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DISCLAIMER

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SUMMARY

The Waste Emplacement/Retrieval System transports Waste Packages (WPs) from the Waste Handling Building (WHB) to the subsurface area of emplacement, and emplaces the WPs once there. The Waste Emplacement/Retrieval System also, if necessary, removes some or all of the WPs from the underground and transports them to the surface. Lastly, the system is designed to remediate abnormal events involving the portions of the system supporting emplacement or retrieval. During emplacement operations, the system operates on the surface between the WHB and North Portal, and in the subsurface in the North Ramp, access mains, and emplacement drifts. During retrieval or abnormal conditions, the operations areas may also extend to a surface retrieval storage site and South Portal on the surface, and the South Ramp in the subsurface.

A typical transport and emplacement operation involves the following sequence of events. A WP is loaded into a WP transporter at the WHB, and coupled to a pair of transport locomotives. The locomotives transport the WP from the WHB, down the North Ramp, and to the entrance of an emplacement drift. Once docked at the entrance of the emplacement drift, the WP is moved outside of the WP transporter, and engaged by a WP emplacement gantry. The WP emplacement gantry lifts the WP, and transports it to its emplacement location, where the WP is then lowered to its final resting position. The WP emplacement gantry remains in the drift while the WP transporter is returned to the WHB by the locomotives. When the transporter reaches the WHB, the sequence of operations is repeated.

Retrieval of all the WPs, or a large group of WPs, under normal conditions is achieved by reversing the emplacement operations. Retrieval of a small set of WPs, under normal or abnormal conditions, is known as recovery. Recovery performed under abnormal conditions will involve a suite of specialized equipment designed to perform a variety of tasks to enable the recovery process. Recovery after abnormal events may require clearing of equipment, rock, and ground support to facilitate recovery operations. Stabilization of existing ground support and installation of new ground support may also be needed. Recovery of WP(s) after an event that has contaminated drifts and/or WPs will require limiting the spread of contamination. Specialized equipment will also be necessary for system restoration (e.g., after a derailment, component failure.).

The Waste Emplacement/Retrieval System interfaces with the Subsurface Facility System and Ground Control System for the size and layout of the underground openings. The system interfaces with the Subsurface Ventilation System for the emplacement drift operating environment and the size of the drift isolation doors. The system interfaces with all WP types for the size, weight, and other important parameters affecting emplacement, recovery, and retrieval. The system interfaces with the Subsurface Emplacement Transportation System for the rail system upon which it operates and the distribution of power through the rail system. The system interfaces with the Monitored Geologic Repository (MGR) Operations Monitoring and Control System for the transmission of data to and from the system equipment, and for remote control of system equipment. The system interfaces with the Ground Control System for any repairs that are made. The system interfaces with the Emplacement Drift System for the WP emplacement mode and hardware. The system interfaces with the Disposal Container Handling System and the Waste Handling Building System for the receipt (during emplacement) and delivery (during retrieval/recovery) of WPs.

QUALITY ASSURANCE

The quality assurance (QA) 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 "Quality Assurance Requirements and Description" requirements. This document was developed in accordance with AP-3.11Q, "Technical Reports."

1. SYSTEM FUNCTIONS AND DESIGN CRITERIA

The functions and design requirements for the system are identified in the following sections. Throughout this document the term "system" shall indicate the Waste Emplacement/Retrieval System. Additionally, the term "recovery" is used to indicate selective removal of a small set of WPs from the underground, while the term "retrieval" is used to indicate removal of groups of WPs or the entire inventory of WPs from the underground. The term "restoration" is used to indicate action taken to remediate an abnormal event involving the Waste Emplacement/Retrieval System.

As used in this section, "normal conditions" will refer to a subsurface environment that is performing essentially as expected (e.g., retrieval or recovery after blast cooling of an emplacement drift); "abnormal conditions" will refer to subsurface conditions that have been disturbed in some way (e.g., Waste Emplacement/Retrieval System accident, design basis event occurrence).

The system architecture and classification are provided in Appendix B.

1.1 SYSTEM FUNCTIONS

1.1.1 The system receives WPs at the WHB.

1.1.2 The system transfers WPs to the subsurface repository.

1.1.3 The system emplaces WPs in their final location within emplacement drifts.

1.1.4 The system retrieves to the surface all emplaced WPs or a group of emplaced WPs under normal conditions.

1.1.5 The system recovers to the surface individually selected emplaced WPs under normal and abnormal conditions.

1.1.6 The system clears and removes rock, ground support, failed equipment, and debris impeding retrieval and recovery operations.

1.1.7 The system installs ground support to permit safe conduct of retrieval and recovery operations.

1.1.8 The system limits or prevents the spread of radioactive contamination.

1.1.9 The system supports the collection of material control and accounting data.

1.1.10 The system operates within the surface and subsurface natural and induced environmental conditions expected at the site.

1.1.11 The system provides features to minimize radiation exposure to workers.

1.1.12 The system provides features and equipment for reducing the risk of, responding to, and recovering from, abnormal events and credible design basis events.

1.1.13 The system provides features for the inspection, testing, and maintenance of system equipment.

1.1.14 The system remediates abnormal events involving the portions of the system supporting waste emplacement, retrieval, and recovery.

1.1.15 The system mitigates the effects of a radioactive spill in the subsurface repository.

1.1.16 The system emplaces and recovers "dummy" WPs to support Performance Confirmation operations.

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 portions of the system supporting emplacement shall have an operational life of 40 years following the start of emplacement.

[F 1.1.1, 1.1.2, 1.1.3, 1.1.16][MGR RD 3.2.C]

1.2.1.2 The portions of the system supporting retrieval, recovery, and restoration shall have an operational life of 160 years after initiation of waste emplacement.

[F 1.1.4, 1.1.5, 1.1.16][MGR RD 3.1.C, 3.2.C, 3.2.H, 3.2.J][10 CFR 63.111(d), 63.111(e)(1), 63.131(b), 63.134(d)]

1.2.1.3 The portions of the system supporting retrieval, recovery, and restoration shall include provisions that support a deferral of closure for up to 300 years after initiation of waste emplacement.

[F 1.1.4, 1.1.5, 1.1.16][MGR RD 3.1.C, 3.2.H][10 CFR 63.111(d), 63.111(e)(1), 63.131(b), 63.134(d)]

1.2.1.4 The system shall be capable of transporting and emplacing WPs at the annual throughput (TBD-3936).

[F 1.1.1, 1.1.2, 1.1.3][MGR RD 3.2.C, 3.2.E]

1.2.1.5 The system shall be designed to retrieve all emplaced WPs within 34 years after the initiation of retrieval operations.

[F 1.1.4][MGR RD 3.1.C, 3.2.J][10 CFR 63.111(e)(1), 63.111(e)(3)]

1.2.1.6 The system shall be designed to emplace and retrieve a minimum of 11,000 WPs.

[F 1.1.2, 1.1.3, 1.1.4, 1.1.16][MGR RD 3.1.C, 3.2.C][10 CFR 63.111(e)(1)]

1.2.1.7 The system shall be designed to recover a minimum of (TBD-330) WPs.

[F 1.1.5, 1.1.16][MGR RD 3.1.C][10 CFR 63.111(d), 63.111(e)(1), 63.131(d)(3)]

1.2.1.8 The system shall emplace WPs in emplacement drifts in a horizontal orientation.

[F 1.1.3, 1.1.16]

1.2.1.9 The system shall emplace WPs within each emplacement drift a minimum of 10 cm between the ends of adjacent WPs.

[F 1.1.3]

1.2.1.10 The system shall emplace individual WPs to within (TBD-3937) m of a designated point along the central axis of an emplacement drift.

[F 1.1.3]

1.2.1.11 The system shall be capable of transporting retrieved WPs to the WHB and to a storage area located up to 4 km (2.5 miles) directly north of the WHB (TBV-336).

[F 1.1.4][MGR RD 3.1.C][10 CFR 63.111(e)(1)]

1.2.1.12 The system shall segment debris (e.g., failed ground support materials and rock) into pieces no greater than (TBD-331) mm or (TBD-331) kg.

[F 1.1.5, 1.1.6]

1.2.1.13 The system shall remove debris from the underground up to the maximum sizes of individual pieces of (TBD-331) mm and (TBD-331) kg.

[F 1.1.5, 1.1.6]

1.2.1.14 The system shall be designed to install temporary ground support to facilitate recovery and retrieval operations.

[F 1.1.7][MGR RD 3.1.C][10 CFR 63.111(e)(1)]

1.2.1.15 The system shall be designed to recover WPs from an emplacement drift that has blocked ventilation.

[F 1.1.5, 1.1.10]

1.2.1.16 The system shall be designed to perform recovery while the Subsurface Emplacement Transportation System and the Site Communications System have failed at any location in the underground.

[F 1.1.5]

1.2.1.17 The system shall be capable of performing recovery from either end of an emplacement drift.

[F 1.1.5]

1.2.1.18 The system shall provide containment of radionuclides during WP transfer from the emplacement drift to the surface.

[F 1.1.5, 1.1.8][MGR RD 3.1.C, 3.1.G][10 CFR 63.112(e)(1)]

1.2.1.19 The system shall ensure that the waste forms remain below the temperatures identified in Table I-1 during emplacement, retrieval, recovery, and restoration.

Table I-1. Waste Form Temperature Limits

Waste Form	Temperature Limit
Commercial Spent Nuclear Fuel	350°C (662°F) (TBV-241)
Vitrified High Level Waste	400°C (752°F) (TBV-092)
Department of Energy Owned Spent Nuclear Fuel	(TBD-179)
Non-Fuel Components	(TBD-181)
Naval Fuel	(TBD-180)

[F 1.1.1, 1.1.2, 1.1.3, 1.1.4, 1.1.5][MGR RD 3.2.L]

1.2.1.20 The system shall re-emplace all of the WPs moved (but not themselves targeted to retrieval or recovery) to perform retrieval and recovery operations. Re-emplacement shall be completed prior to repository closure.

[F 1.1.3, 1.1.4, 1.1.5, 1.1.16][MGR RD 3.1.C][10 CFR 63.111(d), 63.131(d)(3)]

1.2.1.21 The system equipment operated in an area with the potential for contamination shall have an appropriate surface finish and geometry to facilitate decontamination and limit the accumulation of fixed contamination.

[F 1.1.8][MGR RD 3.1.G, 3.3.A]

1.2.1.22 The system shall re-rail and restore to normal operation, if practical, any derailed system equipment.

[F 1.1.14][MGR RD 3.1.G]

1.2.1.23 The system shall transport to the surface any system equipment that cannot be re-railed and restored to normal operation.

[F 1.1.14][MGR RD 3.1.G]

1.2.1.24 The system shall be designed to clear debris from a minimum of 12 mm (0.5 in.) in the smallest dimension to a maximum of 534 mm (21 in.) in the largest dimension off of the rail and out of the way of the rail flange in front of rail mounted equipment as the equipment travels on the Subsurface Emplacement Transportation System.

[F 1.1.4, 1.1.5]

1.2.1.25 The system shall be designed to decontaminate underground openings to below the levels given in Section 222 of "U.S. Department of Energy Radiological Control Manual," or apply a fixative coating over contaminated surfaces to prevent the spread of contamination. (TBV-345)

[F 1.1.15]

1.2.2 Safety Criteria

1.2.2.1 Nuclear Safety Criteria

1.2.2.1.1 The system shall ensure that an uncontrolled descent down the North or South Ramp of system equipment carrying a WP is limited to less than 1×10^{-6} events/year.

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

1.2.2.1.2 The system speed shall be limited to 8 km/hr (TBV-252).

[F 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.1.12][MGR RD 3.1.C][10 CFR 63.111(a)(2), 63.111(b)(2), 63.112(e)(8)]

1.2.2.1.3 The system shall lift the WP no higher than the maximum lift heights specified in Table I-2. (TBV-245)

Table I-2. Maximum WP Lift Heights

WP Lift	Maximum Lift Height
WP in a Vertical Orientation	2 m (6.6 ft) TBV
WP in a Horizontal Orientation	2.4 m (7.9 ft) TBV

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

1.2.2.1.4 The system shall provide features to recover from abnormal and/or design basis events, including backup measures to place and release loads in a safe manner.

[F 1.1.12][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 The structures, systems, and components (SSCs) important to safety shall be designed to permit prompt termination of operations and maintain WPs in a safe and sustainable position during an emergency.

[F 1.1.12][MGR RD 3.1.C, 3.1.G][10 CFR 63.112(e)(10)]

1.2.2.1.6 The system shall be designed to withstand a design basis earthquake of Frequency Category 1 and/or Frequency Category 2, as appropriate to the seismic frequency classification assigned to a specific structure, system, and component. Both vibratory ground motion and fault displacement of the design basis earthquakes must be considered. The surface environment floor response spectra for the system are (TBD-241). The subsurface design basis earthquake input parameters of the design basis earthquakes are defined in Tables I-3 through I-6. (TBD-241, TBV-273)

Table I-3. 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

	Horizontal Motion (g)		Vertical Motion (g)	
Response Frequency (Hz)	Frequency Category 1 (1,000 Year Recurrence)	Frequency Category 2 (10,000 Year Recurrence)	Frequency Category 1 (1,000 Year Recurrence)	Frequency Category 2 (10,000 Year Recurrence)
0.3	0.0222 (TBV)	0.0720 (TBV)	0.0107 (TBV)	0.0378 (TBV)
0.5	0.0399 (TBV)	0.125 (TBV)	0.0205 (TBV)	0.0688 (TBV)
1	0.0649 (TBV)	0.206 (TBV)	0.0385 (TBV)	0.130 (TBV)
2	0.144 (TBV)	0.458 (TBV)	0.0532 (TBV)	0.180 (TBV)
5	0.226 (TBV)	0.717 (TBV)	0.128 (TBV)	0.435 (TBV)
10	0.242 (TBV)	0.765 (TBV)	0.182 (TBV)	0.620 (TBV)
20	0.216 (TBV)	0.681 (TBV)	0.179 (TBV)	0.613 (TBV)
100	0.123 (TBV)	0.391 (TBV)	0.083 (TBV)	0.288 (TBV)

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 1–2 Hz Frequency Range

	Horizontal Motion (g)		Vertical Motion (g)	
Response Frequency (Hz)	Frequency Category 1 (1,000 Year Recurrence)	Frequency Category 2 (10,000 Year Recurrence)	Frequency Category 1 (1,000 Year Recurrence)	Frequency Category 2 (10,000 Year Recurrence)
0.3	0.0497 (TBV)	0.186 (TBV)	0.0266 (TBV)	0.101 (TBV)
0.5	0.0747 (TBV)	0.252 (TBV)	0.0428 (TBV)	0.149 (TBV)
1	0.0927 (TBV)	0.286 (TBV)	0.0659 (TBV)	0.206 (TBV)
2	0.163 (TBV)	0.465 (TBV)	0.0717 (TBV)	0.212 (TBV)
5	0.183 (TBV)	0.471 (TBV)	0.115 (TBV)	0.309 (TBV)
10	0.151 (TBV)	0.374 (TBV)	0.112 (TBV)	0.295 (TBV)
20	0.123 (TBV)	0.302 (TBV)	0.0936 (TBV)	0.244 (TBV)
100	0.0915 (TBV)	0.231 (TBV)	0.0591 (TBV)	0.156 (TBV)

Table I-5. Parameters for the Vibratory Ground Motion Design Basis Earthquake–Subsurface Environment–Repository Interface (Underground) Design Peak Velocity for Design Earthquake Scaled to 5–10 Hz and 1–2 Hz Frequency Ranges

Design Earthquake Frequency (Hz)	Horizontal Motion (cm/sec)		Vertical Motion (cm/sec)	
	Frequency Category 1 (1,000 Year Recurrence)	Frequency Category 2 (10,000 Year Recurrence)	Frequency Category 1 (1,000 Year Recurrence)	Frequency Category 2 (10,000 Year Recurrence)
5 – 10	13.42 (TBV)	33.63 (TBV)	6.26 (TBV)	17.10 (TBV)
1 – 2	14.73 (TBV)	41.84 (TBV)	7.55 (TBV)	22.38 (TBV)

Table I-6. Parameters for the Ground Displacement Design Basis Earthquake–Surface and Subsurface Environment

Ground Displacement Design Basis Earthquake	Fault Displacement (cm)		Comment
	Surface	Subsurface	
Frequency Category 1 (10,000 Year Recurrence)	(TBD)	Less than 1 (TBV)	Considered insignificant with respect to repository design
Frequency Category 2 (100,000 Year Recurrence)	(TBD)	Less than 1 (TBV)	Considered insignificant with respect to repository design except for block-bounding fault displacements: Bow Ridge 12 cm (TBV) Solitario Canyon 30 cm (TBV)

[F 1.1.12][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 locomotive and WP transporter shall be designed to not dislodge from their rails during a Frequency Category 1 (TBV-1246) design basis earthquake.

[F 1.1.12][MGR RD 3.1.C, 3.1.G][10 CFR 63.112(e)(10)]

1.2.2.1.8 The system shall be designed to retain the WP inside the WP transporter during credible design basis events.

[F 1.1.12][MGR RD 3.1.C, 3.1.G][10 CFR 63.112(e)(10)]

1.2.2.1.9 The system shall be designed in accordance with the project ALARA (as low as is reasonably achievable) program goals (TBD-406) and the applicable guidelines in "Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations Will Be As Low As Is Reasonably Achievable" (Regulatory Guide 8.8).

[F 1.1.11][MGR RD 3.1.B, 3.1.C, 3.1.G][10 CFR 63.111(a)(1)]

1.2.2.1.10 The system shall limit the use of diesel-powered equipment to less than the amount identified in a Site Performance Protection Analysis.

[F 1.1.5, 1.1.10, 1.1.12, 1.1.14]

1.2.2.2 Non-Nuclear Safety Criteria

1.2.2.2.1 The system shall provide features to ensure Performance Confirmation "dummy" WPs are disconnected from all instrument leads and power sources prior to recovery.

[F 1.1.5, 1.1.16]

1.2.3 System Environment Criteria

1.2.3.1 The system shall be designed such that components susceptible to radiation can withstand and operate in the radiation environment (TBD-405) in which the component is located.

[F 1.1.10][MGR RD 3.3.A]

1.2.3.2 The system components shall be designed to withstand and operate in the WHB temperature environment defined in Table I-7 for the area in which the component is located.

Table I-7. Temperature Environment

Location of System Component	Normal Environment	Off-Normal Environment
Normally Occupied Areas (e.g., Offices, Maintenance Areas, Access Control)	24 - 22°C (76 - 72°F) Note 1	(TBD-395) °C for (TBD-395) Hours
Normally Unoccupied Areas (e.g., Mechanical & Electrical Equipment Rooms, Cask Receiving & Handling Areas, Pool Areas)	32 - 18°C (90 - 65°F) Note 1	(TBD-395) °C for (TBD-395) Hours
Unoccupied Areas (e.g., Assembly Cells, Canister Transfer Cells, DC Handling Cells)	40 - 18°C (104 - 65°F) Note 1	(TBD-395) °C for (TBD-395) Hours
Electronics Equipment Areas (e.g., Control Rooms, Computer Rooms, Communications Equipment Rooms, Data Processing and Recording Equipment Rooms)	22°C (72°F) Note 1	22°C (72°F) Note 2

Note 1: Special provisions shall be provided if the specified temperature environment is not within the limits specified by the equipment manufacturer.

Note 2: It is intended to maintain these areas at the specified temperature under all anticipated conditions. However, due to economic or design impracticability, areas that house less sensitive electronic components may not be maintained at this temperature. In these cases, cooling will be provided for the electronic components, but not necessarily the entire area.

[F 1.1.10][MGR RD 3.1.G, 3.3.A]

1.2.3.3 The system shall be designed to withstand and operate in the extreme outside temperature environment of -15 degrees C to 47 degrees C.

[F 1.1.10][MGR RD 3.3.A]

1.2.3.4 The system shall be designed to withstand and operate in the extreme subsurface temperature environment of 7 degrees C (TBV-3935) to 50 degrees C.

[F 1.1.10][MGR RD 3.3.A]

1.2.3.5 The system components shall be designed to withstand and operate in the WHB humidity environment defined in Table I-8, for the area in which the component is located.

Table I-8. Humidity Environment

Location of System Component	Normal Environment	Off-Normal Environment
Normally Occupied Areas (e.g., Offices, Maintenance Areas, Access Control)	30% - 60% Note 1	Humidity Not Controlled Note 2
Normally Unoccupied Areas (e.g., Mechanical & Electrical Equipment Rooms, Cask Receiving & Handling Areas, Pool Areas)	(TBD-409) Note 1	Humidity Not Controlled Note 2
Unoccupied Areas (e.g., Assembly Cells, Canister Transfer Cells, DC Handling Cells)	(TBD-409) Note 1	Humidity Not Controlled Note 2
Electronics Equipment Areas (e.g., Control Rooms, Computer Rooms, Communications Equipment Rooms, Data Processing and Recording Equipment Rooms)	40% - 50% Note 1	Humidity Not Controlled Note 2

Note 1: Special provisions shall be provided if the specified humidity environment is not within the limits specified by the equipment manufacturer.
Note 2: Humidity control is not provided due to the mild humidity environment at the repository, and the expected short duration of off-normal conditions.

[F 1.1.10][MGR RD 3.1.G, 3.3.A]

1.2.3.6 The system shall be designed to withstand and operate in the surface external relative humidity environment described in Table I-9.

Table I-9. Surface External Relative Humidity Environment

Parameter	Value
Annual mean value	28%
Minimum summer mean value (June)	13%
Maximum winter mean value (December)	46%

[F 1.1.10][MGR RD 3.3.A]

1.2.3.7 The system shall be designed to withstand and operate in the subsurface relative humidity environment (TBD-389).

[F 1.1.10][MGR RD 3.3.A]

1.2.3.8 The system shall be designed to withstand and operate in the precipitation environment described in Table I-10.

Table I-10. Precipitation (Rainfall)

Parameter	Range/Maximum
Maximum annual precipitation	25 cm/yr (10 in./yr)
Maximum daily precipitation	13 cm/day (5 in./day)

[F 1.1.10][MGR RD 3.3.A]

1.2.3.9 The Waste Package Transporter and Locomotives shall be designed for a maximum wind speed of 54.1-m per second (121 miles per hour).

[F 1.1.10][MGR RD 3.3.A]

1.2.4 System Interfacing Criteria

1.2.4.1 The system shall operate within the surface facilities' physical envelopes of (TBD-257).

[F 1.1.1, 1.1.2, 1.1.4, 1.1.5, 1.1.14]

1.2.4.2 The system shall transport WPs over a maximum distance of 10 km between the WHB and the emplacement drift entrance.

[F 1.1.1, 1.1.2, 1.1.4, 1.1.5, 1.1.14]

1.2.4.3 The portions of the system supporting emplacement shall operate over a maximum grade of ±2.5 percent outside of emplacement drifts and a maximum grade of ±1 percent within the emplacement drifts.

[F 1.1.1, 1.1.2, 1.1.3]

1.2.4.4 The portions of the system supporting retrieval, recovery, and restoration shall operate over a maximum grade of ±2.7 percent outside of emplacement drifts and a maximum grade of ±1 percent within the emplacement drifts.

[F 1.1.4, 1.1.5, 1.1.14]

1.2.4.5 The system shall operate, where practical, on the track provided by the Subsurface Emplacement Transportation System as identified in Table I-11.

Table I-11. Rail Interface

Area	Rail Interface
Surface Facilities, Ramps, Main Drifts, and Turnouts	1.44 m (56 1/2 in.) gage (TBV-274)
Emplacement Drifts	2.95 m (116 in.) rail center to center spacing (TBV-274)

[F 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.1.14]

1.2.4.6 The system shall operate within the Subsurface Emplacement Transportation System curvatures identified in Table I-12. (TBV-253)

Table I-12. Subsurface Waste Emplacement Transportation System Curvatures

Location	Minimum Radius
Ramps and Mains	305 m (TBV)
On the Surface and Within Emplacement Drift Turnouts	20 m (TBV)

[F 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.1.14]

1.2.4.7 The system shall accommodate a minimum 0.80-m (TBV-254) difference in elevation between the bottom of the turnout and the bottom of the emplacement drift.

[F 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.1.14]

1.2.4.8 The system shall emplace and retrieve WPs from emplacement drifts having a maximum length of 700 m.

[F 1.1.3, 1.1.4]

1.2.4.9 The system shall be capable of restoring portions of the system located in, and recovering WPs from, emplacement drifts via the adjoining emplacement drift, with each drift having a maximum length of 700 m.

[F 1.1.5, 1.1.14]

1.2.4.10 The system shall operate within the Ground Control System physical envelopes including clearance provisions for other subsurface system equipment placed in the underground openings as defined in Table I-13 and Figure I-1 (invert and waste package details shown in the figure are for information only).

Table I-13. Physical Envelopes

Subsurface Area	Physical Envelope for the Waste Emplacement System
Main Drifts and Ramps	Equipment Height: 5.60 m (TBV-253) Equipment Width: 3.55 m (TBV-253)
Drift Turnouts	Equipment Height: 5.60 m (TBV-253) Equipment Width: 6.15 m (TBV-253)

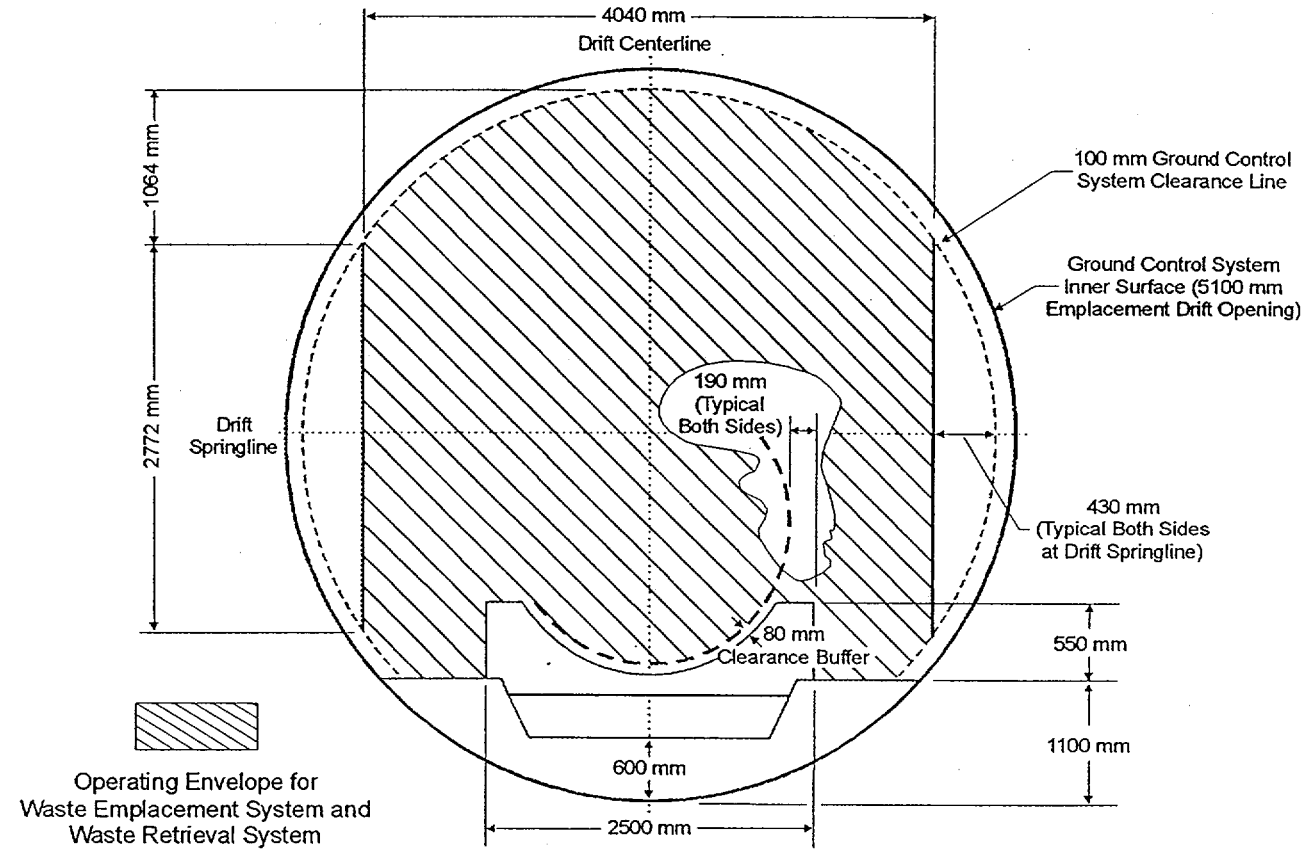

Figure I-1. Emplacement Drift Clearance Envelope

[F 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.1.14]

1.2.4.11 The system shall receive electrical power from the Subsurface Emplacement Transportation System.

[F 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.1.14]

1.2.4.12 The system shall operate with an electrical power feed provided by the Subsurface Emplacement Transportation System at both ends of an emplacement drift.

[F 1.1.4, 1.1.5, 1.1.14]

1.2.4.13 The system shall receive and provide the operational information, status, and control data defined in Table I-14 to the MGR Operations Monitoring and Control System.

Table I-14. System Inputs/Outputs

Inputs	Outputs
Radiation monitoring data and status	Equipment status and status of operations
Subsurface Electrical Distribution System data and status monitoring	Equipment alarm status
Subsurface Fire Suppression System data and status monitoring	Control equipment status and alarms
WP identification and tracking data	Interlock status
Operational message advisory	Video signals
Activity plans and procedures	Communications equipment status
Emergency response commands	Timeout warnings for handling equipment
MGR operational alarm status	Control loads left in improper states (suspended loads, unattended controls, etc.)
Remote Control of System Equipment	

[F 1.1.1, 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.1.14][MGR RD 3.1.C, 3.2.C, 3.2.E, 3.3.K][10 CFR 63.111(a)(2), 63.111(b)(2), 63.112(e)(8)]

1.2.4.14 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."

[F 1.1.1, 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.1.16]

1.2.4.15 The system shall accommodate a WP maximum surface dose rate of TBD-3764.

[F 1.1.1, 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.1.16]

1.2.4.16 The system shall accommodate a maximum WP thermal output of 11.8 kW.

[F 1.1.1, 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.1.16]

1.2.4.17 The system shall limit dynamic and handling loads to within the design limits of the WPs, facilities, and support systems.

[F 1.1.1, 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.1.14][MGR RD 3.3.A, 3.4.2.C]

1.2.4.18 The system equipment operating in the emplacement drift shall pass through the emplacement drift isolation doors to each emplacement drift.

[F 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.1.14]

1.2.4.19 The system shall provide features to obtain the WP unique identifiers and emplacement locations for data input into Safeguards and Security System.

[F 1.1.9][MGR RD 3.1.C, 3.1.D, 3.3.K][10 CFR 63.78]

1.2.5 Operational Criteria

1.2.5.1 The system shall include provisions for the inspection, testing, and maintenance of system equipment.

[F 1.1.1, 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.1.13, 1.1.14][MGR RD 3.1.C, 3.1.G, 3.3.A][10 CFR 63.112(e)(13)]

1.2.5.2 The inherent availability for the system shall be greater than 0.9485.

[F 1.1.1, 1.1.2, 1.1.3][MGR RD 3.3.A]

1.2.6 Codes and Standards Criteria

1.2.6.1 The system shall comply with the applicable provisions of "Standards for Protection Against Radiation" (10 CFR 20).

[F 1.1.1, 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.1.11, 1.1.14][MGR RD 3.1.B]

1.2.6.2 The system shall comply with the applicable provisions of "Occupational Safety and Health Standards" (29 CFR 1910).

[F 1.1.1, 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.1.14][MGR RD 3.1.E]

1.2.6.3 Design of steel structural members shall be in accordance with "Manual of Steel Construction Allowable Stress Design."

[F 1.1.1, 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.1.14][MGR RD 3.1.G]

1.2.6.4 The system designs shall be in accordance with the applicable requirements from Sections 5.2, 5.6, 6.2, and 6.6 of "American National Standard Design Requirements for Light Water Reactor Spent Fuel Storage Facilities at Nuclear Power Plants" (ANSI/ANS-57.2-1983).

[F 1.1.1, 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.1.14][MGR RD 3.1.G]

1.2.6.5 The system designs shall be in accordance with the applicable requirements from Sections 5.1.1, 5.1.5, 5.8, 5.11, 6.1.1, 6.1.5, 6.8, and 6.11 of "Design Criteria for an Independent Spent Fuel Storage Installation (Dry Type)" (ANSI/ANS-57.9-1992).

[F 1.1.1, 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.1.14][MGR RD 3.1.G]

1.2.6.6 The system shall be designed in accordance with Section 4 of "Radioactive Materials - Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4,500 Kg) or More" (ANSI N14.6-1993).

[F 1.1.1, 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.1.14][MGR RD 3.1.G]

1.2.6.7 The system designs shall be in accordance with Sections 1 and 2 of "Structural Welding Code - Steel" (ANSI/AWS D1.1-98).

[F 1.1.1, 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.1.14][MGR RD 3.1.G]

1.2.6.8 Construction of overhead and gantry cranes shall be in accordance with "Rules for Construction of Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder)" (ASME NOG-1).

[F 1.1.1, 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.1.14][MGR RD 3.1.G]

1.2.6.9 The system designs shall be in accordance with "Specifications for Top Running Bridge & Gantry Type Multiple Girder Electric Overhead Traveling Cranes" (CMAA Specification No. 70).

[F 1.1.1, 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.1.14][MGR RD 3.1.G]

1.2.6.10 The system designs shall be in accordance with the applicable requirements of Sections 7.4.5 and 7.4.6 of Draft Report for Comment "Standard Review Plan for Spent Fuel Dry Storage Facilities" (NUREG-1567).

[F 1.1.1, 1.1.2, 1.1.3, 1.1.4, 1.1.5, 1.1.14][MGR RD 3.1.G]

1.2.6.11 The system shall be designed in accordance with the applicable sections of the "National Electrical Code" (NFPA 70).

[MGR RD 3.3.A]

1.2.6.12 The system shall comply with the applicable assumptions contained in the "Monitored Geologic Repository Project Description Document."

1.2.6.13 The system shall comply with the applicable provisions of "Safety and Health Regulations for Construction" (29 CFR 1926).

[MGR RD 3.1.F]

1.3 SUBSYSTEM DESIGN CRITERIA

There are no subsystem design criteria for this system.

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-15 correlates primary verification methodologies for system design 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.

Table I-15. Conformance Verification

Criterion		Verification Method Code				
Number	Title	N/A	Analysis	Exam	Demo	Test
1.2	SYSTEM DESIGN CRITERIA	X				
1.2.1	System Performance Criteria	X				
1.2.1.1			X			
1.2.1.2			X			
1.2.1.3			X			
1.2.1.4			X			
1.2.1.5			X			
1.2.1.6			X			
1.2.1.7			X			
1.2.1.8			X			
1.2.1.9					X	
1.2.1.10					X	
1.2.1.11			X			
1.2.1.12					X	
1.2.1.13					X	
1.2.1.14				X		
1.2.1.15			X			
1.2.1.16			X			
1.2.1.17			X			
1.2.1.18			X			
1.2.1.19			X			
1.2.1.20			X			
1.2.1.21			X			
1.2.1.22			X			
1.2.1.23			X			
1.2.1.24				X		
1.2.1.25			X			
1.2.2	Safety Criteria	X				
1.2.2.1	Nuclear Safety Criteria	X				
1.2.2.1.1			X			
1.2.2.1.2			X			
1.2.2.1.3			X			
1.2.2.1.4			X			
1.2.2.1.5					X	
1.2.2.1.6			X			
1.2.2.1.7			X			
1.2.2.1.8			X			
1.2.2.1.9			X			
1.2.2.1.10			X			
1.2.2.2	Non-Nuclear Safety Criteria	X				
1.2.2.2.1			X			
1.2.3	System Environment Criteria	X				
1.2.3.1			X			
1.2.3.2			X			
1.2.3.3			X			
1.2.3.4			X			
1.2.3.5			X			
1.2.3.6			X			
1.2.3.7			X			
1.2.3.8			X			
1.2.3.9			X			

Table I-15. Conformance Verification (Continued)

Criterion		Verification Method Code				
Number	Title	N/A	Analysis	Exam	Demo	Test
1.2.4	System Interfacing Criteria	X				
1.2.4.1				X		
1.2.4.2			X			
1.2.4.3					X	
1.2.4.4					X	
1.2.4.5					X	
1.2.4.6					X	
1.2.4.7					X	
1.2.4.8					X	
1.2.4.9					X	
1.2.4.10				X		
1.2.4.11				X		
1.2.4.12				X		
1.2.4.13					X	
1.2.4.14			X			
1.2.4.15			X			
1.2.4.16			X			
1.2.4.17			X			
1.2.4.18					X	
1.2.4.19			X			X
1.2.5	Operational Criteria	X				
1.2.5.1			X			
1.2.5.2			X			
1.2.6	Codes and Standards Criteria	X				
1.2.6.1			X			
1.2.6.2			X			
1.2.6.3			X			
1.2.6.4			X			
1.2.6.5			X			
1.2.6.6			X			
1.2.6.7			X			
1.2.6.8			X			
1.2.6.9			X			
1.2.6.10			X			
1.2.6.11			X			
1.2.6.12			X			
1.2.6.13			X			
1.3	SUBSYSTEM DESIGN CRITERIA	X				

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 "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" 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 criterion establishes the operational life of the portions of the system that support waste emplacement. This criterion is required because this system supports the waste handling operations at the repository as required by MGR RD 3.2.C. Additional system operating life, that may be needed to support performance confirmation or retrieval operations conducted after cessation of waste emplacement operations, is not covered by this criterion. To meet the operational life requirement, system components may require replacement in addition to any required preventive maintenance program.

II. Criterion Performance Parameter Basis

MGR RD 3.2.C requires the MGR to be capable of receiving, packaging, emplacing, and isolating nuclear waste at the annual rates specified in Table 3-2 of the MGR RD. Table 3-2 of the MGR RD indicates that waste receipt will commence in the year 2010 and is expected to be completed by the year 2041, spanning a total of 32 years. To account for future potential schedule fluctuations caused by uncertainties in waste remediation, early receipt, and plant life extensions, a 25 percent margin is added, bringing the required operational life of the system to 40 years.

1.2.1.2 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to define the length of time that the portions of the system that support retrieval, recovery, and restoration need to be operable. This criterion is required because this system supports the waste handling operations at the repository as required by MGR RD 3.2.C. This criterion also supports the retrieval requirements of MGR RD 3.2.H, 3.2.J, 3.1.C, and 10 CFR 63.111(e)(1). The system will not be in continuous operation during the entire time period, but the system will need to be designed to perform retrieval and recovery operations at any time during the operational period. In addition, this system supports Performance Confirmation, and this criterion establishes the minimum length of time the system will be needed to support Performance Confirmation operations. The system must continue operations until repository closure, as required by MGR RD 3.1.C and 10 CFR 63.111(d), 10 CFR 63.131(b), and 10 CFR

63.134(d). To meet the operational life requirement, system components may require replacement in addition to any required preventive maintenance program.

II. Criterion Performance Parameter Basis

The operational life of 160 years after the initiation of MGR emplacement is derived from MGR RD 3.2.H and 3.2.J. MGR RD 3.2.H provides a maximum MGR lifetime (excluding the provisional lifetime) of up to 125 years. Conceivably, the order to retrieve could be given at any time up to the time of closure. If the order to retrieve were issued immediately before closure, this system would then have 34 years to complete retrieval operations, as required by MGR RD 3.2.J. Adding the two timespans together gives 159 years, which is rounded up to 160 years in this criterion. The need for recovery and/or restoration may occur at any time up to closure, and thus, the same lifetime is levied upon those portions of the system.

1.2.1.3 Criterion Basis Statement

I. Criterion Need Basis

This criterion establishes the additional length of time the portions of the system that support retrieval, recovery, and restoration may be asked to operate to allow future generations to continue monitoring the repository. The system must continue operations until repository closure, as required by MGR RD 3.1.C, 10 CFR 63.111(d), 10 CFR 63.131(b), and 10 CFR 63.134(d). This criterion also supports the retrieval requirements of MGR RD 3.2.H, 3.1.C, and 10 CFR 63.111(e)(1).

II. Criterion Performance Parameter Basis

The provisional life of 300 years after the initiation of MGR emplacement is taken directly from MGR RD 3.2.H.

1.2.1.4 Criterion Basis Statement

I. Criterion Need Basis

This criterion defines the figure of merit for how fast the system has to emplace waste so that the overall MGR rates can be met. This criterion supports MGR RD 3.2.C and 3.2.E.

II. Criterion Performance Parameter Basis

N/A

1.2.1.5 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to establish the time period within which the system must retrieve all emplaced WPs to support MGR RD 3.2.J, 3.1.C, 10 CFR 63.111(e)(1), and 63.111(e)(3).

II. Criterion Performance Parameter Basis

The time period during which the system must retrieve all emplaced WPs is taken directly from MGR RD 3.2.J.

1.2.1.6 Criterion Basis Statement

I. Criterion Need Basis

This requirement establishes the minimum number of WPs that the system must be able to emplace and retrieve. This criterion responds to MGR RD 3.1.C, 3.2.C, and 10 CFR 63.111(e)(1).

II. Criterion Performance Parameter Basis

Criterion Basis Statement Analysis: Number of WPs Emplaced

Purpose

The purpose of this analysis is to establish the number of WPs to be emplaced.

Assumptions

1. The option used for loading high-level waste (HLW) and Department of Energy Owned Spent Nuclear Fuel (DSNF) canisters into disposal containers (DCs) will be the "co-disposal" option.

Rationale: The "Waste, Quantity, Mix and Throughput Study Report," Paragraph 5.3, identifies two loading options, a "co-disposal" and a "separate" option. The co-disposal option denotes disposal of most of the DSNF in a "5-Pack" HLW DC (1 DSNF canister in each HLW DC). In this option, certain DSNF waste (such as Naval spent nuclear fuel (SNF)) is disposed of separately. The separate option denotes separate disposal of HLW (4 canisters in one DC) and DSNF. The co-disposal option is used as the reference option in the "Waste, Quantity, Mix and Throughput Study Report," as that option offers a reduction in the total number of WPs by approximately 2,000 containers.

2. A total of 10,305 WPs will need to be emplaced.

Rationale: The schedule shown in the "Waste Quantity, Mix and Throughput Study Report," Table 5-6, identifies 7,759 DCs required for Canistered Spent Nuclear Fuel

(CSNF). The same report (Table 5-9) also identifies a total of 2,546 DCs for HLW and DSNF. The total of 10,305 is determined by adding 7,759 and 2,546.

3. The disposal of 50 MT of surplus weapons-grade plutonium will require a maximum of approximately 42 WPs in addition to those required for HLW/DSNF.

Rationale: "Incorporate Plutonium Disposition Materials in the CRWMS Baseline" (Baseline Change Proposal BCP-00-98-0001) requires that the MGR dispose of approximately 50 MT of surplus weapons-usable plutonium (p. 1). It further states that for planning purposes a 2:1 split of 33 MT of MOX SNF (to be disposed of in CNSF WPs) and 17 MT of immobilized plutonium (to be disposed of inside HLW canisters within HLW WPs) will be used (pp.3, 4). This results in an additional 10 CNSF WPs and an additional 14 HLW WPs (p. 23). This would be an overall increase of 24 WPs as a result of plutonium disposal. It is noted, however, that all 50 MT may be disposed of as immobilized plutonium (p. 2). Multiplying the number of additional HLW WPs by 3 to compensate for all immobilized plutonium disposal gives 42 additional WPs. Since 42 additional WPs is bounding and permitted under the baseline change proposal, it is used here to determine the bounding number of WPs to be emplaced.

Criteria Analysis: This section investigates the total number of WPs to be transported and emplaced by the system.

The total number of WPs to be emplaced by the system is 10,305 per Assumption 2. Approximately 42 HLW DCs are required to accommodate the disposal of immobilized plutonium per Assumption 3. Adding 10,305 and 42 provides 10,347 as the maximum number of WPs. Rounding 10,347 up to the nearest 1,000 WPs provides a conservative margin in the number of WPs to be emplaced by the system. The maximum number to be emplaced by the system is therefore 11,000 WPs.

Conclusion

The system is required to transport and emplace 11,000 WPs.

*The software and data used to generate throughput data in "Waste Quantity, Mix and Throughput Study Report" were not qualified. However, it is stated that the report does provide input to repository design. The input used in this analysis based on the report was necessary to establish bounds for design with adequate conservative margins, and hence does not disqualify the results of the analysis. Additionally, the bounding design criteria do not affect nuclear safety.

Note: Donald F. Smith and Ovadia Lev assisted with the preparation of the preceding Criterion Basis Statement Analysis.

1.2.1.7 Criterion Basis Statement

I. Criterion Need Basis

This requirement establishes the minimum number of WPs that the system must be able to recover. It also establishes the role of the system to perform recovery of small numbers of selected WPs under normal and abnormal conditions. This criterion is different from the number of WPs to be retrieved because recovery may be conducted under much harsher conditions than retrieval, and the uses of alternate power sources may limit the effort spent in recovering a WP.

Also, this criterion establishes the ability of the system to support recovery of "dummy" WPs to support Performance Confirmation activities (as a lower level decomposition of 10 CFR 63.131(d)(3)). The need to recover "dummy" WPs is documented in "Performance Confirmation Plan," Sections 3.3.3.4 and Section 4.3, Test Scope Sheet 4.3.4. No special mention of "dummy" WPs is made in the criterion since there is no reason to believe that recovery of a "dummy" WP will be any different than recovery of a real WP.

This criteria responds to MGR RD 3.1.C, 10 CFR 63.111(d), 10 CFR 63.111(e)(1), and 10 CFR 63.131(d)(3).

II. Criterion Performance Parameter Basis

N/A

1.2.1.8 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to establish the emplacement mode. Horizontal in-drift emplacement of WPs is the reference design concept for the MGR.

II. Criterion Performance Parameter Basis

N/A

1.2.1.9 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to support line loading of WPs within emplacement drifts.

II. Criterion Performance Parameter Basis

The WP spacing is obtained from "Monitored Geologic Repository Project Description Document," Section 2.2.1.1.8.

1.2.1.10 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to support proper implementation of line loading as defined by the Emplacement Drift System. Placement of WPs too far away from the intended location could result in unacceptable temperature variations along the length of the emplacement drift.

II. Criterion Performance Parameter Basis

N/A

1.2.1.11 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to determine the location to which the system will transport retrieved WPs, in support of MGR RD 3.1.C and 10 CFR 63.111(e)(1)

II. Criterion Performance Parameter Basis

The location of the potential lag storage area that may support retrieval is obtained from "Repository Surface Design Site Layout Analysis," Attachment I, Figure 4. The distance, as shown on Figure 4, from the edge of the WHB to the farthest edge of the Potential Onsite Storage Area is approximately 2 miles. The unverified value used in this criterion is rounded up to 2.5 miles to account for limited deviations in the location of the WHB, the location of the potential storage area, and the path by which the system would traverse the distance.

1.2.1.12 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to define the capability of the system to support recovery operations. Failed ground support and rockfall are conditions that would lead to initiation of recovery operations.

II. Criterion Performance Parameter Basis

N/A

1.2.1.13 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to define the capability of the system to support recovery operations. Failed ground support and rockfall are conditions that would lead to initiation of recovery operations.

II. Criterion Performance Parameter Basis

N/A

1.2.1.14 Criterion Basis Statement

I. Criterion Need Basis

This criterion supports the requirement to maintain the option of retrievability as specified in MGR RD 3.1.C, and 10 CFR 63.111(e)(1), and also supports the recovery of a WP after a failure in the ground support.

II. Criterion Performance Parameter Basis

N/A

1.2.1.15 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to define the capability of the system to support recovery operations. Failed ground support and rockfall are conditions that would lead to initiation of recovery operations. Partial or full occlusion (and accompanying reduced ventilation) of the emplacement drift at some point in its length may result from the ground support failure and rockfall.

II. Criterion Performance Parameter Basis

N/A

1.2.1.16 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to define the capability of the system to support recovery operations. An abnormal event may damage the ability of the Subsurface Emplacement Transportation System to provide adequate rail and power up to the WP to be recovered, and may also damage the ability of the Site Communications System to provide communications for remote control of the system.

II. Criterion Performance Parameter Basis

N/A

1.2.1.17 Criterion Basis Statement

I. Criterion Need Basis

This requirement is needed to ensure that recovery operations may be conducted even if access to the WPs to be recovered from the normal entrance to the emplacement drift is not practical. It should be noted that the emplacement drift in the current design is the tunnel between the emplacement drift isolation doors and the ventilation raise. Thus, this criterion requires the capability to recover WPs from the end of the emplacement drift with the ventilation raise, which would require crossing over the ventilation raise in the current design.

This criterion is derived from "Retrievability Strategy Report," Section 8.2.1.1.

II. Criterion Performance Parameter Basis

N/A

1.2.1.18 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to define the capability of the system to support recovery operations. A breached WP is one of the conditions that would lead to initiation of recovery operations. This criterion is intended to limit the spread of contamination during the transfer of a breached or contaminated WP to the surface. This criteria responds to MGR RD 3.1.C, 3.1.G, and 10 CFR 63.112(e)(1).

This criterion is supported by guidance contained in the "MGR Compliance Program Guidance Package for the Waste Emplacement System," guidance statement 6.6g6, and "MGR Compliance Program Guidance Package for the Waste Retrieval System," guidance statement 6.6g6.

II. Criterion Performance Parameter Basis

N/A

1.2.1.19 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to define the capability of the system needed to support emplacement, retrieval, and recovery operations. Heat removal from the WP is essential

to maintaining the waste forms below their temperature limits. This criterion supports MGR RD 3.2.L.

II. Criterion Performance Parameter Basis

The maximum temperature value for zircaloy clad SNF was established in "Site Characterization Plan: Yucca Mountain Site, Nevada Research and Development Area, Nevada," Section 7.2.1.3.3. This number was reaffirmed in "Site Characterization Plan Thermal Goals Reevaluation," p. 20; and again in "Thermal Loading Study for FY 1996," Section 7, p. 7-7.

The maximum temperature value for vitrified HLW is consistent with the higher limit (500 degrees C) established in "Site Characterization Plan: Yucca Mountain Site, Nevada Research and Development Area, Nevada," Section 7.2.1.3.3. The higher limit was reaffirmed in "Site Characterization Plan Thermal Goals Reevaluation," p. 20. However, the "Waste Acceptance System Requirements Document," Section 4.2.3.1.G.1, conservatively reduces the temperature limit to the value shown in the criterion.

The other values have not yet been determined.

1.2.1.20 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to ensure that WPs that are moved to enable recovery or retrieval of another WP are re-emplaced.

Also, this criterion establishes the ability of the system to support emplacement of "dummy" WPs to support Performance Confirmation activities (as a lower level decomposition of MGR RD 3.1.C, 10 CFR 63.111(d), and 10 CFR 63.131(d)(3)). The need to emplace "dummy" WPs is documented in "Performance Confirmation Plan," Sections 3.3.3.4 and Section 4.3, Test Scope Sheet 4.3.4. No special mention of "dummy" WPs is made in the criterion since there is no reason to believe that emplacement of a "dummy" WP will be any different than emplacement of a real WP.

II. Criterion Performance Parameter Basis

N/A

1.2.1.21 Criterion Basis Statement

I. Criterion Need Basis

This criterion reduces the accumulation of fixed contamination and supports radiological safety for personnel. This criterion supports MGR RD 3.1.G and 3.3.A.

This criterion is supported by guidance contained in the "MGR Compliance Program Guidance Package for the Waste Emplacement System," guidance statements 6.6g3,

6.6g5, 6.7g3, and 6.7g5; and "MGR Compliance Program Guidance Package for the Waste Retrieval System," guidance statements 6.6g3, 6.6g5, 6.7g3, and 6.7g5.

II. Criterion Performance Parameter Basis

N/A

1.2.1.22 Criterion Basis Statement

I. Criterion Need Basis

This criterion establishes the role of the system to aid in the restoration of the system after an abnormal event. Derailment is one of the possible events that would disable the system. This criterion supports MGR RD 3.1.G.

This criterion is supported by guidance contained in the "MGR Compliance Program Guidance Package for the Waste Emplacement System," guidance statement 6.6g6; and "MGR Compliance Program Guidance Package for the Waste Retrieval System," guidance statement 6.6g6.

II. Criterion Performance Parameter Basis

N/A

1.2.1.23 Criterion Basis Statement

I. Criterion Need Basis

This criterion establishes the role of the system to aid in the restoration of the system after an abnormal event. Derailment is one of the possible events that would disable the system. This criterion is intended to cover the derailment events that are not covered in the previous criterion. This criterion supports MGR RD 3.1.G.

This criterion is supported by guidance contained in the "MGR Compliance Program Guidance Package for the Waste Emplacement System," guidance statement 6.6g6; and "MGR Compliance Program Guidance Package for the Waste Retrieval System," guidance statement 6.6g6.

II. Criterion Performance Parameter Basis

N/A

1.2.1.24 Criterion Basis Statement

I. Criterion Need Basis

The tracks that the system will use are located underground. Loose rock and ground support materials are likely to fall from the roof over time as the repository ages and

ground support measures deteriorate. Furthermore, much of the track is in sections that will be accessed infrequently. Without frequent traffic, debris is likely to build up. Loose rock and other debris on the track or in the flange way next to the track may cause derailments. Derailments can result whenever debris causes a wheel to be lifted off the rail far enough to allow the flange to clear or ride over the top of the rail. This lifting can occur if the wheel surface encounters a piece of debris small enough to become wedged under the wheel. It can also occur if the edge of the flange rides up on a piece of debris.

This criterion is needed to ensure that loose rock that may accumulate on or near the rails will not derail the system.

II. Criterion Performance Parameter Basis

1. Minimum Debris Size Clearing

A derailment is not likely unless the wheel is lifted the depth of the flange. Applying a safety factor of 2, any obstruction less than one-half the depth of a flange should not present a derailment hazard.

Examination of "Manual of Standards and Recommended Practices Section G -- Wheels and Axles" (Figures 9 and 10 of Specifications M-107-84 and M-208-84, freight car and locomotive standard wheels; and Standard S-657-81, passenger car wheel) indicates that a flange height of 1 in. is consistently used for all standard wheels. Thus, the system should be able to clear debris a minimum of 0.5 in. from the top of the rail and the flange way in front of the system rail mounted equipment as the equipment moves forward.

2. Maximum Debris Size Clearing

A derailment is not likely if the debris is so big that the wheel will tend to push the debris rather than ride up on it. The wheel cannot ride up on the debris if the top of the debris is above the center of the wheel.

The largest wheel size chosen for the system will drive the largest debris to be cleared from the tracks, since any smaller wheel encountering the debris would tend to push the debris rather than ride up on it, as mentioned above. Examination of "Manual of Standards and Recommended Practices Section G -- Wheels and Axles" (Figures 9 and 10 of Specifications M-107-84 and M-208-84, freight car and locomotive standard wheels; and Standard S-657-81, passenger car wheel) and "Specifications for Top Running Bridge & Gantry Type Multiple Girder Electric Overhead Traveling Cranes" (Table 4.13.3-4) indicates that the largest standard wheel is a locomotive wheel, 42 in. in diameter. Thus, the system should be designed to clear debris from the rail with a maximum size of 21 in.

1.2.1.25 Criterion Basis Statement

I. Criterion Need Basis

This criterion establishes the role of the system to decontaminate the underground after an abnormal event.

II. Criterion Performance Parameter Basis

Existing standards for levels at which areas are decontaminated are chosen for use in this criterion from the "U.S. Department of Energy Radiological Control Manual," Section 222. Allowances for the use of fixative coatings for areas that cannot be properly decontaminated are also supported in Section 222 and are included here to recognize that all areas may not be able to be adequately decontaminated.

1.2.2.1.1 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to prevent damage to a loaded WP as a result of a runaway WP transporter, which could result in a radiological release. This criterion supports the implementation 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).

This criterion implements a portion of the safety strategy as described in "Decision Package Executive Summary, Strategy to Mitigate Preclosure Offsite Exposure," Description IV of Options 1 and 2. The executive summary is an attachment to interoffice correspondence "Strategy to Mitigate Preclosure Offsite Exposure," and is controlled by input transmittal "Strategy to Mitigate Preclosure Offsite Exposure" (RSO-RSO-99352.T). A portion of that safety strategy is to avoid the occurrence of design basis events by specifically designing the system (WP transporter and locomotives) to prevent accidents during the transport of WPs from the WHB to the emplacement drifts.

The general wording for this criterion was obtained from "Safety Criteria for SDD SS-17, Waste Emplacement System." This criterion is intended to address criteria 1.2.2.1 and 1.2.2.4 of Attachment 1.

II. Criterion Performance Parameter Basis

Under the current design concept, an uncontrolled descent of a WP transporter carrying a WP down the North Ramp of the repository would result in a top speed of the transporter of 63 km/hr at the bottom of the ramp (Table 7.3-1 of "Waste Package Design Basis Events"). Potential derailment of the transporter at such speeds could damage the WP. This criterion conservatively bounds the upper limit of the probability of such an initiating event to less than 1 x 10E-6 events/year to categorize it as an incredible event (if it is not shown to be incredible, specific features must be incorporated to mitigate the impact of the event on the WP to within its design limits), as described in Table 9 of "Preliminary Selection of MGR Design Basis Events."

1.2.2.1.2 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to prevent damage to a loaded WP as a result of a derailed WP transporter that could result in a radiological release. This criterion supports the implementation 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).

This criterion implements a portion of the safety strategy as described in "Decision Package Executive Summary, Strategy to Mitigate Preclosure Offsite Exposure," Description IV of Options 1 and 2. The executive summary is an attachment to "Strategy to Mitigate Preclosure Offsite Exposure," and is controlled by input transmittal "Strategy to Mitigate Preclosure Offsite Exposure" (RSO-RSO-99352.T). A portion of that safety strategy is to avoid the occurrence of Design Basis Events by specifically designing the system (WP transporter and locomotives) to prevent accidents during the transport of WPs from the WHB to the emplacement drifts.

The basis for this criterion was obtained from "Safety Criteria for SDD SS-17, Waste Emplacement System." This criterion is intended to address criteria 1.2.2.2 and 1.2.2.3 of Attachment 1.

II. Criterion Performance Parameter Basis

The maximum speed of 8 km/hr is obtained from criterion 1.2.2.3 of "Safety Criteria for SDD SS-17, Waste Emplacement System."

1.2.2.1.3 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to prevent the WP from being subjected to a drop greater than the height in which the WP design was evaluated against. A drop exceeding the criteria, although unevaluated, could potentially result in a WP breach and subsequent radiological release. This criterion supports the implementation 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).

This criterion implements a portion of the safety strategy as described in "Decision Package Executive Summary, Strategy to Mitigate Preclosure Offsite Exposure," Description V of Options 1 and 2. The executive summary is an attachment to "Strategy to Mitigate Preclosure Offsite Exposure," and is controlled by input transmittal "Strategy to Mitigate Preclosure Offsite Exposure" (RSO-RSO-99352.T). A portion of that safety strategy is to not lift the WP above its design basis height.

The basis for this criterion was obtained from "Safety Criteria for SDD SS-17, Waste Emplacement System." This criterion is intended to address criterion 1.2.2.12 of Attachment 1.

II. Criterion Performance Parameter Basis

The values for the drop heights listed in this criterion are obtained from "Waste Package Design Basis Events," Table 8-1. The DC systems use the same values in their design. These values may also be found in "Safety Criteria for SS-17, Waste Emplacement System," criteria 1.2.2.12 of Attachment 1.

1.2.2.1.4 Criterion Basis Statement

I. Criterion Need Basis

This criterion identifies recovery features for abnormal and design basis events. This criterion supports the implementation of MGR RD 3.1.C, 3.1.G, 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 contained in the "MGR Compliance Program Guidance Package for the Waste Emplacement System," guidance statement 6.6g6; and "MGR Compliance Program Guidance Package for the Waste Retrieval System," guidance statement 6.6g6.

II. Criterion Performance Parameter Basis

N/A

1.2.2.1.5 Criterion Basis Statement

I. Criterion Need Basis

This criterion identifies the need to provide emergency shutdown capability. This criterion implements MGR RD 3.1.C, 3.1.G, and 10 CFR 63.112(e)(10).

The basis for this criterion was obtained from "Safety Criteria for SDD SS-17, Waste Emplacement System." This criterion is intended to address criterion 1.2.2.10 of Attachment 1.

This criterion is supported by guidance contained in the "MGR Compliance Program Guidance Package for the Waste Emplacement System," guidance statement 6.6g6; and "MGR Compliance Program Guidance Package for the Waste Retrieval System," guidance statement 6.6g6.

II. Criterion Performance Parameter Basis

N/A

1.2.2.1.6 Criterion Basis Statement

I. Criterion Need Basis

This criterion supports the implementation of MGR RD 3.1.C, 3.1.G, 10 CFR 63.111(a)(2), 10 CFR 63.111(b)(2), and 10 CFR 63.112(e)(8). The general wording for this requirement is taken from "Seismic Criteria for Bin 2 and Bin 3 SDDs."

This criterion is supported by guidance contained in the "MGR Compliance Program Guidance Package for the Waste Emplacement System," guidance statement 6.7g6; and "MGR Compliance Program Guidance Package for the Waste Retrieval System," guidance statement 6.7g6.

II. Criterion Performance Parameter Basis

The values contained in this criterion are obtained from "Seismic Criteria for Bin 2 and Bin 3 SDDs."

1.2.2.1.7 Criterion Basis Statement

I. Criterion Need Basis

This criterion identifies the need to maintain control of the WP during credible design basis events. This criterion implements MGR RD 3.1.C, 3.1.G, and 10 CFR 63.112(e)(10).

This criterion is supported by guidance contained in the "MGR Compliance Program Guidance Package for the Waste Emplacement System," guidance statements 6.6g1, 6.7g1, and 6.7g6; and "MGR Compliance Program Guidance Package for the Waste Retrieval System," guidance statements 6.6g1, 6.7g1, and 6.7g6.

II. Criterion Performance Parameter Basis

N/A

1.2.2.1.8 Criterion Basis Statement

I. Criterion Need Basis

This criterion identifies the need to maintain control of the WP during credible design basis events. Retention within the WP transporter will reduce the occupational dose associated with restoring the system and associated systems after such an event, and it will protect the WP from direct impacts with other non-system SSCs. This criterion implements MGR RD 3.1.C, 3.1.G, and 10 CFR 63.112(e)(10).

This criterion is supported by guidance contained in the "MGR Compliance Program Guidance Package for the Waste Emplacement System," guidance statement 6.7g6; and

"MGR Compliance Program Guidance Package for the Waste Retrieval System," guidance statement 6.7g6.

II. Criterion Performance Parameter Basis

N/A

1.2.2.1.9 Criterion Basis Statement

I. Criterion Need Basis

MGR RD 3.1.C requires compliance with 10 CFR 63. MGR RD 3.1.B and 10 CFR 63.111(a)(1) require compliance with "Standards for Protection Against Radiation" (10 CFR 20). Section 1101(b) of 10 CFR 20 states: "The licensee shall use, to the extent practical, procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and doses to the members of the public that are as low as is reasonably achievable (ALARA)."

Compliance with "Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations Will Be As Low As Is Reasonably Achievable" (Regulatory Guide 8.8), is invoked because this regulatory guide is one of the primary regulatory documents which addresses ALARA and is acceptable to the U.S. Nuclear Regulatory Commission. This regulatory guide provides guidelines on achieving the occupational ALARA goals during the planning, design, and operations phases of a nuclear facility. According to Section B of this guide, "Effective design of facilities and selection of equipment for systems that contain, collect, store, process, or transport radioactive material in any form will contribute to the effort to maintain radiation doses to station personnel ALARA." Section C.2 addresses facility and equipment design features. The design process of each system must include an evaluation of the applicable requirements in Section C.2 of Regulatory Guide 8.8.

In addition to compliance with the applicable guidelines in Regulatory Guide 8.8, the design of the system must meet the project ALARA program goals. The project ALARA program will include both qualitative and quantitative goals. Regarding the ALARA program of a licensee, Section C.1.a(2) of Regulatory Guide 8.8 states: "The policy and commitment should be reflected in written administrative procedures and instructions for operations involving potential exposures of personnel to radiation and should be reflected in station design features. Instructions to designers, constructors, vendors, and station personnel specifying or reviewing station features, systems, or equipment should reflect the goals and objectives to maintain occupational radiation exposures ALARA."

This criterion supports MGR RD 3.1.G and is supported by guidance contained in the "MGR Compliance Program Guidance Package for the Waste Emplacement System," guidance statements 6.8g1and 6.9g1; and "MGR Compliance Program Guidance Package for the Waste Retrieval System," guidance statements 6.8g1 and 6.9g1.

II. Criterion Performance Parameter Basis

N/A

1.2.2.1.10 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to ensure that unacceptable levels of hydrocarbons are not accumulated in the underground. Hydrocarbons may support microbial life in the underground that may be detrimental to natural and engineered barrier performance. It is intended that the subsurface use of diesel-powered equipment be limited to emergencies, the repair of the Subsurface Electrical Distribution System, or if the Subsurface Emplacement Transportation System is not available.

II. Criterion Performance Parameter Basis

N/A

1.2.2.2.1 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to safely recover Performance Confirmation "dummy" WPs that will be instrumented and powered ("Performance Confirmation Plan," Section 3.3.3.4). The "dummy" WPs will, in some cases, have internal heaters to simulate WP heat output environment. Attempted recovery of an instrumented, energized "dummy" WP would create an unsafe condition.

II. Criterion Performance Parameter Basis

N/A

1.2.3.1 Criterion Basis Statement

I. Criterion Need Basis

Radiation from fuel assemblies, HLW canisters, or other radioactive sources can affect electrical and electronic components. Accumulated doses of radiation (also referred to as Total Integrated Dose) can cause eventual degradation of components containing organic compounds, such as electrical insulation and lubricants. Accumulated doses can also cause damage to components containing polymers. In addition to the material degradation issue, real-time operation of an electronic device may be compromised by the type of radiation it receives, such as neutrons colliding with the lattice atoms of the semiconductor.

Most of the electronic and electrical components will be located in mild environments with small radiation doses. Components that will be installed in radiation environments

should be evaluated for the radiation doses that they can receive, and, where applicable, susceptibility to the type of radiation (X-ray, Gamma, neutron) should also be considered.

Shielding, distance, and duration of exposure can significantly reduce the radiation dose and type of radiation that a component receives. Therefore, detailed analyses on a case by case basis will determine the economic feasibility and practicability of providing shielding, distance from the source, minimizing exposure time, frequent replacement of the affected component, or qualification of the component for the radiation environment.

It should be emphasized that this criterion addresses the radiation doses that can affect operability of the components during normal operations, and is not intended to invoke environmental qualification requirements for post-accident operability.

This criterion supports MGR RD 3.3.A.

II. Criterion Performance Parameter Basis

N/A

1.2.3.2 Criterion Basis Statement

I. Criterion Need Basis

Temperature is one of the primary environmental parameters that can affect the performance or result in advanced degradation of a component. To ensure proper performance, many equipment manufacturers specify the normal temperature environment in which the component must operate. Manufacturers may also specify the maximum off-normal temperature environment that the components can be exposed to or operate in for a limited time. The off-normal condition may be caused by loss of electric power or failure of the ventilation system.

This criterion supports MGR RD 3.1.G and 3.3.A.

II. Criterion Performance Parameter Basis

Normally Occupied Areas (Normal Environment): Temperature range of 76 degrees F to 72 degrees F is taken from Appendix E of "Design Criteria for an Independent Spent Fuel Storage Installation (Water Pool Type)" (ANSI/ANS 57.7-1988). This appendix provides the typical normal temperature ranges for summer and winter for a spent fuel storage and handling facility similar to the MGR. The specified temperatures are intended for personnel comfort; therefore, it is expected that SSCs installed in the normally occupied areas would perform as intended.

Normally Occupied Areas (Off-Normal Environment): Temperature range and duration are TBD.

Normally Unoccupied Areas (Normal Environment): Temperature range of 90 degrees F to 65 degrees F is also taken from Appendix E of ANSI/ANS 57.7-1988. This appendix

provides the typical normal temperature ranges for summer and winter for a spent fuel storage and handling facility similar to the MGR. The specified temperatures apply to areas that are not expected to be occupied for a full shift, but occasional or intermittent occupation may be required. These temperatures are deemed appropriate for short-term occupancy and most mechanical and electrical components. Special provisions must be provided if manufacturer specified temperature limits impose more restrictive requirements for proper equipment operation.

Normally Unoccupied Areas (Off-Normal Environment): Temperature range and duration are TBD.

Unoccupied Areas (Normal Environment): Occupancy in the unoccupied areas is not expected except under special circumstances. Therefore, the main purpose of temperature control in these areas is protection of the electric equipment. Experience indicates that 104 degrees F is the typical maximum ambient temperature during normal operations for areas that are not occupied but house electrical equipment in facilities similar to the MGR, such as nuclear power plants. Special provisions must be provided if manufacturer specified temperature limits impose more restrictive requirements for proper equipment operation. The minimum temperature of 65 degrees F is from Appendix E of ANSI/ANS 57.7-1988. This appendix provides the typical normal temperature ranges for summer and winter for a spent fuel storage and handling facility similar to the MGR. The minimum temperature of 65 degrees F is deemed appropriate for most mechanical and electrical components. Special provisions must be provided if manufacturer specified temperature limits impose more restrictive requirements for proper equipment operation.

Unoccupied Areas (Off-Normal Environment): Temperature range and duration are TBD.

Electronics Equipment Areas (Normal Environment): Temperature of 72 degrees F is taken from Table 1, Chapter 16 of the "Heating, Ventilating, and Air-Conditioning Applications." According to this reference, the specified temperature is typical of the conditions recommended by most computer equipment manufacturers. The specified temperature of 72 degrees F is within the limits of 18 to 27 degrees C (64 to 81 degrees F) provided in Table 1 of the "Environmental Conditions for Process Measurement and Control Systems: Temperature and Humidity" (ISA-S71.01), standard for Class A (Air Conditioned - Severity Level 1) locations. This standard establishes temperature and humidity conditions for industrial process measurement and control equipment. It should be noted that the provided range does not allow the control system to modulate in the specified range, as Note 'd' of Table 1 requires that the operating temperature be selected from the limits provided in the standard. The specified temperature of 72 degrees F is also within the temperature limits of 20 to 23 degrees C (68 to 73 degrees F) for Equipment Group (1)(a)) provided in Table 10 of the "IEEE Standard Definition, Specification, and Analysis of Systems Used for Supervisory Control, Data Acquisition, and Automatic Control" (IEEE Std C37.1-1994). Section 6 of this standard contains a definition of the environment in which control and data acquisition equipment are required to operate. Strict compliance with this IEEE standard is not required; however, the information contained in the standard is used as a guideline.

Electronics Equipment Areas (Off-Normal Environment): Because of the sensitivity of equipment located in these areas, the ventilation system is required to maintain a temperature of 72 degrees F during off-normal conditions. This requirement is especially important in cases where the computer, communication, or data processing equipment is required to operate during a power outage.

1.2.3.3 Criterion Basis Statement

I. Criterion Need Basis

Temperature is considered to be one of the primary environmental parameters that can affect component performance or result in advanced degradation. To ensure proper performance, many equipment manufacturers specify the temperature environment in which the component must operate. This criterion establishes the outdoor temperature environment in which SSCs are expected to operate.

This criterion supports MGR RD 3.3.A.

II. Criterion Performance Parameter Basis

The extreme outside temperature range of -15 degrees C to 47 degrees C is based on the annual extreme minimum and maximum temperatures for the nine meteorological monitoring sites located in the Yucca Mountain area. Locations of the nine sites are shown in Figure 2-1 of the "Engineering Design Climatology and Regional Meteorological Conditions Report"* (controlled by "Engineering Design Climatology and Regional Meteorological Conditions Report" [RSO-NEP-99353.T]). Extreme temperatures (and other data) are in Tables A-1 through A-9 of this report.

The collected temperature data in Tables A-1 through A-9 are based on 11 years of monitoring at Sites 1 through 5 and four years of monitoring at Sites 6 through 9. Site 1 data are typically more representative of the nine sites because it is closest to the repository. However, due to the limited number of years that data were collected, the lowest and highest recorded temperatures for all nine sites are used to bound the extreme temperature range. Site 5 has the lowest recorded temperature of -13.1 degrees C and Site 9 has the highest of 45.1 degrees C. This temperature range was conservatively expanded to -15 degrees C to 47 degrees C.

* As used in the criterion, data from this source does not affect the system's critical characteristics and will not be directly relied upon to address safety or waste isolation issues.

1.2.3.4 Criterion Basis Statement

I. Criterion Need Basis

Temperature is considered to be one of the primary environmental parameters that can affect component performance or result in advanced degradation. To ensure proper performance, many equipment manufacturers specify the temperature environment in

which the component must operate. This criterion establishes the subsurface temperature environment in which SSCs are expected to operate.

This criterion supports MGR RD 3.3.A.

II. Criterion Performance Parameter Basis

The extreme subsurface temperature minimum is bounded by the natural underground air temperature data measured from the exploratory studies facility (ESF) and documented in "Underground Temperature Data Aug 95 to Jan 97 for STA 1+70, 7+54 & 28+26 - IOC.013" (controlled by input transmittal "Underground Temperature Data"). The values used for the entire subsurface are based on the measurement from station 1+70. This station was used because it bounds the lowest values for the entire ESF.

The extreme subsurface temperature maximum is based on performance criterion 1.2.1.4 of the "Subsurface Ventilation System Description Document."

1.2.3.5 Criterion Basis Statement

I. Criterion Need Basis

Humidity is considered to be one of the primary environmental parameters that can affect the performance of computers, electronic, electrical, and mechanical components. Low humidity may result in static discharge in electrical and electronic equipment. High humidity can result in advanced corrosion or biological growth within the component. High humidity may also affect the operation of recorders that use paper. High humidity is not expected to be a major concern at the MGR due to the generally dry climate; however, depending on the nature of the operations, some areas may exhibit high humidity conditions. To ensure proper performance, many equipment manufacturers specify the humidity environment in which the component must operate. This criterion establishes the indoor humidity environment in which SSCs are expected to operate based on the intended installation location.

Humidity is not controlled during off-normal conditions because of the generally low humidity environment at the repository, and the expected short-term duration of off-normal conditions, such as loss of power or ventilation system failure.

This criterion supports MGR RD 3.1.G and 3.3.A.

II. Criterion Performance Parameter Basis

Normally Occupied Areas: Humidity range of 30 to 60 percent is based on the human comfort criteria available in various sources. Table 1 of Chapter 3 of the "Heating, Ventilating, and Air-Conditioning Applications" specifies a humidity value of 20 to 30 percent in winter, and 50 to 60 percent in summer for office buildings. Considering the indoor temperature requirement of 72 degrees F in winter and 76 degrees F in summer, a humidity range of 30 to 60 percent would place the normally occupied areas within the ASHRAE (American Society of Heating, Refrigerating and Air Conditioning Engineers)

summer and winter comfort zone in Figure 4 of Chapter 8 of the ASHRAE "Fundamentals."

Normally Unoccupied Areas: Humidity is not controlled in these areas. The humidity environment for this area is to be determined.

Unoccupied Areas: Humidity is not controlled in these areas. The humidity environment for this area is to be determined.

Electronics Equipment Areas: Humidity range of 40 to 50 percent is based on several sources. Table 1 of Chapter 16 of the "Heating, Ventilating, and Air-Conditioning Applications" specifies a humidity value of 50 percent for typical computer room design conditions based on the recommended value by most computer equipment manufacturers. The specified humidity range of 40 to 50 percent is within the limits (35 to 75 percent) provided in Table 1 of the "Environmental Conditions for Process Measurement and Control Systems: Temperature and Humidity" (ISA-S71.01), standard for Class A (Air Conditioned Severity Level 1) locations. This standard establishes temperature and humidity conditions for industrial process measurement and control equipment. It should be noted that the provided range does not allow the control system to modulate in the specified range, as Note 'd' of Table 1 requires that the operating humidity environment be selected from the limits provided in the standard. The specified humidity range of 40 to 50 percent is also within the limits (40 to 60 percent for Equipment Group (1)(a)) provided in Table 10 of the "IEEE Standard Definition, Specification, and Analysis of Systems Used for Supervisory Control, Data Acquisition, and Automatic Control" (IEEE Std C37.1-1994). Section 6 of this standard contains a definition of the environment in which control and data acquisition equipment are required to operate. Strict compliance with this IEEE standard is not required; however, the information contained in the standard is used as a guideline.

1.2.3.6 Criterion Basis Statement

I. Criterion Need Basis

Humidity is considered to be a primary environmental parameter that can affect SSCs performance and anticipated life expectancy. This criterion establishes the surface external humidity environment at the site.

This criterion supports MGR RD 3.3.A.

II. Criterion Performance Parameter Basis

The humidity values are taken from the "Engineering Design Climatology and Regional Meteorological Conditions Report"* (controlled by "Engineering Design Climatology and Regional Meteorological Conditions Report" [RSO-NEP-99353.T]), Table A-1, Management and Operating Contractor Radiological and Environmental Field Programs Department Site 1 (NTS-60). Using Site 1 data is appropriate because the site is the closest and most representative of the North Portal, South Portal, and ventilation shafts. The annual mean humidity for Site 1 is 28 percent, which is the average of the yearly

averages for each of the time periods (Hour 0400, 1000, 1600, 2200) (from Table A-1). The minimum summer mean humidity for Site 1 is 13 percent, which occurred in the month of June at hour 1600 (from Table A-1). The maximum winter mean humidity for Site 1 is 46 percent (rounded up from 45.9), which occurred in the month of December at hour 0400 (from Table A-1).

* As used in the criterion, data from this source does not affect the system's critical characteristics and will not be directly relied upon to address safety or waste isolation issues.

1.2.3.7 Criterion Basis Statement

I. Criterion Need Basis

Humidity is considered to be a primary environmental parameter that can affect SSCs performance and anticipated life expectancy. This criterion establishes the subsurface humidity environment at the site.

This criterion supports MGR RD 3.3.A.

II. Criterion Performance Parameter Basis

N/A

1.2.3.8 Criterion Basis Statement

I. Criterion Need Basis

Daily precipitation is an environmental parameter that can affect system weatherproofing. This criterion establishes the rainfall rates through which the affected systems must be able to endure and function.

This criterion supports MGR RD 3.3.A.

II. Criterion Performance Parameter Basis

The maximum annual precipitation is derived from the "Engineering Design Climatology and Regional Meteorological Conditions Report" (controlled by "Engineering Design Climatology and Regional Meteorological Conditions Report" [RSO-NEP-99353.T]), p. 4-10 and Figure 4-3. The report identifies a maximum annual precipitation that ranges from 1 to 10 in. for the period of 1949 to 1995. The bounding maximum annual precipitation of 10 in. is taken from the Amargosa Farms site. The Amargosa Farms site is deemed appropriate in the report based on its proximity to Yucca Mountain, p. 2-5, second paragraph.

The maximum daily precipitation is derived from the "Engineering Design Climatology and Regional Meteorological Conditions Report," p. 4-21, fourth paragraph. The reference paragraph states, "The conclusion from the statistical analyses of observed and

estimated precipitation data performed for this report indicate that the maximum daily precipitation within 50 km of Yucca Mountain is not expected to exceed five inches."

1.2.3.9 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to ensure that the wind load on the system does not cause overturning or derailment of a loaded WP transporter.

This criterion supports MGR RD 3.3.A.

II. Criterion Performance Parameter Basis

The maximum wind speed is obtained from "MGR Design Basis Extreme Wind/Tornado Analysis," Section 7.

1.2.4.1 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to define the operating envelope interface between the surface facilities and this system.

II. Criterion Performance Parameter Basis

N/A

1.2.4.2 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to define the distance over which the system will need to travel to perform an emplacement, retrieval, or recovery of a single WP, excluding the distance within the emplacement drift (covered in a separate criterion).

II. Criterion Performance Parameter Basis

Criterion Basis Statement Analysis: Transportation Travel Distance

Purpose

The purpose of this analysis is to identify the maximum distance the system must transport WPs between the WHB on the surface and the entrance to the most distant emplacement drift.

Assumptions

1. The maximum distance of the rail system, when calculated from the DC transfer dock at the WHB to the entrance of the North Portal, is approximately 272 m.

Rationale: A grading plan for the North Portal Repository is part of a recent design analysis ("Repository Surface Design Site Layout Analysis,"* Attachment I, Figure 8). The actual length, when calculated from the end of the WHB to the entrance of the North Portal, is approximately 272 m.

2. The maximum distance of the rail system, when calculated from the entrance at the North Portal to the drift Turnout of the last emplacement drift, located off the West Main, is approximately 8,918 m.

Rationale: Geometry of Ramps and Mains was documented in a recent design analysis ("Repository Subsurface Layout Configuration Analysis,"* Table 7-2). The actual length, when calculated from the North Ramp to the Turnout of the last usable emplacement drift, is approximately 8,918 m.

3. The maximum distance of the rail system, when calculated from the start of a drift turnout to the entrance of an emplacement drift, is approximately 38.4 m.

Rationale: The current layout of the repository uses a total of 115 active emplacement drifts for DC emplacement, an additional 3 drifts (cross block drifts) for ventilation, and 2 stand-by, normally empty emplacement drifts. The last of the drifts to be used for emplacement is drift number 120, a ventilation cross drift.

The length of the turnouts varies with the geometry of the repository and the drift position as numbered. This was documented in "Repository Subsurface Layout Configuration Analysis,"* Table 7-3. As shown in the table, the length of the last turnout is 29.4 m, and the length of the longest turnout is 38.4 m, when calculated from the West Main to the entrance of an emplacement drift.

Criteria Analysis

1. The maximum distance between the WHB and the entrance of the North Portal (Assumption 1) is 272 m. However, to allow for potential modifications to the present layout, a maximum distance of 500 m is selected to provide a conservative margin.

2. The maximum distance between the North Portal and the drift turnout of the emplacement drift farthest from the North Portal (Assumption 2.) is 8,918 m. However, to allow for potential modifications to the present layout, a maximum distance of 9,000 m is selected to provide a conservative margin.

3. The maximum distance from the start of the drift turnout to the entrance of the emplacement drift (Assumption 3) is 38.4 m. However, in order to allow for potential modifications to the present layout, a maximum distance of 50 m is selected to provide a conservative margin.

4. The maximum distance is the distance from the loading dock at the WHB to the entrance of the last possible emplacement drift accessible from the West Main. This one-way distance is equal to the sum of three individual segments as listed in the preceding three paragraphs. These segments have been identified as follows:

- from WHB to North Portal: 500 m
- from North Portal to last turnout: 9,000 m
- from turnout to drift entrance: 50 m

Based on these dimensions, the maximum distance, when measured from the WHB to the entrance of the last emplacement drift, will not exceed 9,550 m. For all practical purposes, this dimension has been rounded up to 10,000 m, or 10 km. Since this distance is based on a one-way trip, the same distance applies to the return trip. Therefore, the total distance for the round trip will not exceed 20,000 m, or 20 km.

Conclusion

The system is required to transport DCs from the WHB to an emplacement drift entrance for a maximum distance of 10 km.

However, in the event that the dimensions provided in this analysis change or increase beyond the present maximum distance, this change would not invalidate the present concept of the system for transport of DCs.

The use of unqualified input (marked *) in this analysis was necessary to establish the bounding characteristics for the design criteria. The inclusion of this input does not disqualify the results of the analysis due to the conservative margin used in establishing the bounding design criteria. Additionally, the bounding design criteria do not affect nuclear safety.

Note: Frank J. Bierich and Donald F. Smith assisted with the preparation of the preceding Criterion Basis Statement Analysis.

1.2.4.3 Criterion Basis Statement

I. Criterion Need Basis

The criterion is needed to establish the maximum grade the portions of the system supporting emplacement must be designed to traverse while transporting WPs.

II. Criterion Performance Parameter Basis

Grade limitations for emplacement operations on the surface are established as an interface in the "Monitored Geologic Repository Site Layout System Description Document," criterion 1.2.4.9. Grade limitations for the subsurface are established in the following criterion basis statement analysis. It should be noted that the grade limit for the surface (2.5 percent) is identical to the limit established in the following analysis for areas between the surface and the entrance to the emplacement drift.

Criterion Basis Statement Analysis: Maximum Grades

Purpose

The purpose of this analysis is to identify the maximum grades that the portions of the system supporting emplacement must operate upon, while moving WPs by rail from the MGR surface to the point of emplacement inside the emplacement drifts.

Assumptions

1. The maximum grade that the system will have to travel over to transport and emplace WPs will be in the ramps that access the subsurface repository.

Rationale: The ramps, which are already constructed, must be inclined to allow access from the subsurface repository to the surface repository. There is no compelling reason for the rest of the MGR that the system will be travelling on to be inclined at a grade greater than the ramps.

2. The system will use the North Ramp exclusively to access the subsurface repository.

Rationale: This assumption is based on the current layout for the surface repository ("Repository Surface Design Site Layout Analysis"), which shows the waste handling facilities adjacent to the North Portal in Attachment I, Figure 4. The location of the waste handling facilities near the North Portal has been a long standing project assumption.

3. The maximum grade in emplacement drifts will be 0.5 percent.

Rationale: A slight grade in emplacement drifts is desired to allow gravity drainage of the drifts; however, excessive grades are unnecessary and complicated to implement. The value for this assumption is based on the most current layout for the subsurface repository. Therefore, the maximum grade will be 0.5 percent, as documented in Section 4.3.16 of the "Repository Subsurface Layout Configuration Analysis."*

Criteria Analysis

1. Grades in the North Ramp. The "ESF Layout Calculation" identifies the design of the ESF including details of the ESF drift grades. From Figure 3, the existing north ramp grades are +2.0000 percent from the surface to North Portal, and -2.1486 percent from the North Portal to the Main Drift. Thus, the maximum grade that the system will encounter should be +/-2.1486 percent, and rounding this grade to +/-2.5 percent provides a conservative margin for the maximum expected grade to be traversed by the system. A limitation for the grade is an important factor in the sizing of the transport locomotives for the current waste emplacement concept. Thus, the design grade for the rail-based transportation system is limited to 2.5 percent, maximum.

2. Grades in Mains. Figure 3 of the "ESF Layout Calculation" identifies the grade of the existing east main as +/-1.3500 percent. Mains that the system must travel over and which have yet to be excavated will have slopes of up to +/-2.1846 percent, as

documented in "Subsurface Repository Slopes,"* Table 8-1. Therefore, rounding this grade to +/-2.5 percent provides a conservative margin for the maximum expected grade to be traversed by the system.

3. Grades in Emplacement Drifts. As assumed previously, the "Repository Subsurface Layout Configuration Analysis"* identifies the grades/slope of all future emplacement drifts at +/-0.5 percent. Therefore, rounding this grade to +/-1.0 percent provides a conservative margin for the maximum expected grade to be traveled by the system within emplacement drifts.

Conclusion

Grades for the North Ramp and mains will not exceed +/-2.5 percent. Grades in the emplacement drifts will not exceed +/-1.0 percent.

However, in the event that the grades/slopes provided in the above Criteria Analysis require a change or increase in excess of the present maximum grades/slopes, this change would not invalidate the present concept for the system. But, it may require additional and/or larger transport locomotives to move the transporter through the ramps and drifts, and it may require larger drive units for the emplacement gantry in the emplacement drifts.

The use of unqualified input [marked *] in this analysis was necessary to establish the bounding characteristics for the design criteria. The inclusion of this input does not disqualify the results of the analysis due to the conservative margin used in establishing the bounding design criteria. Additionally, the bounding design criteria do not affect nuclear safety.

1.2.4.4 Criterion Basis Statement

I. Criterion Need Basis

The criterion is needed to establish the maximum grade the portions of the system supporting recovery, restoration, or retrieval must be designed to traverse.

II. Criterion Performance Parameter Basis

Grade limitations for retrieval, recovery, and restoration operations on the surface are established as an interface in the "Monitored Geologic Repository Site Layout System Description Document," criterion 1.2.4.10. Grade limitations for the subsurface are established in the following criterion basis statement analysis. It should be noted that the grade limit for the surface (2.7 percent) is identical to the limit established in the following analysis for areas between the surface and the entrance to the emplacement drift.

Criterion Basis Statement Analysis: Maximum Grades

Purpose

The purpose of this analysis is to identify the maximum grades that the portions of the system supporting retrieval, recovery, and restoration must operate upon, while moving WPs by rail from the point of emplacement inside the emplacement drifts surface to the surface.

Assumptions

1. The maximum grade that the system will have to travel over to transport and emplace WPs will be in the ramps that access the subsurface repository.

Rationale: The ramps, which are already constructed, must be inclined to allow access from the subsurface repository to the surface repository. There is no compelling reason for the rest of the MGR that the system will be travelling on to be inclined at a grade greater than the ramps.

2. The system will use either the North Ramp or the South Ramp to access the subsurface repository.

Rationale: This assumption is based on the idea that system activities may be initiated by an event that has rendered the North Ramp (the ramp that has been chosen for all waste emplacement activities) unusable.

3. The maximum grade in emplacement drifts will be 0.5 percent.

Rationale: A slight grade in emplacement drifts is desired to allow gravity drainage of the drifts; however, excessive grades are unnecessary and complicated to implement. The value for this assumption is based on the most current layout for the subsurface repository. Therefore, the maximum grade will be 0.5 percent, as documented in Section 4.3.16 of the "Repository Subsurface Layout Configuration Analysis."*

Criteria Analysis

1. Grades in the North Ramp. The "ESF Layout Calculation" identifies the design of the ESF including details of the ESF drift grades. From Figure 3, the existing North Ramp grades are +2.0000 percent from the surface to North Portal, and -2.1486 percent from the North Portal to the Main Drift. Also from Figure 3, the existing South Ramp grades are +2.00 percent from the surface to the South Portal, and -2.6189 percent from the South Portal to the Main Drift. Thus, the maximum grade that the system will encounter should be +/-2.6189 percent, and rounding this grade to +/-2.7 percent provides a margin for the maximum expected grade to be traversed by the system. A limitation for the grade is an important factor in the sizing of the transport locomotives for the current system concept. Thus, the design grade for the rail-based transportation system is limited to +/-2.7 percent, maximum.

2. Grades in Mains. Figure 3 of the "ESF Layout Calculation" identifies the grade of the existing east main as +/-1.3500 percent. Mains that the system must travel over and which have yet to be excavated will have slopes of up to +/-2.1846 percent, as documented in "Subsurface Repository Slopes,"* Table 8-1. Therefore, rounding this grade to +/-2.7 percent provides a conservative margin for the maximum expected grade to be traversed by the system.

3. Grades in Emplacement Drifts. As assumed previously, the "Repository Subsurface Layout Configuration Analysis"* identifies the grades/slope of all future emplacement drifts at +/-0.5 percent. Therefore, rounding this grade to +/-1.0 percent provides a conservative margin for the maximum expected grade to be traveled by the system within emplacement drifts.

Conclusion

Grades for the ramps and mains will not exceed +/-2.7 percent. Grades in the emplacement drifts will not exceed +/-1.0 percent.

However, in the event that the grades/slopes provided in the above Criteria Analysis require a change or increase in excess of the present maximum grades/slopes, this change would not invalidate the present concept for the system. But, it may require additional and/or larger transport locomotives to move the transporter through the ramps and drifts, and it may require larger drive units for the emplacement gantry in the emplacement drifts.

The use of unqualified input [marked *] in this analysis was necessary to establish the bounding characteristics for the design criteria. The inclusion of this input does not disqualify the results of the analysis due to the conservative margin used in establishing the bounding design criteria. Additionally, the bounding design criteria do not affect nuclear safety.

1.2.4.5 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to define the interface between the Subsurface Emplacement Transportation System and this system. Recovery and retrieval of WPs are expected to use the existing rail system to the extent practical. Where it is impractical, such as a damaged section of track that is unusable after an abnormal event, alternate means will be used to perform retrieval and recovery, as specified in a different criterion.

II. Criterion Performance Parameter Basis

The rail gage for the surface facilities, ramp, main drift, and turnout track is taken from "Preliminary Waste Package Transport and Emplacement Equipment Design," Section 4.3.22.

The emplacement drift rail centerline spacing is a tentative value assumed in this document based on the revised emplacement method (palletized emplacement vs. pedestal emplacement) and addition of drip shields to the Emplacement Drift System.

The rail gage is preferred as the interface for the surface facilities, ramp, main drift, and turnout track because the gage selected is a standard gage that allows the use of standardized rail equipment in the design of the system. The rail center-to-center spacing is preferred as the rail interface for the emplacement drift since the gage necessary for gantry emplacement of the WPs and drip shield is non-standard, and center to center spacing allows flexibility for the designer of the Subsurface Emplacement Transportation System to accommodate the non-standard gage without unnecessarily constraining the other system's design.

1.2.4.6 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to define the interface between the Subsurface Emplacement Transportation System, the Subsurface Facility System, and this system. The minimum radius of curvature that the track makes will limit the design of the equipment that rides on top of the tracks.

II. Criterion Performance Parameter Basis

The values of minimum radius of curvature are obtained from the "Repository Subsurface Layout Configuration Analysis," Section 4.3.23. Inspection of Attachment I, Figure 8 of the "Repository Surface Design Site Layout Analysis indicates that the smallest radius of curvature on the surface is the same as that for emplacement drift turnouts.

1.2.4.7 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to ensure the system is able to negotiate the change in elevation between the bottom of the turnout and the bottom of the emplacement drift, which is located at the emplacement drift dock.

II. Criterion Performance Parameter Basis

The difference in elevation is obtained from "Preliminary Waste Package Transport and Emplacement Design," Figure 7.9.2, and is the result of the need to excavate a step in the launching chamber to allow tunnel boring machine excavation of the emplacement drift.

1.2.4.8 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to define the distance over which the system will need to travel within an emplacement drift to perform emplacement or retrieval of WPs.

II. Criterion Performance Parameter Basis

Type I Analysis: Emplacement Travel Distance

Purpose

The purpose of this analysis is to identify the maximum distance the system must transport WPs within the emplacement drifts during emplacement operations.

Assumption

The maximum distance of the rail system, when measured from the drift entrance to the end of the emplacement drift, is approximately 592 m.

Rationale: The length for each emplacement drift was documented in "Repository Subsurface Layout Configuration Analysis,"* Attachment I, Table I-2. This length varies for each drift and the respective drift number. The actual length of the last usable emplacement drift (drift #120), when measured from the drift entrance to its end station, is approximately 501 m, and the usable length of the longest emplacement drift (drift #91) is 592 m. Note that this is near the midpoint of the physical emplacement drift, and represents only the distance over which the system will be able to travel, since there is a break in the Subsurface Emplacement Transportation System near the midpoint of the drift.

Criteria Analysis

The longest distance for WP emplacement in an emplacement drift is approximately 592 m (Assumption above). However, to allow for potential modifications to the present layout, a maximum distance of 700 m is selected to provide a conservative margin.

Conclusion

The system is required to transport WPs within an emplacement drift having a maximum drift length of 700 m.

However, in the event that the dimensions provided in this analysis change or increase beyond the present maximum distance, this change would not invalidate the present concept of the system for transport of WPs.

The use of unqualified input [marked *] in this analysis was necessary to establish the bounding characteristics for the design criteria. The inclusion of this input does not

disqualify the results of the analysis due to the conservative margin used in establishing the bounding design criteria. Additionally, the bounding design criteria do not affect nuclear safety.

Note: Frank J. Bierich and Donald F. Smith assisted with the preparation of the preceding Criterion Basis Statement Analysis.

1.2.4.9 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to define the distance over which the system will need to travel within a tunnel containing two emplacement drifts to perform restoration of the system or recovery of WPs.

This criterion supports the capability to recover all WPs in an entire emplacement tunnel containing two emplacement drifts from one main drift entrance (either the east or west main) as described in the "Retrievability Strategy Report," Section 8.2.1.1. This capability does not preclude restoration and recovery from being conducted within a single emplacement drift, however, if it is operationally more convenient.

II. Criterion Performance Parameter Basis

The basis for the emplacement drift maximum lengths is given in the previous criterion.

1.2.4.10 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to define the physical envelope interface between the system and the Ground Control System, the Emplacement Drift System, and the other equipment located in the subsurface.

II. Criterion Performance Parameter Basis

Preliminary data supporting the physical envelope values outside of emplacement drifts are noted below.

Main Drifts and Ramps-- Height:
3.58 m (Gantry height) (from "Emplacement Gantry Plan & Elevations")
+ 1.22 m (Gantry Carrier height) (from "Gantry Carrier Plan and Elevations")
+ 0.17 m (rail height) (rail height is from "Civil Engineering Handbook," Section 2, Table 4, based on the 115 lb/yd rail selection documented in "Repository Subsurface Layout Configuration Analysis," Section 4.3.31)
+ .63 m (additional clearance) (from "Repository Rail Electrification Analysis," Attachment I, Figure 8)
5.60 m = total height

Main Drifts and Ramps-- Width:
3.55 m (Gantry Carrier width) (from "Gantry Carrier Plan and Elevations")

Drift Turnouts-- Height:
5.60 m (Gantry+Carrier+rail+clearance) (from Main Drifts and Ramps height references above)

Drift Turnouts-- Width:
6.15 m (transporter door swing width) (from "Waste Package Transporter Plan & Elevations")

The emplacement drift physical envelope was taken from "Analysis of Clearance Envelopes for Emplacement Drift Operating Equipment and Space Envelopes for Test Coupons within the Emplacement Drift," Figure 1.

1.2.4.11 Criterion Basis Statement

I. Criterion Need Basis

This criterion identifies the electrical interface with the Subsurface Emplacement Transportation System.

II. Criterion Performance Parameter Basis

N/A

1.2.4.12 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to ensure that the system will be able to operate within an emplacement drift where the power feed has been disrupted by an abnormal event. A disruption of the power feed at one end of the emplacement drift will not hinder access from the other end of the drift.

II. Criterion Performance Parameter Basis

N/A

1.2.4.13 Criterion Basis Statement

I. Criterion Need Basis

This criterion identifies the interface with the MGR Operations Monitoring and Control System and identifies communications required to support MGR RD 3.3.K. This criterion also identifies communication needed to comply with MGR RD 3.1.C, 3.2.C, 3.2.E, 10 CFR 63.111(a)(2), 10 CFR 63.111(b)(2), and 10 CFR 63.112(e)(8).

II. Criterion Performance Parameter Basis

N/A

1.2.4.14 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to ensure mechanical interface consistency between the design of this system and the DC systems. This is done by specifying the design be done in accordance with 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."

II. Criterion Performance Parameter Basis

N/A

1.2.4.15 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to identify the maximum surface dose rate to be expected at the WP surface.

II. Criterion Performance Parameter Basis

N/A

1.2.4.16 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to identify the maximum WP thermal output.

II. Criterion Performance Parameter Basis

The WP thermal output is obtained from "Monitored Geologic Repository Project Description Document," Section 2.2.1.1.11.

1.2.4.17 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to ensure that the system is compatible with external interfacing MGR systems. This criterion supports MGR RD 3.3.A and 3.4.2.C.

II. Criterion Performance Parameter Basis

N/A

1.2.4.18 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to ensure the system is able to pass through the emplacement drift isolation doors of the Subsurface Ventilation System.

II. Criterion Performance Parameter Basis

N/A

1.2.4.19 Criterion Basis Statement

I. Criterion Need Basis

This criterion provides for the tracking of all WPs handled by the system. This criterion supports MGR RD 3.3.K requirements to maintain nuclear inventories and support safeguards and security activities. This requirement supports the MGR RD 3.1.D requirement to implement applicable provisions of "Physical Protection of Plants and Materials" (10 CFR 73), Section 45(d)(1)(iii). This requirement also supports MGR RD 3.1.C for the interim guidance of 10 CFR 63.78 which invokes "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste" (10 CFR 72), Section 72(a).

II. Criterion Performance Parameter Basis

N/A

1.2.5.1 Criterion Basis Statement

I. Criterion Need Basis

This criterion identifies the need to perform inspection and maintenance on system equipment. This criterion responds to MGR RD 3.1.C, 3.1.G, 3.3.A, and 10 CFR 63.112(e)(13).

This criterion is supported by guidance contained in the "MGR Compliance Program Guidance Package for the Waste Emplacement System," guidance statements 6.6g5 and 6.7g5; and "MGR Compliance Program Guidance Package for the Waste Retrieval System," guidance statements 6.6g5 and 6.7g5.

II. Criterion Performance Parameter Basis

N/A

1.2.5.2 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to establish the availability of the system. This criterion supports MGR RD 3.3.A.

II. Criterion Performance Parameter Basis

The availability number is obtained from "Bounded Minimum Inherent Availability Requirements for the System Description Documents," Table 7.2-1. The cited analysis was performed before the Waste Emplacement System and the Waste Retrieval System were combined; however, since the emplacement system was assigned an availability number, and the retrieval system was not, the availability of the combined system is the availability number for the emplacement system.

1.2.6.1 Criterion Basis Statement

I. Criterion Need Basis

This criterion is derived from regulatory precedence cited in MGR RD 3.1.B, which invokes "Standards for Protection Against Radiation" (10 CFR 20).

II. Criterion Performance Parameter Basis

N/A

1.2.6.2 Criterion Basis Statement

I. Criterion Need Basis

This criterion is derived from regulatory precedence cited in MGR RD 3.1.E, which invokes "Occupational Safety and Health Standards" (29 CFR 1910).

II. Criterion Performance Parameter Basis

N/A

1.2.6.3 Criterion Basis Statement

I. Criterion Need Basis

Use of "Manual of Steel Construction Allowable Stress Design" in the design of this system is supported by "MGR Compliance Program Guidance Package for the Waste Emplacement System," guidance statement 7.2g1; and "MGR Compliance Program Guidance Package for the Waste Retrieval System," guidance statement 7.2g1.

This criterion supports MGR RD 3.1.G.

II. Criterion Performance Parameter Basis

N/A

1.2.6.4 Criterion Basis Statement

I. Criterion Need Basis

Use of "American National Standard Design Requirements for Light Water Reactor Spent Fuel Storage Facilities at Nuclear Power Plants" (ANSI/ANS-57.2-1983) in the design of this system is supported by "MGR Compliance Program Guidance Package for the Waste Emplacement System," guidance statement 7.3g1; and "MGR Compliance Program Guidance Package for the Waste Retrieval System," guidance statement 7.3g1.

This criterion supports MGR RD 3.1.G.

II. Criterion Performance Parameter Basis

N/A

1.2.6.5 Criterion Basis Statement

I. Criterion Need Basis

Use of "Design Criteria for an Independent Spent Fuel Storage Installation (Dry Type)" (ANSI/ANS-57.9-1992) in the design of this system is supported by "MGR Compliance Program Guidance Package for the Waste Emplacement System," guidance statements 6.13g4 and 7.4g1; and "MGR Compliance Program Guidance Package for the Waste Retrieval System," guidance statements 6.13g4 and 7.4g1.

This criterion supports MGR RD 3.1.G.

II. Criterion Performance Parameter Basis

N/A

1.2.6.6 Criterion Basis Statement

I. Criterion Need Basis

Use of "Radioactive Materials - Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4,500 Kg) or More" (ANSI N14.6-1993) in the design of this system is supported by "MGR Compliance Program Guidance Package for the Waste Emplacement System," guidance statements 6.11g1 and 7.6g1; and "MGR Compliance Program Guidance Package for the Waste Retrieval System," guidance statements 6.11g1 and 7.6g1.

Section 7 of ANSI N14.6-1993 (addressing special lifting devices for critical loads) is not required by the criterion since the nature of the lifts performed by the system are not comparable to the critical lifts defined in the standard.

This criterion supports MGR RD 3.1.G.

II. Criterion Performance Parameter Basis

N/A

1.2.6.7 Criterion Basis Statement

I. Criterion Need Basis

Use of "Structural Welding Code - Steel" (ANSI/AWS D1.1-98) in the design of this system is supported by "MGR Compliance Program Guidance Package for the Waste Emplacement System," guidance statement 7.5g1; and "MGR Compliance Program Guidance Package for the Waste Retrieval System," guidance statement 7.5g1.

This criterion supports MGR RD 3.1.G.

II. Criterion Performance Parameter Basis

N/A

1.2.6.8 Criterion Basis Statement

I. Criterion Need Basis

Use of "Rules for Construction of Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder)" (ASME NOG-1-1995) in the design of this system is supported by "MGR Compliance Program Guidance Package for the Waste Emplacement System," guidance statement 7.11g1; and "MGR Compliance Program Guidance Package for the Waste Retrieval System," guidance statement 7.11g1.

This criterion supports MGR RD 3.1.G.

II. Criterion Performance Parameter Basis

N/A

1.2.6.9 Criterion Basis Statement

I. Criterion Need Basis

Use of "Specifications for Top Running Bridge & Gantry Type Multiple Girder Electric Overhead Traveling Cranes" (CMAA Specification No. 70) in the design of this system is supported by "MGR Compliance Program Guidance Package for the Waste Emplacement

System," guidance statements 6.11g2 and 7.15g1; and "MGR Compliance Program Guidance Package for the Waste Retrieval System," guidance statements 6.11g2 and 7.15g1.

This criterion supports MGR RD 3.1.G.

II. Criterion Performance Parameter Basis

N/A

1.2.6.10 Criterion Basis Statement

I. Criterion Need Basis

Use of "Standard Review Plan for Spent Fuel Dry Storage Facilities" (NUREG-1567, Draft Report for Comment) in the design of this system is supported by "MGR Compliance Program Guidance Package for the Waste Emplacement System," guidance statements 6.13g2 and 6.13g3; and "MGR Compliance Program Guidance Package for the Waste Retrieval System," guidance statements 6.13g2 and 6.13g3.

This criterion supports MGR RD 3.1.G.

II. Criterion Performance Parameter Basis

N/A

1.2.6.11 Criterion Basis Statement

I. Criterion Need Basis

This criterion responds to MGR RD 3.3.A, which recommends compliance with industry codes and standards. The "National Electrical Code" (NFPA 70) contains provisions considered necessary for safeguarding of personnel and SSCs from hazards arising from the use of electricity.

II. Criterion Performance Parameter Basis

N/A

1.2.6.12 Criterion Basis Statement

I. Criterion Need Basis

The "Monitored Geologic Repository Project Description Document" allocates controlled project assumptions to systems. This criterion identifies the need to comply with the applicable assumptions identified in the subject document. The approved assumptions will provide a consistent basis for continuing the system design.

II. Criterion Performance Parameter Basis

N/A

1.2.6.13 Criterion Basis Statement

I. Criterion Need Basis

This criterion is derived from regulatory precedence cited in MGR RD 3.1.F, which invokes "Safety and Health Regulations for Construction" (29 CFR 1926).

II. Criterion Performance Parameter Basis

N/A

APPENDIX B ARCHITECTURE AND CLASSIFICATION

The system architecture and QA classification are identified in Table I-16. The QA classifications are established in "Classification of the Waste Emplacement/Retrieval System."

Table I-16. System Architecture and QA Classification

System Architecture	Classification				
	QL-1	QL-2	QL-3	CQ	TBV
Emplacement, Retrieval, and Recovery Systems (Normal Conditions)					
Waste Package Transporter	X				N/A
Reusable Railcar				X	460
Gantry Carrier				X	N/A
Emplacement Gantry		X			460
Recovery Systems (Abnormal Conditions)					
Main Drift Forklift			X		N/A
Forks					Note 1
Manipulating Arm					Note 1
Emplacement Drift Forklift			X		N/A
Forks					Note 1
Manipulating Arm					Note 1
Ejector Bucket					Note 1
Multi-Purpose Hauler			X		N/A
Bottom Lift Transporter			X		N/A
Bottom Lift Transporter Carrier	X				N/A
Multi-Purpose Vehicle			X		N/A
Impact Hammer					Note 1
Demolition Shears					Note 1
Bucket					Note 1
Load-Haul-Dump Loader			X		N/A
Covered Shuttlecars				X	N/A
Scaling Machine				X	N/A
Extendable Conveyor				X	N/A
Ball Screw Jack				X	N/A
Temporary Dock				X	N/A
Modified WP Transporter	X				N/A
Temporary Shielding					Note 2
Temporary Ventilation Control and Filtration System					Note 2
Temporary Ground Support Subsystems					Note 2
Decontamination Equipment		X			N/A
Restoration Systems (Abnormal Conditions)					
Re-Railer				X	N/A
Emplacement Drift Restoration Locomotive			X		N/A
Drift Gantry Carrier				X	N/A
Cleanup and Construction Vehicles				X	N/A
General Support Systems					
Locomotives	X				N/A
Railcars				X	N/A
Control and Tracking System	X				N/A

Note 1: SSC classified at higher architecture level
Note 2: Not classified, non-permanent SSC

APPENDIX C ACRONYMS, SYMBOLS, AND UNITS

C.1 ACRONYMS

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

ALARA	As Low as is Reasonably Achievable
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
CSNF	canistered spent nuclear fuel
DC	disposal container
DSNF	Department of Energy owned spent nuclear fuel
ESF	Exploratory Studies Facility
F	Function
HLW	high-level waste
MGR	Monitored Geologic Repository
MGR RD	Monitored Geologic Repository Requirements Document
N/A	not applicable
QA	Quality Assurance
SNF	spent nuclear fuel
SSCs	structures, systems, and components
TBD	to be determined
TBV	to be verified
WHB	Waste Handling Building
WP	waste package

C.2 SYMBOLS AND UNITS

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

%	percent
°C	degrees Celsius
°F	degrees Fahrenheit
cm	centimeter
ft	foot
hr	hour
Hz	Hertz
in.	inch
kg	kilogram
km	kilometer
lb	pound
m	meter
mm	millimeter
MT	metric ton
sec	second
yd	yard
yr	year

APPENDIX D FUTURE REVISION RECOMMENDATIONS AND ISSUES

None.

APPENDIX E REFERENCES

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