YMP	**Scientific Analysis/Calculation Error Resolution Document** *Complete only applicable items.*	QA: QA Page 1 of 28

1. Document Number:	2. Revision/Addendum:	3. ERD:
ANL-WIS-MD-000027	REV 00	04

4. Title:	5. No. of Pages Attached:
Features, Events, and Processes for the Total System Performance Assessment: Analyses	27

6. Description of and Justification for Change (Identify affected pages, applicable CRs and TBVs):

This Error Resolution Document (ERD) is provided to update the FEP Analysis AMR, Rev 00 to correct issues identified in Condition Reports (CRs) 12452, 12543, and 13156 and to correct other minor errors identified in the process of addressing these CRs. There is no impact to the overall conclusion of the AMR caused by these minor corrections.

To satisfy CR 12543, Action 003:

1. Section 3, page 3-1, fourth paragraph, line 1, "Mathcad Version 13.1 (STN: 611161-13.1-00)"

   should be changed to:

   "Mathcad Version 14 (STN: 611161-14.0-00 [DIRS 185959])"

2. Section 3, page 3-1, fourth paragraph, line 5, "Mathcad Version 13.1"

   should be changed to:

   "Mathcad Version 14"

3. FEP 1.2.03.02.0B, page 6-103, paragraph beginning, "The estimate of dose from . . . ", lines 9-12, "The mean annual dose due to nonlithophysal rockfall over the 10,000 year to 1,000,000 year period after closure is estimated to be less than 1% of the mean annual dose due to seismic ground motion, based on the analysis in Section E.6.3."

   should be changed to:

   "The maximum of the mean annual dose due to nonlithophysal rockfall over the 10,000-year to 1,000,000-year period after closure is estimated to be less than 1% of the mean annual dose due to seismic ground motion based on the analysis in Section E.6.3."

(continued on next page)

	Printed Name	Signature	Date
7. Checker	Geoffrey A. Freeze	Geoff Freeze	3/11/09
8. QCS/QA Reviewer	Peter Persoff	Peter Persoff	03/11/2009
9. Originator	Thomas F. Ehrhorn	Tom F Ehr	3/11/09
10. Responsible Manager	Jerry A. McNeish	Jerry A McNeish	3.11.09.

4. FEP 2.1.03.03.0B, page 6-409, second paragraph, lines 5 and 6, "(DTN: MO0709TSPALOCO.000 [DIRS 182994], file: *LA_v5.000_LC_Initiation_Analysis_v2_Conceptual_Description.pdf*)"

   should be changed to:

   "(DTN: MO0709TSPALOCO.000 [DIRS 185808], file: *LA_v5.000_LC_Initiation_Analysis_v2_Conceptual_Description.pdf*, Figure 4)"

5. Table 2.1.03.03.0B-1, page 6-412, "Input", fourth row, "182994"

   should be changed to:

   "185808". (The DIRS report will be updated accordingly.)

6. Table 2.1.03.03.0B-1, page 6-412, "Source", 4th row,

   add:

   ", Figure 4". (The DIRS report will be updated accordingly.)

7. FEP 2.1.14.19.0A, page 6-824, first paragraph, lines 1 and 2, "(DTN: MO0712PBANLNWP.000 [DIRS 184664])"

   should be changed to:

   "(DTN: MO0810PBANLNWP.001 [DIRS 185947], file: Mathcad - Lith Probability of DS Failure.pdf)"

8. FEP 2.1.14.19.0A, page 6-824, first paragraph, lines 7 and 8, "DTNs: MO0712PANLNNWP.000 [DIRS 184480] and MO0712PBANLNWP.000 [DIRS 184664]"

   should be changed to:

   "DTN: MO0810PANLNNWP.001 [DIRS 185842]"

9. Table 2.1.14.19.0A-4, page 6-824, column, "Probability"

   "5.9×10^{-10}

   4.4×10^{-10}

   2.8×10^{-10}

   2.8×10^{-10}"

   should be changed to:

   "7.2×10^{-9}

   5.5×10^{-9}

   3.5×10^{-9}

   2.4×10^{-9}"

10. Table 2.1.14.19.0A-11, page 6-832, fifth row, DTN: "MO0712PANLNNWP.000" and DIRS "184480"

    should be changed to:

    DTN: "MO0810PANLNNWP.001" and DIRS "185842" (The DIRS report will be updated accordingly.)

11. Table 2.1.14.19.0A-11, page 6-832, sixth row, DTN: "MO0712PBANLNWP.000 Probabilistic Analysis of Navy Waste Packages 184664"

    should be changed to:

    DTN: "MO0810PBANLNWP.001 Probabilistic Analysis of Navy Waste Packages (Correction) 185947". (The DIRS report will be updated accordingly.)

12. Page 8-54, entry for 173869,

    add:

    "; DOC.20080317.0008; LLR.20080401.0255; LLR.20080423.0161; DOC.20090302.0002."

13. Page 8-77, entry for 182994

    should be changed to:

    "185808 MO0709TSPALOCO.000. TSPA Localized Corrosion Analysis. Submittal date: 10/20/2008"

14. Page 8-77, after the entry for 182976

    add:

    "183752 MO0710ADTSPAWO.000. TSPA-LA Addendum Groundwater Modeling Cases (V5.005) without Final Documentation (Used for Regulatory Compliance). Submittal date: 10/30/2007."

15. Page 8-77

    delete:

    entry for 182976

16. Page 8-77, entry for 184480

    should be changed to:

    "185842. MO0810PANLNNWP.001. Probabilistic Analysis of Drip Shield Failure and CSNF and CDSP Package OCB Localized Corrosion. Submittal date: 10/21/2008."

17. Page 8-77, entry for 184664

    should be changed to:

"185947. MO0810PBANLNWP.001. Probabilistic Analysis of Navy Waste Packages (Correction). Submittal date: 10/21/2008."

18. Page 8-80, after the entry for 181089

    add:

    "185959 Mathcad V.14. 2007. Windows 2000/XP. STN: 611161-14.0-00." (The DIRS report will be updated accordingly.)

19. Section E.3, page E-1, second paragraph, line 1, "Mathcad Version 13.1 (STN: 611161-13.1-00)"

    should be changed to:

    "Mathcad Version 14 (STN: 611161-14.0-00)"

20. Section E.3, Page E-1, second paragraph, line 5, "Mathcad Version 13.1"

    should be changed to:

    Mathcad Version 14"

21. Table E-1, page E-3, column "Value", fifth row, "4 0.0414634"

    should be changed to:

    "4 0.041463"

22. Table E-1, page E-3, column "Source", fifth row, "DTN: MO0709TSPALOCO.000 [DIRS 182994], TSPA parameter: NonLith_Frac_CSNF_out"

    should be changed to:

    "DTN: MO0709TSPALOCO.000 [DIRS 185808], File: NonLith_Frac_CSNF_out.xls". (The DIRS report will be updated accordingly.)

23. Table E-1, page E-3, column "Source", tenth row,

    "DTN MO0709TSPALOCO.000 [DIRS 182994],

    files: LC_Initiation_Analysis_v2_CSNF_Bin1.TXT
    LC_Initiation_Analysis_v2_CSNF_Bin2.TXT
    LC_Initiation_Analysis_v2_CSNF_Bin3.TXT
    LC_Initiation_Analysis_v2_CSNF_Bin4.TXT
    LC_Initiation_Analysis_v2_CSNF_Bin5.TXT
    LC_Initiation_Analysis_v2_CDSP_Bin1.TXT
    LC_Initiation_Analysis_v2_CDSP_Bin2.TXT
    LC_Initiation_Analysis_v2_CDSP_Bin3.TXT
    LC_Initiation_Analysis_v2_CDSP_Bin4.TXT

LC_Initiation_Analysis_v2_CDSP_Bin5.TXT"

should be changed to:

"DTN MO0709TSPALOCO.000 [DIRS 185808],

files: LC_Initiation_Analysis_v2_Brine&E_CSNF_Bin1.TXT

LC_Initiation_Analysis_v2_Brine&E_CSNF_Bin2.TXT

LC_Initiation_Analysis_v2_Brine&E_CSNF_Bin3.TXT

LC_Initiation_Analysis_v2_Brine&E_CSNF_Bin4.TXT

LC_Initiation_Analysis_v2_Brine&E_CSNF_Bin5.TXT

LC_Initiation_Analysis_v2_Brine&E_CDSP_Bin1.TXT

LC_Initiation_Analysis_v2_Brine&E_CDSP_Bin2.TXT

LC_Initiation_Analysis_v2_Brine&E_CDSP_Bin3.TXT

LC_Initiation_Analysis_v2_Brine&E_CDSP_Bin4.TXT

LC_Initiation_Analysis_v2_Brine&E_CDSP_Bin5.TXT" (The DIRS report will be updated accordingly.)

24. Table E-1, page E-3, column "Source", eleventh row, "DTN: MO0709TSPAREGS [DIRS 182976], file *LA_v5.000_ED_003000_007_Dose_Total.txt*"

should be changed to:

"DTN: MO0710ADTSPAWO.000 [DIRS 183752], file *LA_v5.005_ED_003000_001_Dose_Total.txt*" (The DIRS report will be updated accordingly.)

25. Section E.6.1, page E-5, third paragraph, lines 2 and 3, "(DTN: MO0709TSPAREGS.000 [DIRS 182976], file *LA_v5.000_ED_003000_007_Dose_Total.txt*"

should be changed to:

"(DTN: MO0710ADTSPAWO.000 [DIRS 183752], file *LA_v5.005_ED_003000_001_Dose_Total.txt*"

26. Section E.6.2, page E-7, equation "D_{ED} $(\tau|l,p,b,\mathbf{e}_i)$", lines 5 through 7, "(DTN MO0709TSPAREGS.000 [DIRS 182976], file *LA_v5.000_ED_003000_007_Dose_Total.txt)*."

should be changed to:

"(DTN: MO0710ADTSPAWO.000 [DIRS 183752], file: *LA_v5.005_ED_003000_001_Dose_Total.txt*)."

27. Section E.6.2, page E-7, equation "$t_{LC} = t_{LC}$ $(p,b,\mathbf{e}_i)$", lines 3 through 11

"based on DTN MO0709TSPALOCO.000 [DIRS 182994], files:

LC_Initiation_Analysis_v2_CSNF_Bin1.TXT

LC_Initiation_Analysis_v2_CSNF_Bin2.TXT
LC_Initiation_Analysis_v2_CSNF_Bin3.TXT
LC_Initiation_Analysis_v2_CSNF_Bin4.TXT
LC_Initiation_Analysis_v2_CDSP_Bin1.TXT
LC_Initiation_Analysis_v2_CDSP_Bin2.TXT
LC_Initiation_Analysis_v2_CDSP_Bin3.TXT
LC_Initiation_Analysis_v2_CDSP_Bin4.TXT"

should be changed to (note the addition of Bin5 files):

"based on DTN MO0709TSPALOCO.000 [DIRS 185808], files:
LC_Initiation_Analysis_v2_Brine&E_CSNF_Bin1.TXT
LC_Initiation_Analysis_v2_Brine&E_CSNF_Bin2.TXT
LC_Initiation_Analysis_v2_Brine&E_CSNF_Bin3.TXT
LC_Initiation_Analysis_v2_Brine&E_CSNF_Bin4.TXT
LC_Initiation_Analysis_v2_Brine&E_CSNF_Bin5.TXT
LC_Initiation_Analysis_v2_Brine&E_CDSP_Bin1.TXT
LC_Initiation_Analysis_v2_Brine&E_CDSP_Bin2.TXT
LC_Initiation_Analysis_v2_Brine&E_CDSP_Bin3.TXT
LC_Initiation_Analysis_v2_Brine&E_CDSP_Bin4.TXT"
LC_Initiation_Analysis_v2_Brine&E_CDSP_Bin5.TXT

28. Section E.6.2, page E-8 (ACN01), equation "T_{LC} $(p,b,\mathbf{e}_i)$", lines 3 through 11

"on data in DTN MO0709TSPALOCO.000 [DIRS 182994], files:
LC_Initiation_Analysis_v2_CSNF_Bin1.TXT
LC_Initiation_Analysis_v2_CSNF_Bin2.TXT
LC_Initiation_Analysis_v2_CSNF_Bin3.TXT
LC_Initiation_Analysis_v2_CSNF_Bin4.TXT
LC_Initiation_Analysis_v2_CDSP_Bin1.TXT
LC_Initiation_Analysis_v2_CDSP_Bin2.TXT
LC_Initiation_Analysis_v2_CDSP_Bin3.TXT
LC_Initiation_Analysis_v2_CDSP_Bin4.TXT"

should be changed to (note the addition of Bin5 files):

"on data in DTN MO0709TSPALOCO.000 [DIRS 185808], files:
LC_Initiation_Analysis_v2_Brine&E_CSNF_Bin1.TXT

LC_Initiation_Analysis_v2_Brine&E_CSNF_Bin2.TXT

LC_Initiation_Analysis_v2_Brine&E_CSNF_Bin3.TXT

LC_Initiation_Analysis_v2_Brine&E_CSNF_Bin4.TXT

LC_Initiation_Analysis_v2_Brine&E_CSNF_Bin5.TXT

LC_Initiation_Analysis_v2_Brine&E_CDSP_Bin1.TXT

LC_Initiation_Analysis_v2_Brine&E_CDSP_Bin2.TXT

LC_Initiation_Analysis_v2_Brine&E_CDSP_Bin3.TXT

LC_Initiation_Analysis_v2_Brine&E_CDSP_Bin4.TXT

LC_Initiation_Analysis_v2_Brine&E_CDSP_Bin5.TXT"

29. Section E.6.2, page E-8 (ACN 01), equation "$f_{NL}(b)$", lines 2 and 3, "(DTN: MO0709TSPALOCO.000 [DIRS 182994], TSPA parameter: NonLith_Frac_CSNF_out)"

    should be changed to:

    "(DTN: MO0709TSPALOCO.000 [DIRS 185808], file: NonLith_Frac_CSNF_out.xls)"

30. Table E-3, page E-9 (ACN 01), second column, "Mean Annual Dose – Nonlithophysal Rockfall (mrem)"

    "0.00098

    0.00096

    0.00037

    0.00031"

    should be changed to:

    "0.00426

    0.00380

    0.00122

    0.00134"

31. Table E-3, page E-9 (ACN 01), fourth column, "Ratio of Nonlithophysal Rockfall Dose to Seismic Ground Motion Modeling Case Dose (%)"

    "49

    3.2

    0.37

    0.16"

    should be changed to:

    "213

12.7

1.22

0.67"

32. Table E-3, page E-9 (ACN 01), "Sources", "*LA_v5_ED_003000_007_NL_LC_Dose.txt*"

should be changed to:

"*LA_v5.005_ED_003000_001_NL_LC_Dose.txt*"

33. Table E-3, page E-9 (ACN 01), "Sources", "(a)[a]"

should be changed to:

"[a](a)"

34. Section E.6.3, pages E-9 (ACN 01) and E-10, paragraph directly beneath Table E-3

"A comparison of the ratios in Table E-3 demonstrates that: (1) the mean annual dose from the seismic ground motion modeling case is always greater than the estimated dose due to nonlithophysal rockfall; (2) at 1,000 years, the mean annual dose due to nonlithophysal rockfall is about 50% of the dose from the seismic ground motion modeling case, although the magnitude of the nonlithophysal related dose is very small compared to the individual protection standard of 15 mrem during the first 10,000 years after closure (proposed 10 CFR 63.311(a)(1) [DIRS 178394]); and (3) after 2,000 years, the mean annual dose due to nonlithophysal rockfall is about 3% or less of the dose from the seismic ground motion modeling case. These results indicate that the effects of nonlithophysal rockfall can be screened out of the performance assessment on the basis of low consequence to the seismic ground motion modeling case and to TSPA for the first 10,000 years after repository closure."

should be changed to:

"A comparison of the ratios in Table E-3 demonstrates that when the mean annual dose from the seismic ground motion modeling case is numerically significant (i.e., within an order of magnitude of its maximum value), the mean annual dose from the seismic ground motion modeling case is greater than the estimated dose due to nonlithophysal rockfall. Also, when the mean annual dose from the seismic ground motion modeling case is numerically significant, the mean annual dose due to nonlithophysal rockfall is not more than 13% of the dose from the seismic ground motion modeling case. Moreover, the magnitude of the mean annual dose from seismic ground motion is small (0.2 mrem) compared to the individual protection standard of 15 mrem during the first 10,000 years after closure (proposed 10 CFR 63.311(a)(1) [DIRS 178394]). Inclusion of the effects of nonlithophysal rockfall with the seismic ground motion modeling case would not significantly change the mean annual dose from the modeling case. These results indicate that the effects of nonlithophysal rockfall can be screened out of the performance assessment on the basis of low consequence to the seismic ground motion modeling case and hence to the TSPA for the first 10,000 years after repository closure."

35. Section E.6.2, page E-10, second paragraph, line 13, "(b)[a]"

should be changed to:

"[a](b)"

36. Section E.6.2, page E-10, second paragraph, line 17, "0.001466 mrem at 1,240"

    should be changed to:

    "0.00426 mrem at 1,000"

37. Section E.6.2, page E-10, second paragraph, last line, "*LA_v5_ED_003000_007_NL_LC_Dose.txt*"

    should be changed to:

    "*LA_v5.005_ED_003000_001_NL_LC_Dose.txt*".

38. Section E.6.2, page E-10, third paragraph, line 1, "0.1"

    should be changed to"

    "0.2"

39. Section E.6.2, page E-10, third paragraph, line 3, "(b)[a]"

    should be changed to:

    "[a](b)"

40. Section E.6.2, page E-10, third paragraph, line 4, "about 1%"

    should be changed to:

    "not more than 1%".

41. Section E.6.2, page E-10, third paragraph, lines 4 and 5, "(0.001466 mrem/0.1 mrem = 0.015)"

    should be changed to:

    "(0.00134 mrem/0.2 mrem = 0.0067)"

<u>To satisfy CR 12452, Action 005:</u>

1. FEP 1.1.02.00.0B, page 6-29, Screening Justification, first paragraph, line 2, "SNL 2007 [DIRS 179466]"

   should be changed to:

   "SNL 2009 [DIRS 185407]".

2. FEP 1.1.02.00.0B, page 6-29, Screening Justification, third paragraph, lines 2 and 3, "SNL 2007 [DIRS 179466]"

   should be changed to:

   "SNL 2009 [DIRS 185407]".

3. FEP 1.1.02.00.0B, page 6-30, after the second paragraph,

add:

Blasting methods may be used in the excavation of the starter tunnel to support each tunnel boring machine advance (SNL 2009 [DIRS 185407], Table 4-1, Parameter 01-09). The extent of the damaged zone around a drill-and-blast excavation during construction of the Thermal Test Facility in the Exploratory Studies Facility at Yucca Mountain (Lee 1997 [DIRS 157361], Sections 1, 5, and 6) was considered to be less than 1 m.

Corroborating the Yucca Mountain results, the zone of disturbance around blasted excavations in granite was found to be from approximately 1 m (Martino and Chandler, 2004 [DIRS 185891]) to less than 1.5 m (Pusch and Stanfors, 1992 [DIRS 185890]).

Drill-and-blast methods will not be used in the emplacement area, within an axial separation from waste packages that is greater than the extent of blast damage (1 m), which is a reasonable estimate for the lateral extent of any mechanical or hydrologic feature or process that could affect performance of the nearest waste package.

4. FEP 1.1.02.00.0B, page 6-30, third paragraph, line 1, "tunnel boring machines will maintain circular tunnel geometry,"

should be changed to:

"tunnel boring machines or blasting methods will maintain the desired tunnel geometry,".

5. Table 1.1.02.00.0B-1, page 6-31

replace the SNL 2007 entry with the following:

Lee 1997. *Blast Vibration Monitoring in the Thermal Testing Facility/Connecting Drift and Heated Drift.* [DIRS 157361].	Sections 1, 5, and 6	The extent of the damaged zone around a drill and blast excavation.
SNL 2009. *Postclosure Design Input Parameters for Subsurface Facilities.* [DIRS 185407].	Table 4-1, Parameter 01-09	Primary construction for emplacement drifts, access mains, and exhaust mains will be tunnel boring machine. Blasting will be used for the starter tunnel.
	Table 4-1, Parameter 01-10	Diameter of emplacement drifts.

(The DIRS report will be updated accordingly.)

6. Table 1.1.02.00.0B-2, page 6-31

add the following entries:

Martino and Chandler, 2004.	"Excavation-Induced Damage Studies at the Underground Research Laboratory"	185891
Pusch and Stanfors, 1992.	"The Zone of Disturbance Around Blasted Tunnels at Depth."	185890

(The DIRS report will be updated accordingly.)

7. FEP 1.1.07.00.0A, page 6-47, last paragraph, lines 7 through 10, "*Total System Performance Assessment Data Input Package for Requirements Analysis for Engineered Barrier System In-Drift Configuration* (SNL 2007 [DIRS 179354]); and *Total System Performance Assessment Data Input Package for Requirements Analysis for Subsurface Facilities* (SNL 2007 [DIRS 179466])

   should be changed to:

   "*Postclosure Design Input Parameters for Engineered Barrier System In-Drift Configuration* (SNL 2008 [DIRS 185406]); and *Postclosure Design Input Parameters for Subsurface Facilities* (SNL 2009 [DIRS 185407])

8. FEP 1.1.07.00.0A, page 6-48, first paragraph, lines 1 through 3, "*Total System Performance Assessment Data Input Package for Requirements Analysis for Subsurface Facilities* (SNL 2007 [DIRS 179466]"

   should be changed to:

   "*Postclosure Design Input Parameters for Subsurface Facilities* (SNL 2009 [DIRS 185407]"

9. FEP 1.1.07.00.0A, page 6-48, first paragraph, lines 7 and 8 and 14, "SNL 2007 [DIRS 179466]"

   should be changed to:

   "SNL 2009 [DIRS 185407]"

10. FEP 1.1.07.00.0A, page 6-48, between the paragraph which begins "The layout of the subsurface facility . . . .." and the heading "**Features of the Engineered Barrier System**"

    add:

    The layout of the repository is also governed by two vertical standoff parameters above the non-welded units below the repository. The first, Repository Standoff from Calico Hills Nonwelded Hydrogeologic Unit, (SNL 2009 [DIRS 185407], Table 4-1, Parameter Number 01-22) states that the minimum distance from the base of each emplacement drift and the top of the Calico Hills nonwelded hydrogeologic unit shall be 60 m. The second standoff requirement is presented in the parameter Repository Standoff from Perched Water (SNL 2009 [DIRS 185407], Table 4-1, Parameter Number 01-07). This parameter requires that 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). The 30 m was chosen originally to ensure that the lower extent of the boiling zone would not reach the perched water, thus limiting vaporization (Hardin 1998 [DIRS 100123], Section 5.6.5.2). More recent models, such as the multiscale model used for TSPA, show the lower extent of the boiling zone is limited to approximately 11 m (SNL 2008 [DIRS 184433], Table 6.3-51[a], bounding the lower extent by the lateral extent). As stated in SNL 2009 [DIRS 185407], Table 4-1, Parameter Number 01-07, the standoff from perched water applies specifically to the waste emplacement area. However even though not stated in that parameter, the analysis basis

for the performance assessment does not allow for any part of the repository intersecting perched water.

11. FEP 1.1.07.00.0A, page 6-48, third paragraph, lines 4, 6, and 8, "SNL 2007 [DIRS 179354]"

    should be changed to:

    "SNL 2008 [DIRS 185406]"

12. FEP 1.1.07.00.0A, page 6-48, third paragraph, lines 4 and 8, "4-2"

    should be changed to:

    "4-3"

13. FEP 1.1.07.00.0A, page 6-49, third paragraph, line 7, "SNL 2007 [DIRS 179354]"

    should be changed to:

    "SNL 2008 [DIRS 185406]"

14. FEP 1.1.07.00.0A, page 6-50, third paragraph, line 2, "SNL 2007 [DIRS 179354]"

    should be changed to:

    "SNL 2008 [DIRS 185406]"

15. FEP 1.1.07.00.0A, page 6-51, first paragraph, line 3, "SNL 2007 [DIRS 179354], Table 4-4"

    should be changed to:

    "SNL 2008 [DIRS 185406], Table 4-2"

16. FEP 1.1.07.00.0A, page 6-51, first paragraph, line 5, "SNL 2007 [DIRS 179466]"

    should be changed to:

    "SNL 2009 [DIRS 185407]"

17. Table 1.1.07.00.0A-1, page 6-51, after the entry for DIRS 183627,

    add:

Hardin 1998	*Near-Field/Altered-Zone Models Report*	100123

(The DIRS report will be updated accordingly.)

18. Table 1.1.07.00.0A-1, page 6-51,

    delete the following entries:

    entry for DIRS 179354 and entry for DIRS 179466. (The DIRS report will be updated accordingly.)

19. Table 1.1.07.00.0A-1, page 6-51, after t he entry for DIRS 184433,

add:

SNL 2008	*Postclosure Design Input Parameters for Engineered Barrier System In-Drift Configuration*	185406

(The DIRS report will be updated accordingly.)

20. Table 1.1.07.00.0A-1, page 6-51,

add:

SNL 2009	*Postclosure Design Input Parameters for Subsurface Facilities*	185407

(The DIRS report will be updated accordingly.)

21. Page 8-4, after the entry for 173179,

add:

"107731 Bieniawski, Z.T. 1984. *Rock Mechanics Design in Mining and Tunneling*. Rotterdam, The Netherlands: A.A. Balkema. TIC: 4281.

22. Page 8-5, after the entry for 129637,

add:

"186056 Board, M. 1989. *Basis for In-Situ Geomechanical Testing at the Yucca Mountain Site*. NUREG/CR-5400. Washington, D.C.: U.S. Nuclear Regulatory Commission. ACC: NNA.19890821.0063.

23, Page 8-30, after the entry for 100534,

add:

100123 Hardin, E.L. 1998. *Near-Field/Altered-Zone Models Report*. UCRL-ID-129179. Livermore California: Lawrence Livermore National Laboratory. ACC: MOL.19980630.0560.

24. Page 8-36, after the entry for 142133,

add:

"157361 Lee, M.Y. 1997. *Blast Vibration Monitoring in the Thermal Testing Facility/Connecting Drift and Heated Drift*. WA-0065. Albuquerque, New Mexico: Sandia National Laboratories. ACC: MOL.19971111.0208.

25. Page 8-39, after the entry for 184437,

add:

"185891 Martino, J.B. and Chandler, N.A. 2004. "Excavation-Induced Damage Studies at the Underground Research Laboratory." *International Journal of Rock Mechanics & Mining Sciences, 41.* 1413-1426. [New York, New York]: Elsevier. TIC: 260226.

26. Page 8-45, after the entry for 162574,

    add:

    "185890 Pusch, R. and Stanfors, R. 1992. "The Zone of Disturbance Around Blasted Tunnels at Depth." *International Journal of Rock Mechanics and Mining Science & Geomechanics Abstracts, 29, (5),* 447-456. [New York, New York]: Pergamon Press. TIC: 260227.

27. Page 8-66, after the entry for SCI-PRO-007,

    add:

    "186058 TP-252. *Blast Monitoring*. [Albuquerque, New Mexico]: Sandia National Laboratories. ACC: MOL.19990322.0255.

28. Page 8-78, after the entry for 181283,

    add:

    "186057 SNF37100195001.003. Blast Vibration Monitoring in the Thermal Testing Facility/Connecting Drift and Heated Drift. Submittal date: 04/22/1997.

29. Table A-1, page A-3 (ERD 03), entry for control parameter 01-07, column "Control Parameter",

    add:

    "Repository Standoff from Perched Water"

30. Table A-1, page A-3, entry for control parameter 01-07, column "Representative FEPs Relying on Design/Control Parameter",

    add:

    - FEP 1.1.07.00.0A – Repository Design
    - FEP 2.2.07.07.0A – Perched Water Develops*

31. Table A-1, page A-3, entry for control parameter 01-07, column "Control Parameter Use in Performance Assessment",

    add:

    "Supports the basis for performance assessment initial conditions"

32. Table A-1, page A-5, entry for control parameter 01-22, column "Representative FEPs Relying on Design/Control Parameter",

    add:

    - FEP 1.1.07.00.0A – Repository Design*

33. Table A-1, page A-5, entry for control parameter 01-22, column "Control Parameter Use in Performance Assessment"

add:

"Supports the basis for performance assessment initial conditions"

34. Table E-1, page E-4, rows 1 and 3, "(b)[a]" (two instances)

should be changed to:

"[a](b)"

35. Table E-1, page E-4, row 2, "(a)[a]" (two instances)

should be changed to:

"[a](a)"

36. Table J-1, page J-2,

J2	1.1.02.00.0B	Craig 2001 [DIRS 171411]	P

should be changed to:

J2	1.1.02.00.0B	Craig 2001 [DIRS 171411]	P
		Lee 1997 [DIRS 157361]	P

37. Appendix J, pages J4, J5, and J6

should be replaced with:

Attached pages J4, J5, J6, J6a, and J6b.

38. Table J-2, page J-131, after the entry for Krystinik 1990,

add:

Lee, M.Y. 1997. *Blast Vibration Monitoring in the Thermal Testing Facility/Connecting Drift and Heated Drift*. WA-0065. Albuquerque, New Mexico: Sandia National Laboratories. ACC: MOL.19971111.0208. [DIRS 157361]	Sections 1, 5, and 6	The extent of the damaged zone around a drill-and-blast excavation has been investigated as part of a blast vibration monitoring program that was conducted during construction of the Thermal Test Facility in the Exploratory Studies Facility at Yucca Mountain	1.1.02.00.0B	P	5 (b)	1, 2, 3, 9
	Section 1	The study cited a blasting criterion for limiting damage which indicated that the peak particle velocity at a 1-m distance from the	1.1.02.00.0B	P	5 (b)	1,2,3,9

		perimeter of the excavated opening should be much less than 700 mm/s.				
	Section 5	The blast monitoring program concluded that at a distance of 1 m from the drift wall, peak particle velocity was less than 700 m/s	1.1.02.00.0B	P	5 (b)	1,2,3,9

39. Table J-3, page J-143, after the entry for Krystinik 1990,

add:

Lee, M.Y. 1997. *Blast Vibration Monitoring in the Thermal Testing Facility/Connecting Drift and Heated Drift*. WA-0065. Albuquerque, New Mexico: Sandia National Laboratories. ACC: MOL.19971111.0208. [DIRS 157361]	Sections 1, 5, and 6	The extent of the damaged zone around a drill-and-blast excavation has been investigated as part of a blast vibration monitoring program that was conducted during construction of the Thermal Test Facility in the Exploratory Studies Facility at Yucca Mountain
	Section 1	The study cited a blasting criterion for limiting damage which indicated that the peak particle velocity at a 1-m distance from the perimeter of the excavated opening should be much less than 700 mm/s.
	Section 5	The blast monitoring program concluded that at a distance of 1 m from the drift wall, peak particle velocity was less than 700 m/s

(The DIRS report will be updated accordingly.)

40. Table J-4, page J-147, after the entry for Beason 2003,

add:

Bieniawski 1984	*Rock Mechanics Design in Mining and Tunneling*	107731

(The DIRS report will be updated accordingly.)

41. Table J-4, page J-147, after the entry for Blackwell et al. 2000

add:

Board 1989	*Basis for In-Situ Geomechanical Testing at the Yucca Mountain Site*	186056
Brady and Brown 1985	*Rock Mechanics for Underground Mining*	126811

(The DIRS report will be updated accordingly.)

42. Table J-4, page J-148, after the entry for DTN: SN0612T0502404.014,

add:

DTN: SNF37100195001.003	Blast Vibration Monitoring in the Thermal Testing Facility/Connecting Drift and Heated Drift	186057

(The DIRS report will be updated accordingly.)

43. Table J-4, page J-152, after the entry for Toth et al. 1983,

add:

TP-252	*Blast Monitoring*	186058

(The DIRS report will be updated accordingly.)

<u>To satisfy CR 13156:</u>

Note that an update to ANL-WIS-MD-000027 was not specifically noted in CR-13156. However, the Error Resolution Document initiated in response to that CR clearly states that minor changes to ANL-WIS-MD-000027 will be required (SNL 2007 [DIRS 178765], ERD 03, Attachment 1)

1. FEP 2.1.14.15.0A, page 6-803 (ACN 01), last paragraph, line 2, "[DIRS [180508]"

   should be changed to:

   "[DIRS 186103]"

2. FEP 2.1.14.15.0A, page 6-803 (ACN 01), last paragraph, line 3, "[DIRS 180946]"

   should be changed to:

   "[DIRS 186104]"

3. Table 2.1.14.15.0A-1, page 6-804, second row, "Waste Package Operations", between "process failure" and "[a]"

   add:

   " (low plasticity burnishing)"

4. Table 2.1.14.15.0A-1, page 6-804, second row, "Probability per Canister", "3.8"

   should be changed to:

   "3.77".

5. Table 2.1.14.15.0A-1, page 6-804, third row, "Probability per Canister", "4.36"

   should be changed to:

   "2.19"

6. Table 2.1.14.15.0A-1, page 6-804, fifth row, "Waste Package Operations", "[b]"

   should be changed to:

"e"

7. Table 2.1.14.15.0A-1, page 6-804, sixth row, "Waste Package Operations", ""

should be changed to:

"d"

8. Table 2.1.14.15.0A-1, page 6-804, "Sources"

should be changed to:

"Sources [a]DTN: MO0705EARLYEND.000 [DIRS 186104], file *Table 6-8 and 6-12.doc*, Table 6-8

[b]DTN: MO0701PASHIELD.000 [DIRS 186103], file: *Tables for DTN Readme.doc*, Table 1

[c]DTN: MO0701PASHIELD.000 [DIRS 186103], file *SAPHIRE OUTPUT.zip*

[d]DTN: MO0701PASHIELD.000 [DIRS 186103], file *EarlyFail-WeldDefects.zip*, Section A.7

Additional Source: SNL 2008 [DIRS 173869], Table 4.1-1"

9. FEP 2.1.14.15.0A, page 6-805, paragraph beginning, "The probabilities of events . . . ..", line 3, "3.8×10^{-5}"

should be changed to:

"3.77×10^{-5}"

10. FEP 2.1.14.15.0A, page 6-805, paragraph beginning, "The probabilities of events . . . ..", line 8, "4.36×10^{-9}"

should be changed to:

"2.19×10^{-9}"

11. FEP 2.1.14.15.0A, page 6-807,

"PWR TAD canister loading curve violation:

$\{1 - P_B(0; ((3.8 \times 10^{-5} \times 1.25 \times 10^{-3} + 1.13 \times 10^{-4} + 4.36 \times 10^{-9} \times 1.0) \times 1.65 \times 10^{-7}), 4568)\} = 8.5 \times 10^{-8}$

PWR TAD canister absorber misload:

$\{1 - P_B(0; ((3.8 \times 10^{-5} \times 1.25 \times 10^{-3} + 1.13 \times 10^{-4} + 4.36 \times 10^{-9} \times 1.0) \times 1.25 \times 10^{-7}), 4568)\} = 6.5 \times 10^{-8}$

44-BWR TAD canister absorber misload:

$\{1 - P_B(0; ((3.8 \times 10^{-5} \times 1.25 \times 10^{-3} + 1.13 \times 10^{-4} + 4.36 \times 10^{-9} \times 1.0) \times 1.25 \times 10^{-7}), 2915)\} = 4.1 \times 10^{-8}$

DOE SNF canister absorber misload (DOE1, DOE2, and DOE7):

$\{1 - P_B(0; ((3.8 \times 10^{-5} \times 1.25 \times 10^{-3} + 1.13 \times 10^{-4} + 4.36 \times 10^{-9} \times 1.0) \times 1.25 \times 10^{-7}), 1223)\} = 1.7 \times 10^{-8}$"

should be changed to:

"PWR TAD canister loading curve violation:

$\{1 - P_B(0; ((3.77 \times 10^{-5} \times 1.25 \times 10^{-3} + 1.13 \times 10^{-4} + 2.19 \times 10^{-9} \times 1.0) \times 1.65 \times 10^{-7}), 4568)\} = 8.5 \times 10^{-8}$

PWR TAD canister absorber misload:

$\{1 - P_B(0; ((3.77 \times 10^{-5} \times 1.25 \times 10^{-3} + 1.13 \times 10^{-4} + 2.19 \times 10^{-9} \times 1.0) \times 1.25 \times 10^{-7}), 4568)\} = 6.5 \times 10^{-8}$

44-BWR TAD canister absorber misload:

$\{1 - P_B(0; ((3.77 \times 10^{-5} \times 1.25 \times 10^{-3} + 1.13 \times 10^{-4} + 2.19 \times 10^{-9} \times 1.0) \times 1.25 \times 10^{-7}), 2915)\} = 4.1 \times 10^{-8}$

DOE SNF canister absorber misload (DOE1, DOE2, and DOE7):

$\{1 - P_B(0; ((3.77 \times 10^{-5} \times 1.25 \times 10^{-3} + 1.13 \times 10^{-4} + 2.19 \times 10^{-9} \times 1.0) \times 1.25 \times 10^{-7}), 1223)\} = 1.7 \times 10^{-8}$"

12. Table 2.1.14.15.0A-2, page 6-808, row 3, "Input", "[DIRS 180508]"

    should be changed to:

    "[DIRS 186103]" (The DIRS report will be updated accordingly.)

13. Table 2.1.14.15.0A-2, page 6-808, row 3, "Source"

    should be changed to::

    "file: Tables for DTN Readme.doc, Table 1; file: *SAPHIRE OUTPUT.zip*; file: *EarlyFail-WeldDefects.zip*, Section A.7" (The DIRS report will be updated accordingly.)

14. Table 2.1.14.15.0A-2, page 6-808, row 4, "Input", "[DIRS 180946]"

    should be changed to:

    "[DIRS 186104]" (The DIRS report will be updated accordingly.)

15. Table 2.1.14.15.0A-2, page 6-808, row 4, "Source", "file: *Table 1.doc*, Table 1"

    should be changed to:

    "file: *Table 6-8 and 6-12.doc*, Table 6-8" (The DIRS report will be updated accordingly.)

16. FEP 2.1.14.17.0A, page 6-813, paragraph beginning, "Because the quantity . . . ..", lines 7 and 8, "(4.36×10^{-9} per drip shield; DTN: MO0705EARLYEND.000 [DIRS 180946], file: *Table 1.doc*, Table 1)"

should be changed to:

"(2.19 x 10^{-9} per drip shield; DTN: MO0705EARLYEND.000 [DIRS 186104], file *Table 6-8 and 6-12.doc*, Table 6-8)"

17. FEP 2.1.14.17.0A, page 6-813, paragraph beginning, "Because the quantity . . . ..", line 14, "4.9 x 10^{-5}"

should be changed to:

"2.4 x 10^{-5}"

18. Table 2.1.14.17.0A-1, page 6-814, row 2, "Input", "[DIRS 180946]"

should be changed to:

"[DIRS 186104]" (The DIRS report will be updated accordingly.)

19. Table 2.1.14.17.0A-1, page 6-814, row 2, "Source", "file *Table 1.doc*, Table 1"

should be changed to:

"file *Table 6-8 and 6-12.doc*, Table 6-8" (The DIRS report will be updated accordingly.)-

20. FEP 2.1.14.19.0A, page 6-823, second paragraph, lines 11 and 12, "(DTN: MO0705EARLYEND.000 [DIRS 180946], file: *Table 1.doc*, Table 1)"

should be changed to:

"(DTN: MO0705EARLYEND.000 [DIRS 186104], file: *Table 6-8 and 6-12.doc*, Table 6-8)"

21. Table 2.1.14.19.0A-10, page 6-830, seventh row, "Input", "[DIRS 180946]"

should be changed to:

"[DIRS 186104]" (The DIRS report will be updated accordingly.)

22. Table 2.1.14.19.0A-10, page 6-830, seventh row, "Source", "file: *Table 1.doc*, Table 1)"

should be changed to:

"file: *Table 6-8 and 6-12.doc*, Table 6-8" (The DIRS report will be updated accordingly.)

23. FEP 2.2.14.09.0A, page 6-1117 (ACN 01), paragraph beginning, "Because the quantity . . . ..", lines 7 and 8, "(4.36 x 10^{-9} per drip shield; DTN: MO0705EARLYEND.000 [DIRS 180946], file: *Table 1.doc*, Table 1)"

should be changed to:

"(2.19 x 10^{-9} per drip shield; DTN: MO0705EARLYEND.000 [DIRS 186104], file *Table 6-8 and 6-12.doc*, Table 6-8)"

24. FEP 2.1.14.17.0A, page 6-1117 (ACN 01), paragraph beginning, "Because the quantity . . . ..", line 14, "4.9 x 10^{-5}"

should be changed to:

"2.4×10^{-5}"

25. Table 2.2.14.09.0A-1, page 6-1118, second row, "Input", "[DIRS 180946]"

    should be changed to:

    "[DIRS 186104]" (The DIRS report will be updated accordingly.)

26. Table 2.2.14.19.0A-1, page 6-1118, "Source", "file: *Table 1.doc*, Table 1."

    should be changed to:

    "file: *Table 6-8 and 6-12.doc*, Table 6-8" (The DIRS report will be updated accordingly.)

27. Page 8-50, entry for 178765

    add:

    "; LLR.20080311.0094; DOC.20080918.0002; DOC.20090204.0003."

28. Page 8-76 (ACN 01), entry for 180508

    should be changed to:

    "186103 MO0701PASHIELD.000. Waste Package/Drip Shield Early Failure Probabilities. Submittal date: 02/05/2009."

29. Page 8-76 (ACN 01), entry for 180946

    should be changed to:

    "186104 MO0705EARLYEND.000. Waste Package/Drip Shield Early Failure End State Probabilities. Submittal date: 02/05/2009."

<u>While implementing the changes necessitated by CR 12543, the following additional errors were found:</u>

1. FEP 2.1.06.07.0B, page 6-543, first paragraph, line 19, "2.1.09.03.0B"

   should be changed to:

   "2.1.09.03.0C"

2. Table A-1, page A-4, entry for control parameter 01-15, column "Representative FEPs Relying on Design/Control Parameter", "Geotechnical"

   should be changed to:

   "Geochemical"

3. Table A-1, page A-16, entry for control parameter 07-17, column "Control Parameter"

   delete:

   "Drip Shield Early Failure"

4. Table A-1, page A-18, entry for control parameter 09-03, column "Control Parameter", "Sealing of Boreholes"

   should be changed to:

   "Closure of Boreholes"

5. Appendix I, page I-6, last paragraph, line 4, "CRWMS M&O"

   should be changed to:

   "BSC"

Other Changes:

As a result of this ERD, an update was submitted to DTN: MO0707NONLITHO.000.

Section 8.4 Output DTN: MO0707NONLITHO.000 submittal date should be updated to 12/22/2008.

Impact Evaluation/Results:

The corrections to the individual FEPs, their respective input tables and Appendices A, C, and J do not impact the conclusions or output from *Features, Events, and Processes for the Total System Performance Assessment: Analyses* or any of its downstream documents. The Safety Analysis Report will require updating, specifically to Table 2.2-3, to reflect the changes made to Table A-1. This ERD impacts DTN: MO0706SPAFEPLA.001, *FY 2007 LA FEP List and Screening*.

The following controlled documents that cite ANL-WIS-MD-000027 REV 00 [DIRS 183041] were checked for impacts as a result of these corrections:

- ANL-EBS-MD-000033, Rev 06, *Engineered Barrier System: Physical and Chemical Environment.*
- ANL-EBS-MD-000049, Rev 03, Addendum 01, *Multiscale Thermohydrologic Model.*
- ANL-EBS-PA-000011, Rev 00, *Postclosure Design Input Parameters for Engineered Barrier System In-Drift Configuration.*
- ANL-EBS-PA-000012, Rev 00, *Postclosure Design Input Parameters for Subsurface Facilities.*
- ANL-NBS-HS-000057, Rev 00, *Postclosure Analysis of the Range of Design Thermal Loadings.*
- ANL-WIS-MD-000024, Rev 01, Postclosure Nuclear Safety Design Bases.
- ANL-WIS-MD-000026, Rev 00, *Features, Events, and Processes for the Total System Performance Assessment: Methods.*

- CAL-DN0-NU-000002, Rev 00C, *Waste Package Flooding Probability Evaluation.*
- MDL-MGR-HS-000001, Rev 00, ACN 01, *Irrigation Recycling Model.*
- MDL-MGR-MD-000001, Rev 02, *Biosphere Model Report.*
- MDL-NBS-HS-000011, Rev 03, *Saturated Zone Site-Scale Flow Model.*
- MDL-WIS-PA-000005, Rev 00, *Total System Performance Assessment Model/Analysis for the License Application – Volume I.*
- MDL-WIS-PA-000005, Rev 00, *Total System Performance Assessment Model/Analysis for the License Application – Volume III.*
- TDR-PCS-SE-000001, Rev 05, Addendum 01, *Performance Confirmation Plan.*
- LA-SAR.

The following impacts were observed:

- ANL-EBS-PA-0000011 – Some FEP/parameter relationships will need to be updated as a result of this ERD.
- ANL-EBS-PA-0000012 – Some FEP/parameter relationships will need to be updated as a result of this ERD.
- ANL-WIS-MD-0000024 – Some FEP/parameter relationships will need to be updated as a result of this ERD.
- LA-SAR – As a result of this ERD, Table 2.2-3 will require updating. Because of the effects on other documents, other parameter/FEP changes will be required to the LA-SAR. (A consolidated LCR is being prepared to effect those changes.)

J2. FEP 1.1.02.00.0B – MECHANICAL EFFECTS OF EXCAVATION AND CONSTRUCTION IN EBS

This FEP uses data from the following references:

"Transmittal of Level 5 Deliverable SPW205M5, 'Excavation-Induced Fracture Study'" (Craig 2001 [DIRS 171411])

Blast Vibration Monitoring in the Thermal Testing Facility/Connecting Drift and Heated Drift (Lee 1997 [DIRS 157361])

J2.1 QUALIFICATION OF DATA FROM CRAIG 2001

Craig, R.W. 2001. "Transmittal of Level 5 Deliverable SPW205M5, 'Excavation-Induced Fracture Study'." Letter from R.W. Craig (USGS) to T.C. Gunter (DOE/YMSCO), September 26, 2001, with enclosure. ACC: MOL.20011114.0003. [DIRS 171411]

The data from this report to be qualified for intended use within this FEP include:

> Energy is focused on the rock to be removed, so that excess energy is not dispersed into the surrounding rock, as from blasting (Craig 2001 [DIRS 171411], pp. 1, 3, and 8).
>
> Examination of the tunnel walls and associated alcoves, niches, and drillholes has been used to define the character and extent of mechanical damage induced by tunnel boring (Craig 2001 [DIRS 171411], pp. 3 to 11, and 16).
>
> In rock with few fractures, the tunnel boring machine-induced fracturing of the tunnel periphery is confined to a depth of influence of less than 5 centimeters (Craig 2001 [DIRS 171411], p. 16).

J2.1.1 Qualification Method

The method of qualification of the data from Craig (2001 [DIRS 171411]) listed above is the Technical Assessment method (SCI-PRO-001, Attachment 3, Method 5). The rationale for using this method is that it was the most suitable considering the data and their existing documentation. The technical assessment included determination that the employed methodology was acceptable, determination that confidence in the data acquisition or development was warranted, and confirmation that the data had been used in similar applications. Qualification process attributes used in the technical assessment of these data are selected from the list provided in Attachment 4 of SCI-PRO-001. Attributes specifically applicable to these data are:

- Qualification of personnel or organizations generating the data are comparable to qualification requirements of personnel generating similar data under an approved program that supports the YMP license application process or postclosure science (#1).
- The technical adequacy of equipment and procedures used to collect and analyze the data (#2).

- The extent to which the data demonstrate the properties of interest (e.g., physical, chemical, geological, mechanical) (#3).
- Extent and reliability of the documentation associated with the data (#9).

J2.1.2 Technical Assessment

Qualifications of Personnel or Organizations Generating the Data—The excavation-induced fracture study was conducted by members of the U.S. Bureau of Reclamation Underground Geologic Mapping team, for which Steve Beason was the principal investigator. The U.S. Bureau of Reclamation is one of the government agencies responsible for geologic mapping of federal projects, particularly dam sites and tunnels, and has provided engineering geologic services to the DOE and USGS for characterization of the Yucca Mountain site since the mid-1980s. The YMP geologists from the U.S. Bureau of Reclamation mapped approximately 10 km of underground tunnels at Yucca Mountain, including the ESF and the Enhanced Characterization of the Repository Block (ECRB) Cross-Drift, between 1994 and 1997. The team subsequently compiled their findings in completion reports for the various excavations (e.g., Albin et al. 1997 [DIRS 101367]; Eatman et al. 1997 [DIRS 157677]).

Technical Adequacy of Equipment and Procedures Used—The data collection method consists of recording visual observations made by the mapping geologists in a scientific notebook, which in turn is technically reviewed. This method is typical of geologic investigations; it is prescribed through the procedure that governed the underground mapping, U.S. Geological Survey Procedure YMP-USGS-GP-32, *Underground Geologic Mapping*.

Extent and Reliability of the Documentation Associated with the Data—The underground excavation observations were made and recorded in a scientific notebook (Beason 2003 [DIRS 171953], pp. 77 to 80), following the then-current YMP procedure AP-SIII.1Q, *Scientific Notebooks*, which incorporated the quality assurance requirements of *Quality Assurance Requirements and Description* (DOE 2004 [DIRS 171539], Supplement III), and, by extension, the requirements of 10 CFR 60, Subpart G [DIRS 100015]. A scientific notebook procedure has been used on the YMP since 1996. The Beason notebook (2003 [DIRS 171953], pp. 77 to 81) documents the scientific observations, the person who entered the data in the notebook and the technical review of the notebook entry.

Extent to Which the Data Demonstrate the Properties of Interest—The data were collected to compare the relative excavation effects of different mining techniques, including use of the tunnel boring machine, alpine miner, and drill and blast techniques. This FEP specifically uses the observations derived from the tunnel boring machine excavations. The observations directly relate to concerns regarding ability to maintain the circular cross-section of a tunnel-boring machine tunnel, depth of damage, and significance of the damage to modeling studies.

Data Have Been Used in Similar Applications—The underground tunnel data collected by the U.S. Bureau of Reclamation mapping team has been used extensively for YMP performance assessment and facility layout. The geologic and fracture data provide input into the hydrologic models for the unsaturated zone, and the information obtained regarding the mechanical stability of the rock has been used to determine the extent and orientation of the underground facilities.

J2.1.3 Data Qualified for intended use

The data from Craig (2001 [DIRS 171411]) cited above are appropriate for the intended use within FEP 1.1.02.00.0B (Mechanical Effects of Excavation and Construction in EBS). The technical assessment of these data provides sufficient confidence that the data meet qualification criteria outlined above and can be considered qualified for intended use within this FEP.

J2.2 QUALIFICATION OF DATA FROM LEE 1997

Lee, M.Y. 1997. *Blast Vibration Monitoring in the Thermal Testing Facility/Connecting Drift and Heated Drift*. WA-0065. Albuquerque, New Mexico: Sandia National Laboratories. ACC: MOL.19971111.0208. [DIRS 157361]

The data from this report to be qualified for intended use within this FEP include:

> The extent of the damaged zone around a drill-and-blast excavation has been investigated as part of a blast vibration monitoring program that was conducted during construction of the Thermal Test Facility in the Exploratory Studies Facility at Yucca Mountain (Lee 1997 [DIRS 157361], Sections 1, 5, and 6).
>
> The study cited a blasting criterion for limiting damage, which indicated that the peak particle velocity at a 1-m distance from the perimeter of the excavated opening should be less than 700 mm/s (Lee 1997 [DIRS 157361], Section 1).
>
> The blast monitoring program concluded that at a distance of 1 m from the drift wall, peak particle velocity was much less than 700 mm/s (Lee 1997 [DIRS 157361], Section 5).

J2.2.1 Qualification Method

The method of qualification of the data from Lee (1997 [DIRS 157361]) listed above is the Technical Assessment method (SCI-PRO-001, Attachment 2, Method 5). The rationale for using this method is that it was the most suitable considering the data and their existing documentation. The technical assessment included determination that the employed methodology was acceptable, determination that confidence in the data acquisition or development was warranted, and confirmation that the data had been used in similar applications. Qualification process attributes used in the technical assessment of these data are selected from the list provided in Attachment 3 of SCI-PRO-001. Attributes specifically applicable to these data are:

- Qualification of personnel or organizations generating the data are comparable to qualification requirements of personnel generating similar data under an approved program that supports the YMP license application process or postclosure science (#1).
- The technical adequacy of equipment and procedures used to collect and analyze the data (#2).
- The extent to which the data demonstrates the properties of interest (e.g., physical, chemical, geological, mechanical) (#3).

- Extent and reliability of the documentation associated with the data (#9).

J2.2.2 Technical Assessment

Qualification of Personnel or Organizations Generating the Data—The blast vibration monitoring during construction of the Thermal Test Facility in the ESF at Yucca Mountain was conducted by members of Sandia National Laboratories, for which Moo Lee was the principal investigator. Sandia is a top-level national research organization, and has highly trained and experienced employees capable of performing the mechanical and physical tests to proper procedures. During construction of the ESF, Sandia was responsible for ESF design verification activities including (1) instrumentation monitoring, (2) evaluation of rock mass indices and tunnel stability, (3) blast monitoring and damage assessment during alcove construction, and (4) in situ stress measurements.

Technical Adequacy of Equipment and Procedures Used—The data collection methods included near-field investigation using grouted geophones and seismographs, far-field investigation using a commercial seismograph, and borehole inspection both before and after blasting. These methods are typical of blast monitoring. The blast monitoring data were collected in accordance with Sandia's technical procedure, TP-252, *Blast Monitoring* (SNL 1996 [DIRS 186058]).

Extent and Reliability of the Documentation Associated with the Data—The blast seismic monitoring and blast damage assessment were performed during the excavation of the Thermal Test Facility in the ESF at Yucca Mountain. The monitoring activities were developed as part of the In Situ Design Verification Activity conducted under Sandia work agreement WA-0065 in support of ESF design. Data and supporting documents are archived as DTN: SNF37100195001.003 [DIRS 186057].

Extent to Which the Data Demonstrate the Properties of Interest—The blast monitoring data were collected to help design controlled and smooth blasting to preserve the integrity of the rock surrounding the Thermal Test Facility. A specific objective of this monitoring activity was to estimate the extent of blast damage around the alcove perimeter. This FEP specifically uses the estimate of the extent of blast damage to evaluate the ability to maintain the desired tunnel geometry using blasting methods, and to evaluate the resulting changes in the mechanical properties of the rock around the drift.

Data Have Been Used in Similar Applications—The blast monitoring data were collected using geophones, accelerometers, seismographs, and downhole video cameras. These data collection techniques are based on industry standard methods for geological site characterization (Bieniawski 1984 [DIRS 107731], Chapter 5). The NRC has developed an analysis of the in situ geomechanical testing needs at Yucca Mountain (NUREG/CR-5400, Board 1989 [DIRS 186056]). The recommended in situ testing includes blast monitoring and disturbed zone determination and characterization (Board 1989 [DIRS 186056], Section 6.2). NUREG/CR-5400 recommends the use of a borescope with a video attachment to examine borehole walls as part of the assessment of the damage zone around the underground opening (Board 1989 [DIRS 186056], Section 6.4.2). The recommended instrumentation for thermomechanical room-scale

tests include acoustic emission systems (Board 1989 [DIRS 186056], Table 6) which involve the use of geophones and accelerometers as part of the monitoring system (Brady and Brown 1985 [DIRS 126811], Section 18.2.7).

J2.2.3 Data Qualified for Intended Use

The data from Lee (1997 [DIRS 157361]) cited above are appropriate for the intended use within FEP 1.1.02.00.0B (Mechanical Effects of Excavation and Construction in EBS). The technical assessment of these data provides sufficient confidence that the data meet qualification criteria outlined above and can be considered qualified for intended use within the FEP.