.1.4 The waste package accommodates the thermal loading strategy for the repository.

1.1.5 The disposal container/waste package provides identification of individual disposal containers and their contents.

1.1.6 The disposal container/waste package provides safety for personnel, equipment, and the environment.

1.1.7 The disposal container/waste package prevents adverse reactions involving the waste form.

1.1.8 The disposal container/waste package withstands loading, handling, sealing, transfer, emplacement, and retrieval loads.

1.1.9 The waste package withstands the emplacement drift environment for the period of interest.

1.1.10 The disposal container/waste package provides conditions needed to maintain the physical and chemical stability of the waste form.
1.1.11 The waste package minimizes mobilization of radionuclides.

1.1.12 The waste package allows heat transfer between the waste form canister and the environment external to the waste package.

1.1.13 The disposal container/waste package accommodates handling, sealing, loading, emplacement, and retrieval operations.

1.1.14 The disposal container/waste package outer surface facilitates decontamination.

1.2 SYSTEM DESIGN CRITERIA

This section presents the design criteria for the system. Each criterion in this section has a corresponding Criterion Basis Statement in Appendix A of Volume I that describes the need for the criterion as well as a basis for the performance parameters imposed by the criterion. Each criterion in this section also contains bracketed traces indicating traceability, as applicable, to the functions (F) in Section 1.1, the “Monitored Geologic Repository Requirements Document” (MGR RD) (as modified by input transmittal “Preliminary Draft Requirements from the Monitored Geologic Repository Requirements Document” [TBV-3855]), and “Revised Interim Guidance Pending Issuance of New U.S. Nuclear Regulatory Commission (NRC) Regulations (Revision 01, July 22, 1999), for Yucca Mountain, Nevada.” In anticipation of the interim guidance being promulgated as a Code of Federal Regulations, it will be referred to as “10 CFR 63” in this system description document. For the applicable version of the codes, standards, and regulatory documents imposed on the design of this system, refer to Appendix E.

1.2.1 System Performance Criteria

1.2.1.1 The disposal container shall accommodate the HLW canisters identified in Table I-1. Table I-1 also identifies nominal parameters (size, weight, and materials) that may be used in design (TBV-264). (TBV-455 is also placed on this criterion because that TBV is placed on the reference document, in accordance with Deficiency Report VAMO-98-D-132.)
Table I-1. HLW Canisters

<table>
<thead>
<tr>
<th>Canister Producer</th>
<th>Nominal Outside Diameter</th>
<th>Nominal Overall Height</th>
<th>Individual Canister Weight</th>
<th>Canister Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hanford Site (Short)*</td>
<td>61 cm (24 in.) (TBV-264)</td>
<td>300 cm (118 in.) (TBV-264)</td>
<td>2,150 kg (4,740 lb) (TBV-264)</td>
<td>304L Stainless Steel (TBV-264)</td>
</tr>
<tr>
<td>Hanford Site (Long)**</td>
<td>61 cm (24 in.) (TBV-264)</td>
<td>457.2 cm (180 in.) (TBV-264)</td>
<td>4,200 kg (9,259 lb) (TBV-264)</td>
<td>304L Stainless Steel (TBV-264)</td>
</tr>
<tr>
<td>Idaho National Engineering and Environmental Laboratory</td>
<td>61 cm (24 in.) (TBV-264)</td>
<td>300 cm (118 in.) (TBV-264)</td>
<td>2,325 kg (5,126 lb) (TBV-264)</td>
<td>304L Stainless Steel (TBV-264)</td>
</tr>
<tr>
<td>Savannah River Site**</td>
<td>61 cm (24 in.) (TBV-264)</td>
<td>300 cm (118 in.) (TBV-264)</td>
<td>2,162 kg (4,810 lb) (TBV-264)</td>
<td>304L Stainless Steel (TBV-264)</td>
</tr>
<tr>
<td>West Valley Demonstration Project</td>
<td>61 cm (24 in.) (TBV-264)</td>
<td>300 cm (118 in.) (TBV-264)</td>
<td>2,152 kg (4,744 lb) (TBV-264)</td>
<td>304L Stainless Steel (TBV-264)</td>
</tr>
</tbody>
</table>

* There is no clear indication from Hanford on which canister will actually be produced.
** 17 MT of IPWF is included in Savannah River Site canisters.

Note: For definition of acronyms, symbols and units, see Appendix C.

[F 1.1.1][MGR RD 3.2.A]

1.2.1.2 The disposal container shall accommodate DOE SNF identified in Table I-2. (TBD-161) The DOE SNF will arrive at the MGR in disposable canisters of the sizes and weights identified in Table I-3.

Table I-2. DOE SNF Waste Forms

<table>
<thead>
<tr>
<th>Waste Form</th>
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</thead>
<tbody>
<tr>
<td>Aluminum-Clad DOE-Owned Spent Fuel</td>
</tr>
<tr>
<td>MOX (FFTF) DOE-Owned Fuel (TBD-161)</td>
</tr>
</tbody>
</table>

Table I-3. DOE SNF Canisters

<table>
<thead>
<tr>
<th>Canister Type</th>
<th>Nominal Diameter</th>
<th>Maximum Length</th>
<th>Maximum Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSNFP 18 in. x 10 ft</td>
<td>457 mm (18 in.)</td>
<td>3,000 mm (118.11 in.)</td>
<td>2,270 kg (5,005 lb)</td>
</tr>
<tr>
<td>NSNFP 18 in. x 15 ft</td>
<td>457 mm (18 in.)</td>
<td>4,570 mm (179.92 in.)</td>
<td>2,721 kg (6,000 lb)</td>
</tr>
<tr>
<td>NSNFP 24 in. x 10 ft</td>
<td>610 mm (24 in.)</td>
<td>3,000 mm (118.11 in.)</td>
<td>4,080 kg (8,996 lb)</td>
</tr>
<tr>
<td>NSNFP 24 in. x 15 ft</td>
<td>610 mm (24 in.)</td>
<td>4,570 mm (179.92 in.)</td>
<td>4,535 kg (10,000 lb)</td>
</tr>
<tr>
<td>4-MCO 24 in. x 12 ft</td>
<td>610 mm (24 in.)</td>
<td>3,780 mm (148.10 in.)</td>
<td>8,910 kg (19,642 lb)</td>
</tr>
</tbody>
</table>

Note: For definition of acronyms, symbols and units, see Appendix C.

[F 1.1.1][MGR RD 3.2.B]
1.2.1.3 The disposal container/waste package shall be designed, in conjunction with the Emplacement Drift System and the natural barrier, such that the expected annual dose to the average member of the critical group shall not exceed 25 mrem total effective dose equivalent at any time during the first 10,000 years after permanent closure, as a result of radioactive materials released from the geologic repository.

[F 1.1.1, 1.1.9][MGR RD 3.1.C][10 CFR 63.113(b)]

1.2.1.4 The disposal container shall consist of two cylinders; an inner cylinder that is stainless steel (alloy 316) with a nominal thickness of 5 cm, and an outer cylinder that is alloy 22 material with a nominal thickness of 2 cm.

[F 1.1.1, 1.1.2][MGR RD 3.1.C][10 CFR 63.113(a)]

1.2.1.5 The waste package shall be designed to achieve a reliability of (TBD-3755) percent during the first 10,000 years after emplacement in an emplacement drift.

[F 1.1.1][MGR RD 3.1.C][10 CFR 63.113(b), 63.114(d), 63.114(e)]

1.2.1.6 The waste package shall maintain the temperature of HLW glass below 400 degrees C (752 degrees F) (TBV-092) under normal conditions, and below 460 degrees C (860 degrees F) (TBV-245) for short-term exposure to fire, as specified by Criterion 1.2.2.1.11.

[F 1.1.10, 1.1.11, 1.1.12][MGR RD 3.1.C][10 CFR 63.111(a)(2), 63.111(b)(2), 63.111(e)(8), 63.113(b)]

1.2.1.7 The waste package shall maintain zircaloy cladding of DOE SNF to less than 350 degrees C (662 degrees F) (TBV-241) under normal conditions, and below 570 degrees C (1,058 degrees F) (TBV-245) for short-term exposure to fire, as specified by Criterion 1.2.2.1.11. The temperature of other types of DOE fuel cladding shall be limited to (TBD-179).

[F 1.1.10, 1.1.11, 1.1.12][MGR RD 3.1.C][10 CFR 63.111(a)(2), 63.111(b)(2), 63.112(e)(8), 63.113(b)]

1.2.1.8 The disposal container/waste package shall prevent the breach of the waste form canister during normal handling operations.

[F 1.1.10][MGR RD 3.1.C][10 CFR 63.111(a)(2), 63.113(b)]

1.2.1.9 The disposal container/waste package shall be designed to support/allow retrieval up to 300 years after the start of emplacement operations.

[F 1.1.8, 1.1.13][MGR RD 3.1.C, 3.2.H][10 CFR 63.111(e)(1)]
1.2.1.10 Combined concentrations of \( \text{O}_2 \), \( \text{H}_2 \), \( \text{H}_2\text{O} \), \( \text{CO}_2 \), and \( \text{CO} \) within a waste package shall not exceed 0.25 percent of internal volume (TBV-094) prior to waste package breach.

[F 1.1.7, 1.1.10, 1.1.11][MGR RD 3.1.C][10 CFR 63.111(e)(1), 63.113(b)]

1.2.1.11 The disposal container/waste package, excluding the labels, shall have an external surface finish Roughness Average of 250 μm (6.36 μm) or less.

[F 1.1.14][MGR RD 3.1.C][10 CFR 63.112(e)(2)]

1.2.1.12 The disposal container/waste package shall have all external surfaces (surfaces exposed to the external environment after closing and sealing a disposal container) accessible for visual inspection and decontamination (e.g., no blind holes).

[F 1.1.14][MGR RD 3.1.C][10 CFR 63.112(e)(2)]

1.2.1.13 The disposal container/waste package shall have a label (or other means of identification) with a unique waste package identifier.

[F 1.1.5][MGR RD 3.1.B, 3.1.C, 3.3.K][10 CFR 63.112(e)(2), 63.78]

1.2.1.14 All labels (or other means of identification) applied to the waste package shall not impair the integrity of the waste package.

[F 1.1.1, 1.1.5][MGR RD 3.1.C][10 CFR 63.113(b)]

1.2.1.15 All information contained on all labels (or other means of identification) applied to the disposal container shall be legible or read by remote means until permanent closure of the repository.

[F 1.1.5][MGR RD 3.1.C, 3.1.D, 3.3.K][10 CFR 63.112(e)(2), 63.78]

1.2.1.16 Lifting features of the disposal container/waste package shall be designed for three times the maximum weight of the loaded and sealed disposal container without generating a combined shear stress or maximum tensile stress in excess of the corresponding minimum tensile yield strength of the materials of construction.

[F 1.1.8, 1.1.13][MGR RD 3.1.C, 3.1.G][10 CFR 63.111(a)(2), 63.111(b)(2), 63.112(e)(2), 63.112(e)(8)]
1.2.1.17 Lifting features of the disposal container/waste package shall be designed for five times the weight of the loaded disposal container without exceeding the ultimate tensile strength of the materials.

[F 1.1.8, 1.1.13][MGR RD 3.1.C, 3.1.G][10 CFR 63.111(a)(2), 63.111(b)(2), 63.112(e)(2), 63.112(e)(8)]

1.2.1.18 The waste package shall be designed to withstand transfer, emplacement, and retrieval operations without breaching.

[F 1.1.8, 1.1.13][MGR RD 3.1.C][10 CFR 63.111(a)(2), 63.111(b)(2), 63.112(e)(8)]

1.2.1.19 The disposal container/waste package shall be constructed of non-combustible and heat resistant materials only.

[F 1.1.7, 1.1.10][MGR RD 3.1.C][10 CFR 63.111(a)(2), 63.111(b)(2), 63.112(e)(8)]

1.2.1.20 Disposal container/waste package materials shall exclude the use of explosive or pyrophoric materials.

[F 1.1.2, 1.1.11][MGR RD 3.1.C][10 CFR 63.111(a)(2), 63.111(b)(2), 63.112(e)(8)]

1.2.1.21 Disposal container/waste package materials shall exclude the use of free liquids.

[F 1.1.7, 1.1.10]

1.2.2 Safety Criteria

1.2.2.1 Nuclear Safety Criteria

1.2.2.1.1 During the preclosure period, the waste package shall be designed to withstand (while in a horizontal orientation) a 13 MT (28,665 lb) (TBV-245) rock (spherical geometry assumed) falling 3.1 m (10.2 ft) (TBV-245) onto the side of the waste package without breaching. (TBV-245)

[F 1.1.1, 1.1.2, 1.1.6][MGR RD 3.1.C, 3.1.G][10 CFR 63.111(a)(2), 63.111(b)(2), 63.112(e)(8)]
1.2.2.1.2 During the preclosure period, the disposal container/waste package shall be designed to withstand (while in a vertical orientation) a 2.3 MT (5,100 lb) (TBV-245) spherical object falling 2 m (6.6 ft) (TBV-245) onto the end of the disposal container without breaching. (TBV-245)

[F 1.1.1, 1.1.2, 1.1.6][MGR RD 3.1.C, 3.1.G][10 CFR 63.111(a)(2), 63.111(b)(2), 63.112(e)(8)]

1.2.2.1.3 During the preclosure period, the disposal container/waste package, shall be designed to withstand (while in a vertical orientation) a drop from a height of 2 m (6.6 ft) (TBV-245) onto a flat, unyielding surface without breaching. (TBV-245)

[F 1.1.1, 1.1.2, 1.1.6][MGR RD 3.1.C, 3.1.G][10 CFR 63.111(a)(2), 63.111(b)(2), 63.112(e)(8)]

1.2.2.1.4 During the preclosure period, the disposal container/waste package, shall be designed to withstand (while in a horizontal orientation) a drop from a height of 2.4 m (7.9 ft) (TBV-245) onto a flat, unyielding surface without breaching. (TBV-245)

[F 1.1.1, 1.1.2, 1.1.6][MGR RD 3.1.C, 3.1.G][10 CFR 63.111(a)(2), 63.111(b)(2), 63.112(e)(8)]

1.2.2.1.5 During the preclosure period, the waste package shall be designed to withstand (while in a horizontal orientation) the greater stress resulting from a drop of 1.9 m (6.2 ft) (TBV-245) onto a steel support in an emplacement drift, or a drop of 2.4 m (7.9 ft) (TBV-245) onto a concrete pier, without breaching by puncture. (TBV-245)

[F 1.1.1, 1.1.2, 1.1.6][MGR RD 3.1.C, 3.1.G][10 CFR 63.111(a)(2), 63.111(b)(2), 63.112(e)(8)]

1.2.2.1.6 During the preclosure period, the waste package shall be designed to withstand a tip over from a vertical position with slap down onto a flat, unyielding surface without breaching. (TBV-245)

[F 1.1.1, 1.1.2, 1.1.6][MGR RD 3.1.C, 3.1.G][10 CFR 63.111(a)(2), 63.111(b)(2), 63.112(e)(8)]

1.2.2.1.7 The waste package shall be designed to withstand a Design Basis Earthquake of Frequency Category 2. Both vibratory ground motion and fault displacement of the Frequency Category 2 Design Basis Earthquake must be considered, taking credit as appropriate for interfacing systems that alter or mitigate the effect of the design basis earthquake on the waste package. The surface environment floor response spectra for the system are (TBD-241). The subsurface parameters of the
design basis earthquake are defined in Tables I-4 through I-7. (TBD-241, TBV-273)

Table I-4. Parameters for the Vibratory Ground Motion Design Basis Earthquake–Subsurface Environment–Repository Interface (Underground) Design Spectral Accelerations for Design Earthquake Scaled to 5–10 Hz Frequency Range

<table>
<thead>
<tr>
<th>Response Frequency (Hz)</th>
<th>Horizontal Motion</th>
<th>Vertical Motion</th>
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<tbody>
<tr>
<td></td>
<td>Frequency Category 2 (10,000 Year Recurrence)</td>
<td>Frequency Category 2 (10,000 Year Recurrence)</td>
</tr>
<tr>
<td>0.3</td>
<td>0.0720 g (TBV)</td>
<td>0.0378 g (TBV)</td>
</tr>
<tr>
<td>0.6</td>
<td>0.126 g (TBV)</td>
<td>0.0688 g (TBV)</td>
</tr>
<tr>
<td>1.0</td>
<td>0.206 g (TBV)</td>
<td>0.139 g (TBV)</td>
</tr>
<tr>
<td>2.0</td>
<td>0.483 g (TBV)</td>
<td>0.180 g (TBV)</td>
</tr>
<tr>
<td>5.0</td>
<td>0.747 g (TBV)</td>
<td>0.435 g (TBV)</td>
</tr>
<tr>
<td>10</td>
<td>0.765 g (TBV)</td>
<td>0.620 g (TBV)</td>
</tr>
<tr>
<td>20</td>
<td>0.681 g (TBV)</td>
<td>0.613 g (TBV)</td>
</tr>
<tr>
<td>100</td>
<td>0.391 g (TBV)</td>
<td>0.288 g (TBV)</td>
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Table I-5. Parameters for the Vibratory Ground Motion Design Basis Earthquake–Subsurface Environment–Repository Interface (Underground) Design Spectral Accelerations for Design Earthquake Scaled to 1–2 Hz Frequency Range

<table>
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<tr>
<th>Response Frequency (Hz)</th>
<th>Horizontal Motion</th>
<th>Vertical Motion</th>
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<tr>
<td></td>
<td>Frequency Category 2 (10,000 Year Recurrence)</td>
<td>Frequency Category 2 (10,000 Year Recurrence)</td>
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<tr>
<td>0.3</td>
<td>0.186 a (TBV)</td>
<td>0.101 g (TBV)</td>
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<tr>
<td>0.6</td>
<td>0.252 g (TBV)</td>
<td>0.149 g (TBV)</td>
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<tr>
<td>1.0</td>
<td>0.286 g (TBV)</td>
<td>0.206 g (TBV)</td>
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<td>2.0</td>
<td>0.486 g (TBV)</td>
<td>0.212 g (TBV)</td>
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<td>5.0</td>
<td>0.471 g (TBV)</td>
<td>0.309 g (TBV)</td>
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<td>10</td>
<td>0.374 g (TBV)</td>
<td>0.265 g (TBV)</td>
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<td>0.302 g (TBV)</td>
<td>0.244 g (TBV)</td>
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<tr>
<td>100</td>
<td>0.231 g (TBV)</td>
<td>0.156 g (TBV)</td>
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Table I-6. Parameters for the Vibratory Ground Motion Design Basis Earthquake–Subsurface Environment–Repository Interface (Underground) Design Peak Velocity (cm/sec) for Design Earthquake Scaled to 5–10 Hz and 1–2 Hz Frequency Ranges

<table>
<thead>
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<th>Design Earthquake Frequency (Hz)</th>
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<td>Frequency Category 2 (10,000 Year Recurrence)</td>
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<td>5–10</td>
<td>33.65 (TBV)</td>
<td>17.10 (TBV)</td>
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<tr>
<td>1–2</td>
<td>41.64 (TBV)</td>
<td>22.38 (TBV)</td>
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Table I-7. Parameters for the Ground Displacement Design Basis Earthquake—Surface and Subsurface Environment

<table>
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<th>Ground Displacement Design Basis Earthquake</th>
<th>Fault Displacement</th>
<th>Comment</th>
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<td>Frequency Category 2 (100,000 Year Recurrence)</td>
<td>(TBD) cm</td>
<td>Less than 1 cm (TBV)</td>
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</tbody>
</table>

Note: For definition of acronyms, symbols and units, see Appendix C.

[F 1.1.1, 1.1.2, 1.1.6][MGR RD 3.1.C, 3.1.G][10 CFR 63.111(a)(2), 63.111(b)(2), 63.112(e)(8)]

1.2.2.1.8 During the preclosure period, the waste package shall be designed to withstand the impact of a 0.5 kg (1.1 lb) (TBV-245) missile (modeled as a 1 cm diameter, 5 cm long valve stem) travelling at 5.7 m per second (18.7 ft/sec) (TBV-245) without breaching. (TBV-245)

[F 1.1.1, 1.1.2, 1.1.6][MGR RD 3.1.C, 3.1.G][10 CFR 63.111(a)(2), 63.111(b)(2), 63.112(e)(8)]

1.2.2.1.9 During the preclosure period, the waste package shall be designed to withstand, without breaching, the maximum impact resulting from a transporter runaway, derailment, and impact at a speed of 63 km/hr (39 mi/hr) (TBV-245), taking credit, as appropriate, for interfacing systems that prevent or mitigate the impact on the waste package. (TBV-245)

[F 1.1.1, 1.1.2, 1.1.6][MGR RD 3.1.C, 3.1.G][10 CFR 63.111(a)(2), 63.111(b)(2), 63.112(e)(8)]

1.2.2.1.10 During the preclosure period, the waste package shall be designed to withstand a maximum internal pressure of (TBD-235) without breaching. (TBV-245)

[F 1.1.1, 1.1.2, 1.1.6][MGR RD 3.1.C, 3.1.G][10 CFR 63.111(a)(2), 63.111(b)(2), 63.112(e)(8)]

1.2.2.1.11 The waste package/disposal container shall be designed to withstand the hypothetical fire criteria defined in 10 CFR 71 ("Packaging and Transportation of Radioactive Materials"), Section 73(c)(4). (TBV-245)

[F 1.1.1, 1.1.2, 1.1.6][MGR RD 3.1.C, 3.1.G][10 CFR 63.111(a)(2), 63.111(b)(2), 63.112(e)(8)]
1.2.2.1.12 During the preclosure period, the disposal container/waste package shall be designed such that nuclear criticality shall not be possible unless at least two unlikely, independent, and concurrent or sequential changes have occurred in the conditions essential to nuclear criticality safety. The system must be designed for criticality safety assuming occurrence of design basis events, including those with the potential to flood (TBD-235) the disposal container prior to sealing. The calculated effective multiplication factor ($k_{eff}$) must be sufficiently below unity to show at least a 5 percent margin after allowance for the bias in the method of calculation and the uncertainty in the experiments used to validate the method of calculation. (TBV-245)

[F 1.1.3][MGR RD 3.1.C, 3.1.G][10 CFR 63.111(a)(2), 63.111(b)(2), 63.112(e)(6), 63.112(e)(8)]

1.2.2.1.13 During the postclosure period, criticality events due to fissionable material emplaced in the waste package shall not increase the total radionuclide inventory of the disposal container by more than 1 percent. The percentage radionuclide inventory increase for the waste package shall be measured by the sum of the products of probability of criticality occurrence (for a single DHLW disposal container, as a function of time), multiplied by the radionuclide inventory increment (measured in curies) due to that criticality, divided by the radionuclide inventory of a single DHLW disposal container, with the sum taken over time and any other parameters that characterize the occurrence of criticality. Both the radionuclide inventory and the increment due to criticality shall be evaluated at 1,000 years following the criticality shutdown. (TBV-096)

[F 1.1.3][MGR RD 3.1.C][10 CFR 63.113(b)]

1.2.2.2 Non-nuclear Safety Criteria

Non-nuclear safety criteria for this system will be identified in a later revision, as necessary.

1.2.3 System Environment Criteria

1.2.3.1 The waste package shall meet all performance requirements during and after exposure to the emplacement drift external environments identified in Table I-8 (TBD-234) and the induced/handling environments identified in Table I-9 (TBD-276).
Table 1-8. Emplacement Drift External Environment

<table>
<thead>
<tr>
<th>Environment</th>
<th>Range</th>
<th>Duration/Frequency of Occurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microbe Influx</td>
<td>0–10^14 microbes/yr/m of drift</td>
<td>10,000 yr</td>
</tr>
<tr>
<td>pH</td>
<td>8.2–10.2</td>
<td>10,000 yr</td>
</tr>
<tr>
<td>Colloid Concentration</td>
<td>8x10^4–6x10^6 ma/ml</td>
<td>10,000 yr</td>
</tr>
<tr>
<td>Temperature</td>
<td>TBD-234</td>
<td>TBD-234</td>
</tr>
<tr>
<td>Humidity</td>
<td>TBD-234</td>
<td>TBD-234</td>
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<td>Radiation</td>
<td>TBD-234</td>
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<tr>
<td>TBD-234</td>
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</table>

Table 1-9. Induced/Handling External Environment

<table>
<thead>
<tr>
<th>Environment</th>
<th>Range</th>
<th>Duration/Frequency of Occurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vibration</td>
<td>TBD-276</td>
<td>TBD-276</td>
</tr>
<tr>
<td>Shock</td>
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<td>Acceleration</td>
<td>TBD-276</td>
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</tr>
<tr>
<td>TBD-276</td>
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<td>TBD-276</td>
</tr>
</tbody>
</table>

Note: For definition of acronyms, symbols and units, see Appendix C.

1.2.4 System Interfacing Criteria

1.2.4.1 The system shall be designed in accordance with the interface agreements defined in “Interface Control Document for the Waste Packages/Disposal Containers and the Surface Repository Facilities and Systems for Mechanical, Envelope and Functional Interfaces.”

1.2.4.2 The system shall be designed in accordance with the interface agreements defined in “Interface Control Document for Waste Packages and the Mined Geologic Disposal System Repository Subsurface Facilities and Systems for Mechanical and Envelope Interfaces.”

1.2.4.3 Waste package design shall reduce the dose rate at all external surfaces of a waste package to (TBD-3764) rem/hr or less. This criterion identifies a disposal container interface with the Disposal Container Handling System, the Waste Emplacement/Retrieval System, and the Performance Confirmation Emplacement Drift Monitoring System.
1.2.4.4 The waste package shall be designed to have a maximum thermal output of 11.8 kW.

[F 1.1.4]

1.2.4.5 The quantity of waste forms disposed of in this suite of disposal containers shall total 640 MTU of commercial HLW, 4,027 MTU of defense HLW, and, in combination with DOE SNF disposal containers, not more than 2,437 MWU of DOE SNF. This criterion identifies the primary disposal container interface with the DOE Spent Nuclear Fuel Disposal Container System.

[F 1.1.1][MGR RD 3.1.A, 3.2.B]

1.2.4.6 The disposal container shall be designed to be loaded and sealed in a vertical orientation. This criterion identifies the primary disposal container interface with the Canister Transfer System and the Disposal Container Handling System.

[F 1.1.13]

1.2.4.7 The disposal container/waste package shall be designed to be handled in both horizontal and vertical orientations. This criterion identifies the primary disposal container interface with the Disposal Container Handling System, and Waste Emplacement/Retrieval System.

[F 1.1.13]

1.2.4.8 The disposal container/waste package shall be designed to support required welding times. This criterion identifies a primary disposal container interface with the Disposal Container Handling System.

[F 1.1.13]

1.2.5 Operational Criteria

Operational criteria for this system will be identified in a later revision, if necessary.

1.2.6 Codes and Standards Criteria

1.2.6.1 The disposal container shall be designed in accordance with applicable sections of "1995 ASME Boiler and Pressure Vessel Code" (Section III, Division 1, Subsection NG-1995).

[MGR RD 3.3.A]
1.2.6.2 The disposal container shall be designed in accordance with applicable sections of "1995 ASME Boiler and Pressure Vessel Code" (Section III, Division 1, Subsection NB-1995).

[MGR RD 3.3.A]

1.2.6.3 The disposal container shall be designed in accordance with applicable sections of "Nuclear Criticality Control of Special Actinide Elements" (ANSI/ANS-8.15-1981).

[MGR RD 3.3.A]

1.2.6.4 The disposal container shall be designed in accordance with applicable sections of "Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors" (ANSI/ANS-8.1-1998).

[MGR RD 3.3.A]

1.2.6.5 The disposal container shall be designed in accordance with applicable sections of "Criteria for Nuclear Safety Controls in Operations with Shielding and Confinement" (ANSI/ANS-8.10-1983).

[MGR RD 3.3.A]

1.2.6.6 The disposal container shall be designed in accordance with applicable sections of "Criticality Safety Criteria for the Handling, Storage, and Transportation of LWR Fuel Outside Reactors" (ANSI/ANS-8.17-1984).

[MGR RD 3.3.A]

1.3 SUBSYSTEM DESIGN CRITERIA

Subsystem design criteria for this system will be identified in a later revision, if necessary.
1.4 CONFORMANCE VERIFICATION

This section outlines the methods to be used to verify the conformance of the system with its design criteria.

1.4.1 The methods of conformance verification to be used are:

Analysis. Analysis is the process of accumulating results and conclusions intended to verify that a requirement has been satisfied. Analytical verification of compliance may include compilation and interpretation of results of tests, demonstrations, and examinations of lower-level components of the system. Analysis may also include logical arguments, modeling, calculations, tradeoff studies, reports (design and/or tradeoff), and other relevant information to verify compliance with a requirement, when physical testing of a system is impracticable.

Examination. Examination is the process of conducting careful observation and inspection, without use of special laboratory appliances and procedures, to verify compliance with specified requirements. Examination is a relatively direct method, involving, at most, simple physical manipulation or measurement. It is generally non-destructive and does not necessarily involve operation of the system being evaluated.

Demonstration. Demonstration is the qualitative process of displaying or operating a system or item in or near its operational environment to verify compliance with requirements. It differs from testing in that it is generally a qualitative and direct determination of the performance of a function and is performed without special instrumentation or other special equipment.

Test. Test is the quantitative process whereby data are collected, under controlled conditions, to document the performance of a product with respect to a standard. Manipulation and analysis of data derived from testing is an integral part of the method. Special instrumentation and scientific procedures are commonly employed. A test may be conducted in a laboratory or in the field (in situ).

1.4.2 Table I-10 correlates the criteria with the method to be used to verify compliance with the criteria. In the following table, items marked “N/A” (not applicable) have no verification required. These items are titles or contain explanatory materials. The other columns “Analysis,” “Demo,” “Exam,” and “Test” refer to the verification methods identified in Section 1.4.1.
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<th>Criterion Title</th>
<th>Verification Method Code</th>
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APPENDIX A CRITERION BASIS STATEMENTS

This section presents the criterion basis statements for criteria in Section 1.2 of Volume I. Descriptions of the traces to the “Monitored Geologic Repository Requirements Document” (MGR RD) (as modified by input transmittal “Preliminary Draft Requirements from the Monitored Geologic Repository Requirements Document”) and “Revised Interim Guidance Pending Issuance of New U.S. Nuclear Regulatory Commission (NRC) Regulations (Revision 01, July 22, 1999), for Yucca Mountain, Nevada” are shown as applicable. In anticipation of the interim guidance being promulgated as a Code of Federal Regulations, it will be referred to as “10 CFR 63” in this system description document.

1.2.1.1 Criterion Basis Statement

I. Criterion Need Basis

This requirement, in conjunction with Criterion 1.2.1.2, establishes the types of high-level waste (HLW) that the suite of defense HLW disposal containers must be designed to contain. This requirement only identifies the type of canisters to be used in design. Additional information is provided (size, weight, and material) that may be used in design.

This criterion provides a lower level decomposition of MGR RD 3.2.A by specifying the waste forms that will make up the 640 MTU of commercial HLW and 4,027 MTU of defense HLW to be disposed of at the Monitored Geologic Repository (MGR). The commercial HLW is produced by West Valley Demonstration Project, and the defense HLW is produced by Hanford, Savannah River Site, and Idaho National Engineering and Environmental Laboratory.

II. Criterion Performance Parameter Basis

Hanford long canister overall height and weight are from “Incorporating Hanford 15 Foot (4.5 Meter) Canister Into Civilian Radioactive Waste Management System (CRWMS) Baseline.”

Remaining information is obtained from “Characteristics of Potential Repository Wastes” (Volume 1, Table 3.1.1, Figure 3.2.1, Figure 3.3.1, and Figure 3.4.2) (TBV-455). This information includes the Hanford Site long canister outside diameter, neck outside diameter, and canister material, because these are not expected to change from the short canister design, as noted in “Incorporating Hanford 15 Foot (4.5 Meter) Canister Into Civilian Radioactive Waste Management System (CRWMS) Baseline”: “The specifications for the 4.5 m canistered waste form are expected to remain the same in all areas except those associated with the increased canister length, weight, heat generation, and fill height.”
1.2.1.2 Criterion Basis Statement

I. Criterion Need Basis

This requirement, in conjunction with Criterion 1.2.1.1, establishes the types of waste (U.S. Department of Energy [DOE] Spent Nuclear Fuel [SNF]) that the suite of defense HLW disposal containers must be designed to contain. Co-disposal of DOE SNF and HLW in the defense HLW disposal container is assumed in “Waste Quantity, Mix and Throughput Study Report” (Section 5.4.2).

This criterion provides a lower level decomposition of MGR RD 3.2 B by specifying the waste forms that will make up part of the 2,437 MTU of DOE SNF to be disposed of at the MGR.

II. Criterion Performance Parameter Basis

The DOE SNF waste forms are identified in “Evaluation of Codisposal Viability for Aluminum-Clad DOE-Owned Spent Fuel: Phase I Intact Codisposal Canister” (p. 1) and “Evaluation of Codisposal Viability for MOX (FFTF) DOE-Owned Fuel” (p. 1). Other waste forms are to be determined (TBD).

The DOE SNF canister types, nominal diameters, maximum lengths, and maximum weights presented in the table as a part of this criterion are obtained from “Integrated Interface Control Document Volume 1: U.S. Department of Energy Spent Nuclear Fuel to the Monitored Geologic Repository for Mechanical and Envelope Interfaces,” Figures B-5, B-6, B-10, B-11, and B-13.

1.2.1.3 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to define the overall level of performance of the repository to which this system will contribute. This criterion supports MGR RD 3.1.C and 10 CFR 63.113(b).

II. Criterion Performance Parameter Basis

The performance parameters are taken from 10 CFR 63.113(b).

1.2.1.4 Criterion Basis Statement

I. Criterion Need Basis

This criterion is required for the system to comply with management direction put into effect via the “Monitored Geologic Repository Project Description Document,” which places constraints on the materials of construction and the nominal material thickness of
each of two concentric cylinders that make up the disposal container. This criterion is also a consideration of 10 CFR 63.113(a), which requires the MGR include multiple barriers, including an engineered barrier system.

II. Criterion Performance Parameter Basis

The material and nominal thickness parameters are obtained from the “Monitored Geologic Repository Project Description Document” (Section 2.2.1.10).

1.2.1.5 Criterion Basis Statement

I. Criterion Need Basis

This criterion is a consideration of MGR RD 3.1.C and 10 CFR 63.113(b), and specifically addresses the performance assessment requirements of 10 CFR 63.114(d) and 10 CFR 63.114(e). This criterion is needed to ensure the rate of “failure” of the waste packages remains within acceptable limits. The term includes juvenile failure, operational failure, and failure as a result of other unexpected or design basis events.

The term “reliability” is defined as the probability that the waste package will not breach due to non-mechanistic failure at a rate of more than one waste package per 10,000 at any time during the first 10,000 years after emplacement.

II. Criterion Performance Parameter Basis

The 10,000-year parameter is derived from “Performance Assessment Input for Performance Allocation Study” (Section 5.1) (Input Transmittal RSO-PA-99262.T). The reliability parameter has not yet been determined.

1.2.1.6 Criterion Basis Statement

I. Criterion Need Basis

This requirement is intended to ensure that the glass transition temperature is not exceeded, in which case the glass waste could go through a change of phase from a glass to a crystalline structure. Variations in condition of the borosilicate glass affect the projected durability of vitrified HLW, and can increase the potential for unacceptable radionuclide release rates in some fraction of the inventory. This criterion is needed to ensure the expected annual dose to the critical group during the first 10,000 years after permanent closure does not exceed 25 mrem, as required by 10 CFR 63.113(b).

This criterion is also needed in consideration of 10 CFR 63.111(a)(2), 10 CFR 63.111(b)(2), and 10 CFR 63.112(e)(8) to ensure the disposal container system performs its intended safety function assuming the occurrence of a design basis event.
This criterion is supported by Guidance Statements 6.7g2, 6.12g1, 6.12g3, and 6.13g1 contained in the “MGR Compliance Program Guidance Package for the Defense High-Level Waste (DHLW) Disposal Container.”

II. Criterion Performance Parameter Basis

The temperature value for normal conditions is taken from the “Waste Acceptance System Requirements Document,” Section 4.2.3.1.G.1. The temperature value for short-term exposure to fire is derived by rounding down the glass transition temperature provided by the “Waste Acceptance System Requirements Document” (p. A-3).

1.2.1.7 Criterion Basis Statement

I. Criterion Need Basis

This requirement is intended to ensure that the DOE waste forms are not exposed to a temperature at which they would degrade to a point that would raise the potential for larger release rates. This criterion is needed to ensure the expected annual dose to the critical group during the first 10,000 years after permanent closure does not exceed 25 mrem, as required by 10 CFR 63.113(b).

This criterion is also needed in consideration of 10 CFR 63.111(a)(2), 10 CFR 63.111(b)(2), and 10 CFR 63.112(e)(8) to ensure the disposal container system performs its intended safety function assuming the occurrence of a design basis event.

This criterion is supported by Guidance Statements 6.7g2, 6.12g1, 6.12g3, and 6.13g1 contained in the “MGR Compliance Program Guidance Package for the Defense High-Level Waste (DHLW) Disposal Container.”

II. Criterion Performance Parameter Basis

The zircaloy cladding temperature limit under normal conditions is taken from the “Thermal Loading Study for FY 1996” (Executive Summary, p. ix). The temperature limit for zircaloy cladding under short-term exposure to fire is taken from “Standard Review Plan for Dry Cask Storage Systems” (NUREG-1536) (p. 4-1). The temperature limit for DOE SNF with other types of cladding is not yet determined.

1.2.1.8 Criterion Basis Statement

I. Criterion Need Basis

This requirement is a consideration of 10 CFR 63.111(a)(2) to protect against radiation exposure and release of radioactive materials during normal handling operations. Also, this criterion is provided to protect canisters and cladding as barriers to radionuclide release in consideration of 10 CFR 63.113(b).
This criterion is supported by Guidance Statements 6.12g1, 6.12g3, and 6.13g1 contained in the “MGR Compliance Program Guidance Package for the Defense High-Level Waste (DHLW) Disposal Container.”

II. Criterion Performance Parameter Basis

N/A

1.2.1.9 Criterion Basis Statement

I. Criterion Need Basis

This requirement contributes to the ability to retrieve waste packages as required by 10 CFR 63.111(e)(1). This requirement dictates a time period in which the disposal containers must be capable of being moved after emplacement.

This criterion is supported by Guidance Statements 6.12g1 and 6.13g1 contained in the “MGR Compliance Program Guidance Package for the Defense High-Level Waste (DHLW) Disposal Container.”

II. Criterion Performance Parameter Basis

The 300-year time period is taken from MGR RD 3.2.H, which requires the MGR support a deferral of closure for up to 300 years.

1.2.1.10 Criterion Basis Statement

I. Criterion Need Basis

This requirement is intended to preserve the waste form condition and configuration. Breach of the canisters due to oxidation/corrosion would remove the canister walls as barriers to radionuclide releases and therefore remove their contribution to overall repository performance. This criterion is a consideration of the waste retrievability requirement of 10 CFR 63.111(e)(1). In addition, the possibility of a breach of the disposal container due to gas generation is reduced, in consideration of 10 CFR 63.113(b).

A non-oxidizing environment is desirable to prevent early corrosion of the waste form canisters prior to waste package breach and provides defense-in-depth. It is therefore reasonable to be applied to the Defense High Level Waste disposal container design.

II. Criterion Performance Parameter Basis

The performance parameters used in this criterion are taken from the criterion analysis provided in the “Uncanistered Spent Nuclear Fuel Disposal Container System Description Document” (Volume II, Criterion Basis Statement 1.2.1.14), which derives non-oxidizing environment characteristics. That criterion analysis derives the non-oxidizing environment
characteristics based on the emplacement of uncanistered SNF disposal containers containing commercial SNF.

An analysis to determine appropriate concentration limits for waste packages containing defense HLW, commercial HLW, and DOE SNF has not yet been performed. However, concentration limits used for uncanistered SNF disposal containers, which are to be verified, provide reasonable bases for the defense HLW disposal container.

1.2.1.11 Criterion Basis Statement

I. Criterion Need Basis

This requirement supports decontamination of the disposal container/waste package. By limiting surface roughness of the disposal container, the decontamination process will not be impeded. This requirement is derived from the “Mined Geologic Disposal System Functional Analysis Document,” function 1.4.3.2.2.4.5, and “Design Criteria for an Independent Spent Fuel Storage Installation (Dry Type)” (ANSI/ANS-57.9-1992), Section 6.2.2.1.2(5).

Limiting surface roughness may also reduce the time required to perform work in the vicinity of radioactive materials, which is required by 10 CFR 63.112(e)(2).

This criterion is supported by Guidance Statement 7.1g1 contained in the “MGR Compliance Program Guidance Package for the Defense High-Level Waste (DHLW) Disposal Container.”

II. Criterion Performance Parameter Basis

A published reference for the recommended surface finish of tools, equipment, casks, containers etc., which may become radioactively contaminated does not exist; therefore, the following rule of thumb based on both Commercial Nuclear and Nuclear Navy experience will be used as the basis for selecting the surface finishes. (Note: The highest number has the roughest finish.)

250 μin: Use in applications where the item is not expected/designed to become radioactively contaminated. However, if exposed to radioactive contamination, this finish can still be decontaminated.

125 μin: Use in applications where the item is more likely to become radioactively contaminated than the 250 case, but still not routinely exposed to contamination.

63 μin: Use in applications where the item is expected to be routinely exposed to radioactive contamination.
The 250 μin value is selected for the disposal container because the container is not expected to become contaminated due to waste handling operations. In addition, the postclosure performance of one finish over another is not a distinguishing factor for long term performance in the models used for TSPA.

1.2.1.12 Criterion Basis Statement

I. Criterion Need Basis

This requirement guides disposal container design away from a design that would be difficult to decontaminate by precluding undesirable external geometries (e.g., blind holes). This requirement is intended to be assessed against the as-designed disposal container, without regard to actual disposal container use, which would preclude surface visibility (e.g., waste package emplacement on pedestals would preclude visibility of the pedestal to disposal container contact points).

Also, accessibility of the waste package surface to visual inspection may reduce the time required to perform work in the vicinity of radioactive materials, which is required by 10 CFR 63.112(e)(2).

II. Criterion Performance Parameter Basis

N/A

1.2.1.13 Criterion Basis Statement

I. Criterion Need Basis

This criterion supports the tracking of all waste packages as required by MGR RD 3.1.C, MGR RD 3.3.K, and 10 CFR 63.78. This criterion also supports the MGR RD 3.1.B requirement to implement the applicable provisions of “Standards for Protection Against Radiation” (10 CFR 20). Also, identification of waste package contents may reduce the time required to perform work in the vicinity of radioactive materials, which is required by 10 CFR 63.112(e)(2).

Waste packages located in surface and subsurface facilities of the MGR are “accessible only to individuals authorized to ... work in the vicinity of the containers...” and are located in storage vaults or hot cells. Therefore, labeling of waste packages is subject to the exemptions provided by 10 CFR 20.1905(e).

II. Criterion Performance Parameter Basis

N/A
1.2.1.14 Criterion Basis Statement

I. Criterion Need Basis

Label material and method of attachment to the waste package must be considered so that the waste package will not be impaired in its ability to limit the dose rate specified in 10 CFR 63.113(b).

II. Criterion Performance Parameter Basis

N/A

1.2.1.15 Criterion Basis Statement

I. Criterion Need Basis

This requirement establishes the length of time that the labels must be legible. This requirement supports MGR RD 3.1.C and is a decomposition of 10 CFR 63.112(e)(2) in that legibility by remote means may reduce the time required to perform work in the vicinity of radioactive materials. Labels are needed to support the tracking of all waste packages as required by MGR RD 3.3.K and 10 CFR 63.78. This criterion also supports the MGR RD 3.1.D requirement to implement the applicable provisions of “Physical Protection of Plants and Materials” (10 CFR 73), Section 45(d)(1)(iii).

II. Criterion Performance Parameter Basis

N/A

1.2.1.16 Criterion Basis Statement

I. Criterion Need Basis

This criterion requires that the disposal container/waste package lifting features be designed to withstand handling loads and is needed to reduce the probability of the occurrence of a design basis event in consideration of 10 CFR 63.111(a)(2), 10 CFR 63.111(b)(2), and 10 CFR 63.112(e)(8). Reducing the probability of a design basis event may also reduce the time required to perform work in the vicinity of radioactive materials, which is a consideration of 10 CFR 63.112(e)(2).

II. Criterion Performance Parameter Basis

The factors-of-safety are obtained from Section 4.2.1.1 of “Radioactive Materials - Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4,500 kg) or More” (ANSI N14.6-1993). The scope of ANSI N14.6-1993 encompasses special lifting devices and those features of the attachment members of the containers that affect the function and safety of the lift. The Yucca Mountain Project may develop (for use in its
disposal container designs) different values based on loading conditions that are representative of repository operations, if they are justified. A technical report would provide the supporting technical justification for the project-specific values along with a rationale for not using ANSI N14.6-1993. The stress design factors specified in ANSI N14.6-1993 will be used in the disposal container designs unless project-specific values are required.

1.2.1.17 Criterion Basis Statement

I. Criterion Need Basis

This criterion requires that the disposal container/waste package lifting features be designed to withstand handling loads and is needed to reduce the probability of the occurrence of a design basis event in consideration of 10 CFR 63.111(a)(2), 10 CFR 63.111(b)(2), and 10 CFR 63.112(e)(8). Reducing the probability of a design basis event may also reduce the time required to perform work in the vicinity of radioactive materials, which is a consideration of 10 CFR 63.112(e)(2).

II. Criterion Performance Parameter Basis

The factors-of-safety are obtained from Section 4.2.1.1 of “Radioactive Materials - Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4,500 kg) or More” (ANSI N14.6-1993). The scope of ANSI N14.6-1993 encompasses special lifting devices and those features of the attachment members of the containers that affect the function and safety of the lift. The Yucca Mountain Project may develop (for use in its disposal container designs) different values based on loading conditions that are representative of repository operations, if they are justified. A technical report would provide the supporting technical justification for the project-specific values along with a rationale for not using ANSI N14.6-1993. The stress design factors specified in ANSI N14.6-1993 will be used in the disposal container designs unless project-specific values are required.

1.2.1.18 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed for the disposal container/waste package to comply with 10 CFR 63.111(a)(2), 10 CFR 63.111(b)(2), 10 CFR 63.112(e)(8), which require the disposal container system perform its intended safety function assuming the occurrence of design basis events.

This criterion is supported by Guidance Statements 6.12g3 and 6.13g1 contained in the “MGR Compliance Program Guidance Package for the Defense High-Level Waste (DHLW) Disposal Container.” The Guidance Statements require the disposal container be designed considering normal loading conditions.
II. Criterion Performance Parameter Basis

N/A

1.2.1.19 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed in consideration of thermal loads and fire hazards in support of MGR RD 3.1.C, 10 CFR 63.111(a)(2), 10 CFR 63.111(b)(2), and 10 CFR 63.112(e)(8), which require the disposal container system perform its intended safety function assuming the occurrence of design basis events.

II. Criterion Performance Parameter Basis

N/A

1.2.1.20 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed in consideration of fire hazards (pyrophoric materials), explosion hazards (explosive materials), and thermal loads (conditions resulting in the ignition of a pyrophoric material and the results of an explosion or fire). This criterion supports MGR RD 3.1.C, 10 CFR 63.111(a)(2), 10 CFR 63.111(b)(2), and 10 CFR 63.112(e)(8), which require the disposal container system perform its intended safety function assuming the occurrence of design basis events.

II. Criterion Performance Parameter Basis

N/A

1.2.1.21 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to support the functions of the waste package to prevent adverse reactions involving the waste form and to provide conditions needed to maintain the physical and chemical stability of the waste form.

II. Criterion Performance Parameter Basis

N/A
1.2.2.1.1 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed in consideration of 10 CFR 63.111(a)(2), 10 CFR 63.111(b)(2), and 10 CFR 63.112(e)(8) and to ensure the disposal container system performs its intended safety function assuming the occurrence of a design basis event. The general wording for this requirement is taken from "Nuclear Safety Criteria for the Disposal Container System Description Documents (SDDs)" (Attachment I, p. 1) (Input Transmittal RSO-RSO-99333.Ta).

This criterion is supported by Guidance Statements 6.12g1, 6.12g3, and 6.13g1 contained in the "MGR Compliance Program Guidance Package for the Defense High-Level Waste (DHLW) Disposal Container."

II. Criterion Performance Parameter Basis


1.2.2.1.2 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed in consideration of 10 CFR 63.111(a)(2), 10 CFR 63.111(b)(2), and 10 CFR 63.112(e)(8) and to ensure the disposal container system performs its intended safety function assuming the occurrence of a design basis event. The general wording for this requirement is taken from "Nuclear Safety Criteria for the Disposal Container System Description Documents (SDDs)" (Attachment I, p. 1) (Input Transmittal RSO-RSO-99333.Ta).

This criterion is supported by Guidance Statements 6.12g1, 6.12g3, and 6.13g1 contained in the "MGR Compliance Program Guidance Package for the Defense High-Level Waste (DHLW) Disposal Container."

II. Criterion Performance Parameter Basis

1.2.2.1.3 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed in consideration of 10 CFR 63.111(a)(2), 10 CFR 63.111(b)(2), and 10 CFR 63.112(e)(8) and to ensure the disposal container system performs its intended safety function assuming the occurrence of a design basis event. The general wording for this requirement is taken from “Nuclear Safety Criteria for the Disposal Container System Description Documents (SDDs)” (Attachment I, p. 1) (Input Transmittal RSO-RSO-99333.Ta).

This criterion is supported by Guidance Statements 6.7g1, 6.12g1, 6.12g3, and 6.13g1 contained in the “MGR Compliance Program Guidance Package for the Defense High-Level Waste (DHLW) Disposal Container.”

II. Criterion Performance Parameter Basis


1.2.2.1.4 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed in consideration of 10 CFR 63.111(a)(2), 10 CFR 63.111(b)(2), and 10 CFR 63.112(e)(8) and to ensure the disposal container system performs its intended safety function assuming the occurrence of a design basis event. The general wording for this requirement is taken from “Nuclear Safety Criteria for the Disposal Container System Description Documents (SDDs)” (Attachment I, p. 1) (Input Transmittal RSO-RSO-99333.Ta).

This criterion is supported by Guidance Statements 6.7g1, 6.12g1, 6.12g3, and 6.13g1 contained in the “MGR Compliance Program Guidance Package for the Defense High-Level Waste (DHLW) Disposal Container.”

II. Criterion Performance Parameter Basis

1.2.2.1.5 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed in consideration of 10 CFR 63.111(a)(2), 10 CFR 63.111(b)(2), and 10 CFR 63.112(e)(8) and to ensure the disposal container system performs its intended safety function assuming the occurrence of a design basis event. The general wording for this requirement is taken from “Nuclear Safety Criteria for the Disposal Container System Description Documents (SDDs)” (Attachment I, p. 1) (Input Transmittal RSO-RSO-99333.Ta).

This criterion is supported by Guidance Statements 6.7gl, 6.12g1, 6.12g3, and 6.13g1 contained in the “MGR Compliance Program Guidance Package for the Defense High-Level Waste (DHLW) Disposal Container.”

II. Criterion Performance Parameter Basis


1.2.2.1.6 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed in consideration of 10 CFR 63.111(a)(2), 10 CFR 63.111(b)(2), and 10 CFR 63.112(e)(8) and to ensure the disposal container system performs its intended safety function assuming the occurrence of a design basis event. The general wording for this requirement is taken from “Nuclear Safety Criteria for the Disposal Container System Description Documents (SDDs)” (Attachment I, p. 1) (Input Transmittal RSO-RSO-99333.Ta).

This criterion is supported by Guidance Statements 6.12g1, 6.12g3, and 6.13g1 contained in the “MGR Compliance Program Guidance Package for the Defense High-Level Waste (DHLW) Disposal Container.”

II. Criterion Performance Parameter Basis

1.2.2.1.7 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed in consideration of 10 CFR 63.111(a)(2), 10 CFR 63.111(b)(2), and 10 CFR 63.112(e)(8) and to ensure the disposal container system performs its intended safety function assuming the occurrence of a design basis event. The general wording for this requirement is taken from "Nuclear Safety Criteria for the Disposal Container System Description Documents (SDDs)" (Attachment I, p. 2) (Input Transmittal RSO-RSO-99333.Ta).

This criterion is supported by Guidance Statements 6.12g1, 6.12g3, and 6.13g1 contained in the "MGR Compliance Program Guidance Package for the Defense High-Level Waste (DHLW) Disposal Container."

II. Criterion Performance Parameter Basis

The event parameters are taken from "Nuclear Safety Criteria for the Disposal Container System Description Documents (SDDs)" (Attachment I, pp. 2 and 3) (Input Transmittal RSO-RSO-99333.Ta).

1.2.2.1.8 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed in consideration of 10 CFR 63.111(a)(2), 10 CFR 63.111(b)(2), and 10 CFR 63.112(e)(8) and to ensure the disposal container system performs its intended safety function assuming the occurrence of a design basis event. The general wording for this requirement is taken from "Nuclear Safety Criteria for the Disposal Container System Description Documents (SDDs)" (Attachment I, p. 3) (Input Transmittal RSO-RSO-99333.Ta).

This criterion is supported by Guidance Statements 6.12g1, 6.12g3, and 6.13g1 contained in the "MGR Compliance Program Guidance Package for the Defense High-Level Waste (DHLW) Disposal Container."

II. Criterion Performance Parameter Basis

The event parameters are taken from "Nuclear Safety Criteria for the Disposal Container System Description Documents (SDDs)" (Attachment I, p. 3) (Input Transmittal RSO-RSO-99333.Ta).
1.2.2.1.9 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed in consideration of 10 CFR 63.111(a)(2), 10 CFR 63.111(b)(2), and 10 CFR 63.112(e)(8) and to ensure the disposal container system performs its intended safety function assuming the occurrence of a design basis event. The general wording for this requirement is taken from “Nuclear Safety Criteria for the Disposal Container System Description Documents (SDDs)” (Attachment I, p. 3) (Input Transmittal RSO-RSO-99333.Ta).

This criterion is supported by Guidance Statements 6.12g1, 6.12g3, and 6.13g1 contained in the “MGR Compliance Program Guidance Package for the Defense High-Level Waste (DHLW) Disposal Container.”

II. Criterion Performance Parameter Basis

The event parameters are taken from “Nuclear Safety Criteria for the Disposal Container System Description Documents (SDDs)” (Attachment I, p. 3) (Input Transmittal RSO-RSO-99333.Ta).

1.2.2.1.10 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed in consideration of 10 CFR 63.111(a)(2), 10 CFR 63.111(b)(2), and 10 CFR 63.112(e)(8) and to ensure the disposal container system performs its intended safety function assuming the occurrence of a design basis event. The general wording for this requirement is taken from “Nuclear Safety Criteria for the Disposal Container System Description Documents (SDDs)” (Attachment I, p. 3) (Input Transmittal RSO-RSO-99333.Ta).

This criterion is supported by Guidance Statements 6.12g1, 6.12g3, and 6.13g1 contained in the “MGR Compliance Program Guidance Package for the Defense High-Level Waste (DHLW) Disposal Container.”

II. Criterion Performance Parameter Basis

The event parameters have not been determined.

1.2.2.1.11 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed in consideration of 10 CFR 63.111(a)(2), 10 CFR 63.111(b)(2), and 10 CFR 63.112(e)(8) and to ensure the disposal container system performs its
intended safety function assuming the occurrence of a design basis event. This criterion is in consideration of a fire event that is defined in "Packaging and Transportation of Radioactive Materials" (10 CFR 71), Section 73(c)(4).

Until a comprehensive analysis of fire hazards at the MGR is performed and establishes the credibility and/or magnitude of a design basis fire for the waste package, the hypothetical fire criteria for transportation casks, from 10 CFR 71.73(c)(4), is assumed. Therefore, this criterion remains to be verified.

The fire event is defined as exposure of the waste package fully engulfed in an average flame temperature of at least 800 degrees C (1,475 degrees F) for a period of 30 minutes, with an average emissivity coefficient of at least 0.9. For purposes of calculation, the surface absorptivity shall be either that value which the waste package may be expected to possess if exposed to the fire specified or 0.8, whichever is greater, and the convective coefficient shall be that value which may be demonstrated to exist if the waste package were exposed to the fire specified.

The general wording for this requirement is taken from "Nuclear Safety Criteria for the Disposal Container System Description Documents (SDDs)" (Attachment I, p. 3) (Input Transmittal RSO-RSO-99333.Ta).

This criterion is supported by Guidance Statements 6.7g2, 6.12g1, 6.12g3, and 6.13g1 contained in the "MGR Compliance Program Guidance Package for the Defense High-Level Waste (DHLW) Disposal Container."

II. Criterion Performance Parameter Basis


1.2.2.1.12 Criterion Basis Statement

I. Criterion Need Basis

This requirement applies the criticality requirement from 10 CFR 63.112(e)(6) to the disposal container/waste package design during the preclosure period.

The general wording for this requirement is taken from "Nuclear Safety Criteria for the Disposal Container System Description Documents (SDDs)" (Attachment I, p. 4) (Input Transmittal RSO-RSO-99333.Ta). The reference provides input regarding Design Basis Events, therefore this requirement partially supports 10 CFR 63.111(a)(2), 10 CFR 63.111(b)(2), and 10 CFR 63.112(e)(8).
This criterion is supported by Guidance Statements 6.12g1 and 6.13g1 contained in the "MGR Compliance Program Guidance Package for the Defense High-Level Waste (DHLW) Disposal Container."

II. Criterion Performance Parameter Basis

The performance parameters for this requirement are taken from "Nuclear Safety Criteria for the Disposal Container System Description Documents (SDDs)" (Attachment I, p. 4) (Input Transmittal RSO-RSO-99333.Ta). Sections IV.1 and IV.2 (p. 6-1) of "Standard Review Plan for Dry Cask Storage Systems" (NUREG-1536) support the effective multiplication factor parameter.

1.2.2.1.13 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to ensure the expected annual dose to the critical group during the first 10,000 years after permanent closure does not exceed 25 mrem, as required by 10 CFR 63.113(b).

II. Criterion Performance Parameter Basis

The actual content and quantification of the postclosures criticality criterion has not been confirmed. As a result, this criterion will need to be verified.

The 1 percent inventory increase measured at 1,000 years was chosen as the standard below which the consequences of postclosures criticalities would be held because the effect of the relatively small incremental increase in the inventory (of 1 percent due to criticality events) will be negligible compared to the effect of other total system performance related parameters, such as infiltration rate, which can vary by over 100 percent.

1.2.3.1 Criterion Basis Statement

I. Criterion Need Basis

This requirement defines the external (outside the waste package) environment for which the disposal container should be designed. 10 CFR 63.113(b) is traced because this requirement considers the waste package influenced emplacement drift environment and its impact on the capability of the disposal container system to limit the expected annual dose to the average member of the critical group to 25 mrem at any time during the first 10,000 years after permanent closure of the repository.

Also, in consideration of MGR RD 3.4.2.C, this criterion defines the induced handling environment (credible loads) the disposal container/waste package must withstand.
II. Criterion Performance Parameter Basis

The environment parameters are taken from "Performance Allocation Study Preliminary Results" (Table 4), which is the attachment to the input transmittal entitled "Manager System Requirements/System Description Documents." The induced handling environments are to be determined.

1.2.4.1 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to ensure mechanical interface consistency between the design of this system and the repository surface facilities and systems. This is done by specifying the design be done in accordance with the interface agreements defined in "Interface Control Document for the Waste Packages/Disposal Containers and the Surface Repository Facilities and Systems for Mechanical, Envelope and Functional Interfaces." This criterion supports the waste handling operations of MGR RD 3.2.C.

II. Criterion Performance Parameter Basis

N/A

1.2.4.2 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to ensure mechanical interface consistency between the design of this system and the subsurface facilities and systems. This is done by specifying the design be done in accordance with the interface agreements defined in "Interface Control Document for Waste Packages and the Mined Geologic Disposal System Repository Subsurface Facilities and Systems for Mechanical and Envelope Interfaces." This criterion supports the waste handling operations of MGR RD 3.2.C.

II. Criterion Performance Parameter Basis

N/A

1.2.4.3 Criterion Basis Statement

I. Criterion Need Basis

This requirement is needed as an interface between the waste package and the Waste Emplacement/Retrieval System to allow adequate waste package transporter shielding design for an acceptable dose rate at the external surfaces of the transporter (in support of "Standards for Protection Against Radiation" [10 CFR 20], Subparts A, B, and C). This requirement is not intended to yield disposal container design features that are added
solely for the purpose of shielding (unshielded waste packages are recommended in the "Waste Package Size Study Report," p. 6-5), but is intended to establish the expected maximum dose rate the Waste Emplacement/Retrieval System will be designed to reduce.

This criterion is supported by Guidance Statements 6.12g1 and 6.13g1 contained in the "MGR Compliance Program Guidance Package for the Defense High-Level Waste (DHLW) Disposal Container."

II. Criterion Performance Parameter Basis

The maximum dose rate at the external surface of the waste packages has not yet been determined.

1.2.4.4 Criterion Basis Statement

I. Criterion Need Basis

This criterion is required for the system to comply with management direction put into effect via the "Monitored Geologic Repository Project Description Document," which places a constraint on the maximum heat output of individual waste packages. This criterion is also required to allow the design of the transporter used in the Waste Emplacement/Retrieval System. A maximum heat load criterion provides a bounding heat load that must be sustained by the transporter during emplacement operations.

II. Criterion Performance Parameter Basis

The maximum thermal output limit is obtained from the "Monitored Geologic Repository Project Description Document" (Section 2.2.1.1.11).

1.2.4.5 Criterion Basis Statement

I. Criterion Need Basis

This requirement is needed to comply with MGR RD 3.1.A and 3.2.B. This criterion defines the split of DOE SNF disposed of in the Defense High Level Waste Disposal Container and the DOE SNF disposal container. This requirement also establishes the limits for disposal of commercial HLW and defense HLW within the Defense High Level Waste Disposal Container. Co-disposal of DOE SNF and high-level waste in the Defense High Level Waste Disposal Container is assumed in "Waste Quantity, Mix and Throughput Study Report" (Section 5.4.2).
II. Criterion Performance Parameter Basis

The total quantities of commercial HLW and defense HLW (640 MTU and 4,027 MTU, respectively) were taken from MGR RD 3.2.B. The maximum amount of DOE-owned SNF available to be disposed of at the MGR (2,437 MTU) is also taken from MGR RD 3.2.B. The split of DOE SNF between the defense HLW disposal container and the DOE SNF disposal container has yet to be determined.

1.2.4.6 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to align the disposal container/waste package design with surface repository disposal container/waste package handling operations.

II. Criterion Performance Parameter Basis

N/A

1.2.4.7 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to align the disposal container/waste package design with surface repository disposal container/waste package handling operations.

II. Criterion Performance Parameter Basis

N/A

1.2.4.8 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to ensure the disposal container design accommodates welding and sealing equipment used by the Disposal Container Handling System and facilitates optimum welding times.

II. Criterion Performance Parameter Basis

N/A
1.2.6.1 Criterion Basis Statement

I. Criterion Need Basis

In support of MGR RD 3.3.A, the “1995 ASME Boiler and Pressure Vessel Code” (Section III, Division 1, Subsection NG-1995) provides nuclear industry specific codes, standards and conformity assessment programs. American Society of Mechanical Engineers (ASME) codes and standards are internationally recognized for the design, manufacturing and installation of mechanical devices. Requirements set forth in “Domestic Licensing of Production and Utilization Facilities” (10 CFR 50), Section 55 are specific in the use of ASME Boiler and Pressure Codes as “quality standards commensurate with the importance of the safety function to be performed” (10 CFR 50.55(a)(1)).

II. Criterion Performance Parameter Basis

N/A

1.2.6.2 Criterion Basis Statement

I. Criterion Need Basis

In support of MGR RD 3.3.A, the “1995 ASME Boiler and Pressure Vessel Code” (Section III, Division 1, Subsection NB-1995) provides nuclear industry specific codes, standards and conformity assessment programs. ASME codes and standards are internationally recognized for the design, manufacturing and installation of mechanical devices. Requirements set forth in “Domestic Licensing of Production and Utilization Facilities” (10 CFR 50), Section 55 are specific in the use of ASME Boiler and Pressure Codes as “quality standards commensurate with the importance of the safety function to be performed” (10 CFR 50.55(a)(1)).

II. Criterion Performance Parameter Basis

N/A

1.2.6.3 Criterion Basis Statement

I. Criterion Need Basis

The criterion supports MGR RD 3.3.A. “Nuclear Criticality Control of Special Actinide Elements” (ANSI/ANS-8.15-1981) is cited as an industry standard used in the development of the “Disposal Criticality Analysis Methodology Topical Report.”

II. Criterion Performance Parameter Basis

N/A
1.2.6.4 Criterion Basis Statement

I. Criterion Need Basis


II. Criterion Performance Parameter Basis

N/A

1.2.6.5 Criterion Basis Statement

I. Criterion Need Basis


II. Criterion Performance Parameter Basis

N/A

1.2.6.6 Criterion Basis Statement

I. Criterion Need Basis


II. Criterion Performance Parameter Basis

N/A
APPENDIX B ARCHITECTURE AND CLASSIFICATION

The QA classification as established in "Classification of the MGR Defense High-Level Waste Disposal Container System" defines the overall system as QL-1. The next level of system architecture and assumed QA classification are identified in Table I-11.

Table I-11. System Architecture and Quality Assurance Classification

<table>
<thead>
<tr>
<th>System Architecture</th>
<th>QL-1</th>
<th>QL-2</th>
<th>QL-3</th>
<th>CQ</th>
</tr>
</thead>
<tbody>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5HLW/DOE Spent Fuel</td>
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<tr>
<td>5HLW/DOE Spent Fuel, Long</td>
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<td>X</td>
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</tr>
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</table>
APPENDIX C ACRONYMS, SYMBOLS, AND UNITS

This section provides a listing of acronyms, symbols, and units used in Volume I.

C.1 Acronyms

ASME American Society of Mechanical Engineers
CRWMS Civilian Radioactive Waste Management System
CQ Conventional Quality
DHLW Defense High-Level Waste
DOE U. S. Department of Energy
F Function
FFTF Fast Flux Test Facility
HLW High-Level Waste
IPWF Immobilized Plutonium Waste Form
MCO Multi-Canister Overpack
MGDS Mined Geologic Disposal System
MGR Monitored Geologic Repository
MGR RD Monitored Geologic Repository Requirements Document
MOX Mixed Oxide
M&O Management and Operating Contractor
NSNFP National Spent Nuclear Fuel Program
QA Quality Assurance
QL Quality Level
SDD System Description Document
SNF Spent Nuclear Fuel
TBD To Be Determined
TBV To Be Verified

C.2 Symbols

C Celsius
CO₂ carbon dioxide
CO carbon monoxide
F Fahrenheit
g acceleration due to gravity
H₂ hydrogen
H₂O water
O₂ oxygen
C.3 Units

cm  centimeter
ft  feet
hr  hour
Hz  Hertz
in.  inch
kg  kilogram
km  kilometer
kW  kilowatt
lb  pound
m  meter
mg  milligram
mi  mile
ml  milliliter
mm  millimeter
mrem  one thousandth of a rem
MT  metric ton
MTU  metric tons uranium
pH  hydrogen ion concentration potential
rem  Roentgen equivalent man
sec  second
yr  year
μin  microinch
μm  micrometer
APPENDIX D FUTURE REVISION RECOMMENDATIONS AND ISSUES

This appendix identifies issues and actions that require further evaluation. The disposition of these issues and actions could alter the functions and design criteria that are allocated to this system in future revisions to this document. However, the issues and actions identified in this appendix do not require TBDs or TBVs beyond those already identified.

Issue 1—Label Legibility
Future criteria must consider observation by both human and electronic means.

Issue 2—Disposal Container Lid Matching
The need for unique identification of the fabricated disposal container to a set of matched inner and outer lids needs to be investigated. If disposal containers will be matched to their lids, an identification system between the disposal container and its lids will be needed. The design criteria for such an identification will then need to be identified.

Issue 3—Handling Interface
The handling interface with the Disposal Container Handling System needs to be identified for empty disposal container handling, loaded disposal container handling, and lid handling.

Issue 4—Welding and Inspection Interface
The welding and inspection interface with the Disposal Container Handling System needs to be identified for inner and outer lid welding and inspection operations.

Issue 5—Inerting Interface and Operational Requirements
The filling of the container with an inert gas needs to be identified as an interface with the Disposal Container Handling System. Applicable disposal container requirements need to be determined.

Issue 6—Metric vs. Standard Units
Consistent display of both metric and standard units should be incorporated into criteria. Conversion leads to inconsistencies in the number of significant digits, accuracy, and summed values.

Issue 7—Identification as Disposal Container or Waste Package
A consistent method of identification of the waste form container as a “disposal container” or a “waste package” needs to be determined.

Issue 8—Disposal Container Materials of Construction
Criterion 1.2.1.4, which is a design constraint imposed by the “Monitored Geologic Repository Project Description Document,” will be moved to the Design Description section (Section 2) of this document in the next revision.
Issue 9-- Waste Package Performance  
Performance allocations for the waste packages to meet overall regulatory requirements need to be determined.

Issue 10-- Waste Package Postclosure Criticality Requirements  
Postclosure criticality requirements will be determined for a future revision.
APPENDIX E REFERENCES

This section provides a listing of references used in Volume I.


