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Total System Performance Assessment Data Input Package for Requirements Analysis for Subsurface Facilities

Prepared for:
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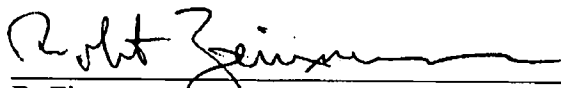
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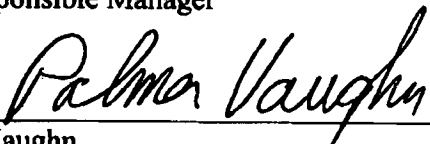
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CHANGE HISTORY

<u>Revision Number</u>	<u>Interim Change No.</u>	<u>Date</u>	<u>Description of Change</u>
00		Sept 2007	Initial issue

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ACRONYMS

BSC	Bechtel SAIC Company
DOE	U.S. Department of Energy
IED	information exchange drawing
NA	Not Applicable
TFMs	tracers, fluids, and materials
TSPA	Total System Performance Assessment
WP	Waste Package

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1. TSPA PARAMETER(S) IDENTIFICATION AND DESCRIPTION

This document provides design information related to subsurface facilities as direct inputs for the Total System Performance Assessment (TSPA) from preclosure design and engineering organizations to be used for postclosure technical products. This design information provides a record for these design and engineering inputs for reference in other postclosure technical products. Section 4 contains tables that include a general description of the parameters and document identifiers for the design documents from which the specific parameter values were obtained. This design information will be part of the basis for postclosure analyses by the Lead Laboratory, for the License Application.

The requirements for subsurface are derived from *Level 3 Technical Baseline for the Yucca Mountain Project* (BSC 2007 [DIRS 179341]) and *Postclosure Modeling and Analyses Design Parameters* (BSC 2007 [DIRS 179342]). The design requirements and constraints in those documents have been implemented during preliminary design, and will be verified during final design, construction, and operations to ensure that the repository meets the constraints imposed on the repository in analysis of postclosure safety.

Development of this document was planned by *Technical Work Plan for: Total System Performance Assessment (TSPA) Parameter Selection and Documentation with TSPA Data Input Package (TDIP)* (SNL 2007 [DIRS 179320]) and was controlled by LS-PRO-001, *Technical Reports*.

2. TSPA IMPLEMENTATION

This document was developed to facilitate configuration control and information exchange between preclosure design and postclosure analyses. The License Application design configuration and parameter values are used as inputs to process models and analyses that feed the TSPA.

3. PARAMETER VALUE UNCERTAINTY

The nominal design inputs provided in Section 4 are generally treated as constants in postclosure analyses. Postclosure analyses and models developed, using assumed values not found in Section 4, establish a basis for review and approval of new or revised designs. The process for evaluating the impacts of design changes is described in *Postclosure Nuclear Safety Design Basis* (SNL 2007 [DIRS 177464], Section 6.1.8). As design evolves, the impacts of any changes in the nominal or preliminary design inputs will be addressed in the appropriate postclosure sensitivity analyses.

4. DIRECT INPUTS

Table 4-1 consists of five columns. The first three columns are derived requirements from *Postclosure Modeling and Analyses Design Parameters* (BSC 2007 [DIRS 179342], Table 1), for the subsurface facilities. Column 1 is 'Parameter Number', Column 2 is 'Parameter', and Column 3 is 'Derived Requirement'. Column 5 in Table 4-1 is 'Remarks', and it identifies the design documents (typically IEDs) that implement the design requirement, or the design documents that were used as inputs to the analyses and models that are the basis for that design

requirement. The 'Remarks' Column, also includes descriptions of information contained on the design documents.

4.1 PARAMETERS/DATA

The parameters and requirements for subsurface facilities from *Postclosure Modeling and Analyses Design Parameters* (BSC 2007 [DIRS 179342]) are provided in the following tables:

- Table 4-1, Subsurface Facilities Requirements
- Table 4-2, Subsurface Ventilation
- Table 4-3, Sealing and Closure.

Table 4-1. Subsurface Facilities Requirements

Parameter Number	Parameter	Derived Requirement	IED	Remarks
01-01	Repository Geographic and Geologic Location	The interface for the location of the subsurface facilities of the repository within the footprint of the emplacement area boundary and repository host horizon within the lithostratigraphic detail shall be controlled through the Subsurface Facilities Layout Geographical Data IEDs and Geotechnical and Thermal Properties IED.	800-IED-WIS0-01701-000-00B	(BSC 2007 [DIRS 179927]); see discussion of parameter 01-02 for details.
			800-IED-WIS0-01801-000-00C	(BSC 2007 [DIRS 182926]); see discussion of parameter 01-03 for details.
			800-IED-MGR0-00401-000-00G	(BSC 2007 [DIRS 179928]) shows geotechnical and thermal properties and thickness of lithostratigraphic layers.
			800-IED-MGR0-00402-000-00A	(BSC 2007 [DIRS 178277]) shows geotechnical and thermal parameters
			800-IED-MGR0-00403-000-00A	(BSC 2007 [DIRS 178796]) shows geotechnical and thermal parameters
01-02	Repository Layout	The interface for the general layout and configuration of the subsurface facilities, including shafts, ramps, mains, emplacement drifts, observation drifts, and other subsurface features, and waste package nominal endpoint coordinates, elevations, and available drift lengths shall be controlled through Subsurface Facilities Layout Geographical Data IEDs.	800-IED-WIS0-01701-000-00B	<ul style="list-style-type: none"> • (BSC 2007 [DIRS 179927]) shows the following characteristics: Waste package endpoint coordinates and elevations, available drift lengths, and tolerances by emplacement panel (Table 1 to 5) based on the Nevada coordinate system. Elevations are based on National Geodetic Vertical Datum. • Footprint of emplacement area boundary (Figure 1). • Tolerances of +/- 10 m on endpoint coordinates and elevations and (+/- 20 m) on drift lengths. • Grade of the emplacement drifts nominally horizontal so that overall water drainage travels directly into the rock to prevent water accumulation. • Repository non-emplacement opening providing a repository grade so overall water drainage and accumulation travels away from WP emplacement areas.

Table 4-1. Subsurface Facilities Requirements (Continued)

Parameter Number	Parameter	Derived Requirement	IED	Remarks
01-02 (Continued)			800-IED-WIS0-00701-000-00A	(BSC 2005 [DIRS 173705], Table 1) shows decay heat history of the unit-cell WPs and line-load as a whole.
			TMRB-2007-040	(BSC 2007 [DIRS 182337]), <i>Clarifications on Repository Ground Support Design Issues.</i>
01-03	Repository Geologic Location	NA The interface for the repository areas, emplacement area by geologic unit, fault intersection coordinates, and borehole locations shall be controlled through the Subsurface Facilities Geological Data IED.	TMRB-2007-043	(BSC 2007 [DIRS 182328]); <i>Remove the Requirement for Backfill in the Subsurface Exhaust and Access Mains</i>
			TMRB-2007-029	(BSC 2007 [DIRS 182336]), <i>Update SS Committed Material IED</i>
			800-IED-WIS0-01801-000-00C	(BSC 2007 [DIRS 182926]) shows: Geologic units (Figure 1) Emplacement areas by geological unit with tolerances/ranges for lithophysical and non-lithophysical (Table 1) Fault/Emplacement Intersections (DTN:MO0707FAULTEMP.000 [DIRS 182092]) Borehole locations close to repository footprint (Figure 3). The Probabilistic Seismic Hazard Analysis (CRWMS M&O 1998 [DIRS 103731]) examines displacements at specific points along block bounding faults, intra-block faults, existing small faults, shears, and fractures. The assessed features are likely to be found within the repository waste-emplacement area by assessing the probability of displacement along existing small faults, shears, and fractures. The displacement in the intact rock with an annual exceedance probability of 10^{-8} is less than 0.1 cm.

Table 4-1. Subsurface Facilities Requirements (Continued)

Parameter Number	Parameter	Derived Requirement	IED	Remarks
01-03 (Continued)			800-IED-WIS0-01801-000-00C	(BSC 2007 [DIRS182926]) shows what emplacement drift information is required to properly assign seepage information to the two geologic zones - lithophysal and non-lithophysal. The following drift information is used to model postclosure performance: <ul style="list-style-type: none"> Minimum standoff distance from last waste package to centerline of exhaust main (800-KM0-SSE0-00901-000-00B (BSC 2005 [DIRS 176940], Note 8))
01-04	Repository Elevation	The emplacement drifts shall be located a minimum of 120 m above the water table (worst-case postulated water level, ~850 m).	800-POC-MGR0-00100-000-00E	(BSC 2003 [DIRS 165572], Section 7.1.1) documents water table standoff design constraint.
01-05	Repository Standoff from Quaternary Fault	The emplacement drifts shall be located a minimum of 60 m from a Quaternary fault with potential for significant displacement.	800-IED-WIS0-01801-000-00C	(BSC 2007 [DIRS182926]): Emplacement drift numbers and emplacement areas by geological unit are given as well as the fault intersect coordinates (with emplacement drift invert) by the Pagany Wash, Drill Hole Wash, Sever Wash, and Ghost Dance Fault. The Solitario Canyon Fault and Bow Ridge Fault lie outside the emplacement area of the repository and require standoffs as defined in <i>Underground Layout Configuration</i> (BSC 2003 [DIRS 165572], Section 7.1.3).
01-06	Repository Elevation	The overburden thickness from the emplacement area to the topographic surface shall be a minimum of 200 m.	NA	NA

Table 4-1. Subsurface Facilities Requirements (Continued)

Parameter Number	Parameter	Derived Requirement	IED	Remarks
01-07	Repository Standoff from Perched Water	The emplacement drifts shall be located a minimum of 30 m from the top of the Tptpv2 (Topopah Spring Tuff crystal-poor vitric zone) because perched water may occur at the base of the Tpt (Topopah Spring Tuff).	800-P0C-MGR0-00100-000-00E	(BSC 2003 [DIRS 165572], Section 7.1.2).
01-08	Orientation of Emplacement Drifts	The emplacement drifts will be nominally parallel, and the design azimuth shall be within a range of 70° to 80°.	800-IED-WIS0-01701-000-00B	(BSC 2007 [DIRS 179927]) shows the coordinates for emplacement drift and emplacement drift alignment. Tolerances of +/- 10 m have been established for endpoint coordinates and elevations.
01-09	Excavation Methods	The repository ramps, access mains, exhaust mains, and emplacement drifts shall be constructed by tunnel boring machines.	NA	NA
01-10	Emplacement Drift Configuration	The emplacement drifts shall be circular in cross section with a diameter nominally 5.5 m (-0/+10%).	NA	NA
01-11	Emplacement Drift Gradient	The grade of the emplacement drift shall be nominally horizontal so that overall water drainage travels directly into the rock to prevent water accumulation.	800-IED-WIS0-01701-000-00B	(BSC 2007 [DIRS 179927], Note 5).
01-12	Non-Emplacement Opening Gradient	The repository non-emplacement opening shall provide a repository grade so overall water drainage and accumulation travels away from emplacement areas.	800-IED-WIS0-01701-000-00B	(BSC 2007 [DIRS 179927], Note 6).

Table 4-1. Subsurface Facilities Requirements (Continued)

Parameter Number	Parameter	Derived Requirement	IED	Remarks
01-13	Emplacement Drift Spacing	The subsurface facility shall be designed to locate the emplacement drifts 81 m (+/- 5%) apart to prevent thermal interaction between adjacent drifts and allow drainage of thermally mobilized water within the rock pillars to percolate past the drifts.	NA	NA
01-14	Verification of Design Rock Properties	Post-excavation inspections of each drift shall be performed to verify the host rock properties are bounded by the rock properties described within the in situ observations and model assumptions used in postclosure analysis per the Geotechnical and Thermal Parameters IEDs. Post-excavation inspections will include geologic mapping to define that fracture geometric variability is within the model input parameter range used in rockfall calculations.	NA	NA
01-15	Design of Ground Support System	The interface for the design and materials used for ground support shall be controlled through the Subsurface Facilities Ground Support Configuration IED.	TMRB-2007-040	(BSC 2007 [DIRS 182337])
			TMRB-2007-029	(BSC 2007 [DIRS 182336])
			800-IED-WIS0-01301-000-00B	(BSC 2006 [DIRS 180503]) shows the gamma radiation levels that are used to determine they are low enough and will have no effect on the Stainless Steel Type 316L ground support.

Table 4-1. Subsurface Facilities Requirements (Continued)

Parameter Number	Parameter	Derived Requirement	IED	Remarks
01-16	Air Circulation through Ground Support	The permanent ground support shall allow air circulation between the host rock and ground support for moisture removal.	TMRB-2007-040	(BSC 2007 [DIRS 182337]) Groundwater flow is modeled in TSPA-LA as being completely unaffected by any rock reinforcement materials. The ground control system is expected to degrade following repository closure. The goal is to ensure that pore water liberated from the host rock matrix and percolation flux drains through sub-boiling region of the fracture network to the water table rather than accumulate above the repository horizon.
01-18	Unheated Drift Length	As boundary conditions for the thermohydrologic model in the postclosure, the emplacement drifts shall include at least a 60-m long area at one end of the drift and a 15-m long area at the other end without emplaced waste packages.	800-KM0-SSE0-00901-000-00B	(BSC 2005 [DIRS 176940]).
01-19	Flood Protection	The portal and shaft collar locations shall be situated such that they can be protected from water inflow as a result of the probable maximum flood.	TMRB-2007-043	(BSC 2007 [DIRS 182328]).

Table 4-1. Subsurface Facilities Requirements (Continued)

Parameter Number	Parameter	Derived Requirement	IED	Remarks
02-03	Committed Materials	During construction of the emplacement drifts and operation and closure of the repository, administrative controls will be imposed to prevent impact on waste isolation from materials used, lost, or left in the repository. These controls will be supported by technical evaluation. The Subsurface Facilities Committed Materials (IEDs) lists materials that are intended to be present in the repository at closure and have been found to be acceptable by analysis. All tracers, fluids, and materials (TFMs) that may be used during construction, operation, or closure will be controlled. An initial list of TFMs approved for use will be listed on TFM IED(s).	TMRB-2007-029	(BSC 2007 [DIRS 182336]), Update Subsurface Committed Materials IED

Table 4-1. Subsurface Facilities Requirements (Continued)

Parameter Number	Parameter	Derived Requirement	IED	Remarks
02-03 (Continued)		The following constraints will be imposed on the administrative control of TFMs, construction materials, and committed materials: a) All material not technically evaluated and determined acceptable prior to the permanent closure of the repository will be removed from subsurface facilities prior to permanent closure. b) Committed materials that are proposed to remain in the underground repository following permanent closure period will be technically evaluated and determined acceptable prior to use. c) Administrative controls will include accounting and inspection, as appropriate, to confirm that controls on the approved TFM quantities and compositions are met.	TMRB-2007-040	(BSC 2007 [DIRS 182337])
			TMRB-2007-043	(BSC 2007 [DIRS 182328]); <i>Remove the Requirement for Backfill in the Subsurface Exhaust and Access Mains</i>

Table 4-2. Subsurface Ventilation

Parameter Number	Parameter	Derived Requirement	Remarks
06-01	Duration of Ventilation Period	The duration of the ventilation period shall be a minimum of 50 years after final emplacement.	TMRB-2007-041 (BSC 2007 [DIRS 182340]); <i>Add Nominal Ventilation Air-Flow Rate to IED.</i>
06-02	Drift Wall Temperature	The maximum emplacement drift wall temperature shall not exceed 200°C to avoid adverse mineralogical transitions.	NA
06-03	Waste Package Temperature Limit	The waste package surface temperature shall be kept below 300°C for the first 500 years and below 200°C for the next 9500 years to eliminate postclosure issues (i.e., phase stability).	NA
06-04	Cladding Temperature Limit	The maximum temperature limit for the CSNF cladding upon emplacement shall not exceed 350°C (to prevent damage from creep or hydride reorientation).	Note: Derived requirement may change if CSNF cladding performance is not included in performance assessment.
06-05	Maximum Temperature of HLW Glass Canisters	The maximum HLW glass temperature shall be less than 400°C.	NA

Table 4-3. Sealing and Closure

Parameter Number	Parameter	Derived Requirement	Remarks
09-01	Closure of Shafts and Ramps	Closure of the shafts and ramps shall include backfilling of the opening.	TMRB-2007-043 (BSC 2007 [DIRS 182328]); <i>Remove the Requirement for Backfill in the Subsurface Exhaust and Access Mains</i>
09-02	Closure of Ramps, Access, and Exhaust Mains	Ramps, access, and exhaust mains shall be backfilled at closure to limit igneous intrusion.	TMRB-2006-018 (BSC 2006 [DIRS 180434]); <i>Remove the Requirement for Design and Installation of Magma Bulkheads in the Subsurface Repository.</i>

Table 4-3. Sealing and Closure(Continued)

Parameter Number	Parameter	Derived Requirement	Remarks
09-03	Sealing of Boreholes	In the event that an emplacement drift unexpectedly encounters a borehole during repository construction, such boreholes shall either be sealed or waste packages will have a sufficient standoff distance from the location of the borehole penetration into the waste emplacement drift, or both.	TMRB-207-043 (BSC 2007 [DIRS 182328]); <i>Remove the Requirement for Backfill in the Subsurface Exhaust and Access Mains</i>
09-04	Reclamation of Lands Disturbed by Repository	Lands disturbed by the repository shall be reclaimed following the <i>Reclamation Implementation Plan</i> (YMP 2001 [DIRS 154386], Section 1), as established in the final environmental impact statement (DOE 2002 [DIRS 155970]), to ensure there are no preclosure disturbances that will impact postclosure performance.	NA

English units are the source values (conversions to metric are informational and rounded off) unless only presented in metric.

4.1.1 Subsurface Facilities Direct Input that Applies to the Performance Assessment

Total System Performance Assessment Data Input Package for Requirements Analysis for EBS In-Drift Configuration (SNL 2007 [DIRS 179354]) provides the requirements for the engineered barrier system in-drift configuration requirements. This section and Table 4-1 provide the balance of the overall subsurface facility layout. The following four information exchange drawings (IEDs) are the key document sources that satisfy the derived requirements in Table 4-1:

1. TMRB-2007-029, Update Subsurface committed Materials IED [DIRS 182336]
2. TMRB-2007-040, Clarifications on Repository Ground Support Design Issues [DIRS 182337]
3. 800-IED-WIS0-01701-000-00B, *IED Subsurface Facilities Layout Geographical Data* [DIRS 179927]
4. 800-IED-WIS0-01801-000-00C, *IED Subsurface Facilities Layout Geological Data* [DIRS182926].

4.2 NON-PARAMETER INFORMATION

Not applicable.

4.3 SOFTWARE

Software was not used to develop or modify any of the parameter values identified in this report.

5. JUSTIFICATION

The inputs identified in Section 4 represent the best available, sometimes preliminary, design information to be used for postclosure analyses and models.

5.1 IDENTIFICATION OF PROCESS MODELS AND/OR ABSTRACTIONS

No models or abstractions are provided by this design interface document.

5.2 TSPA OR PROCESS-LEVEL MODEL INPUT

No models or abstractions are provided by this design interface document.

5.3 MODEL VALIDATION

No models or abstractions are provided by this design interface document.

5.4 MODEL OUTPUTS AND/OR ANALYSIS OUTPUT AND RATIONALE

No models or abstractions are provided by this design interface document.

6. REFERENCES

6.1 DOCUMENTS CITED

- 165572 BSC (Bechtel SAIC Company) 2003. *Underground Layout Configuration*. 800-POC-MGR0-00100-000-00E. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20031002.0007; ENG.20050817.0005.
- 173705 BSC 2005. *IED Waste Package Decay Heat Generation [Sheet 1 of 1]*. 800-IED-WIS0-00701-000-00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20050406.0006.
- 176940 BSC 2005. *Repository Subsurface Emplacement Drift Panel 2 General Arrangement [Sheet 1 of 1]*. 800-KM0-SSE0-00901-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20051019.0004.
- 180503 BSC 2006. *IED Waste Package Radiation Characteristics [Sheet 1 of 1]*. 800-IED-WIS0-01301-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20061017.0004.
- 180434 BSC 2006. *TMRB Decisional Proposal - Remove the Requirement for Design and Installation of Magma Bulkhead in the Subsurface Repository*. TMRB-2006-018. Las Vegas, Nevada: Bechtel SAIC Company. ACC: X.

- 179928 BSC 2007. *IED Geotechnical and Thermal Parameters*. 800-IED-MGR0-00401-000 REV 00G. Las Vegas, Nevada: Bechtel SAIC Company.
ACC: ENG.20070601.0020.
- 178277 BSC 2007. *IED Geotechnical and Thermal Parameters II [Sheet 1 of 1]*. 800-IED-MGR0-00402-000-00A. Las Vegas, Nevada: Bechtel SAIC Company.
ACC: ENG.20070108.001.
- 178796 BSC 2007. *IED Geotechnical and Thermal Parameters III [Sheet 1 of 1]*. 800-IED-MGR0-00403-000-00A. Las Vegas, Nevada: Bechtel SAIC Company.
ACC: ENG.20070108.001.
- 179927 BSC 2007. *IED Subsurface Facilities Layout Geographical Data*. 800-IED-WIS0-01701-000 REV 00B. Las Vegas, Nevada: Bechtel SAIC Company.
ACC: ENG.20070326.0017.
- 182926 BSC 2007. *IED Subsurface Facilities Layout Geological Data*. 800-IED-WIS0-01801-000-00C. Las Vegas, Nevada: Bechtel SAIC Company.
ACC: ACC: ENG.20070913.0012
- 179341 BSC 2007. *Level 3 Technical Baseline for the Yucca Mountain Project*. 000-30R-MGR0-01700-000-002. Las Vegas, Nevada: Bechtel SAIC Company.
ACC: ENG.20070207.0011.
- 179342 BSC 2007. *Postclosure Modeling and Analyses Design Parameters*. TDR-MGR-MD-000037 REV 01. Las Vegas, Nevada: Bechtel SAIC Company.
ACC. ENG.20070521.0012 and ACC. ENG.20070829.0011.
- 182340 BSC 2007. *TMRB Decision Proposal – Add Nominal Ventilation Air-Flow Rate to IED*. TMRB-2007-041. Las Vegas, Nevada: Bechtel SAIC Company.
- 182337 BSC 2007. *TMRB Decision Proposal -Clarifications on Repository Ground Support Design Issues*. TMRB-2007-040. Las Vegas, Nevada: Bechtel SAIC Company.
- 182328 BSC 2007. *TMRB Decision Proposal –Remove the Requirement for Backfill in the Subsurface Exhaust and Access mains*. TMRB-2007-043. Las Vegas, Nevada: Bechtel SAIC Company.
- 182336 BSC 2007. *TMRB Decision Proposal –Update Subsurface Committed Materials IEDs*. TMRB-2007-029. Las Vegas, Nevada: Bechtel SAIC Company.
- 103731 CRWMS M&O 1998. *Probabilistic Seismic Hazard Analyses for Fault Displacement and Vibratory Ground Motion at Yucca Mountain, Nevada*. Milestone SP32IM3, September 23, 1998. Three volumes. Las Vegas, Nevada: CRMS M&O.
ACC: MOL.19981207.0393.

- 155970 DOE (U.S. Department of Energy) 2002. *Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada*. DOE/EIS-0250. Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: MOL.20020524.0314; MOL.20020524.0315; MOL.20020524.0316; MOL.20020524.0317; MOL.20020524.0318; MOL.20020524.0319; MOL.20020524.0320.
- 177464 SNL (Sandia National Laboratories) 2007. *Postclosure Nuclear Safety Design Bases*. ANL-WIS-MD-000024 REV 01. Las Vegas, Nevada: Sandia National Laboratories.
- 179320 SNL 2007. *Technical Work Plan for: Total System Performance Assessment (TSPA) Parameter Selection and Documentation with TSPA Data Input Package (TDIP)*. TWP-MGR-PA-000044 REV 00. Las Vegas, Nevada: Sandia National Laboratories. ACC: DOC.20070116.0002.
- 179354 SNL 2007. *Total System Performance Assessment Data Input Package for Requirements Analysis for EBS In-Drift Configuration*. TDR-TDIP-ES-000010 REV 00. Las Vegas, Nevada: Sandia National Laboratories.
- 182092 DTN: MO0707FAULTEMP.000 Fault/Emplacement Drift Intersections. Submittal date: 07/19/2007
- 154386 YMP (Yucca Mountain Site Characterization Project) 2001. *Reclamation Implementation Plan*. YMP/91-14, Rev. 2. Las Vegas, Nevada: Yucca Mountain Site Characterization Office. ACC: MOL.20010301.0238.

6.2 CODES, STANDARDS, REGULATIONS, AND PROCEDURES

LS-PRO-001, *Technical Reports*

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