	# Model Error Resolution Document *Complete only applicable items.*	QA: QA Page 1

INITIATION

1. Originator:	2. Date:	3. ERD No.
Russell Jarek	3/13/08	MDL-WIS-PA-000003 ERD 01

4. Document Identifier:	5. Document Title:
MDL-WIS-PA-000003 REV 03	Seismic Consequence Abstraction

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

The following evaluations/changes/corrections are posted to correct the conditions identified in CRs 11320, 11477, 11522, and 11758; in addition related editorial corrections and a clarification on spatial variability are provided. Each CR is addressed with all identified changes and justification for no impact to results of MDL-WIS-PA-000003 REV 03. Also included is clarification for a direct input use that is related to TBV-8734. See attached documentation (14 pages and DIRS update) for a detailed description of the CRs and corrections/clarifications, and their associated evaluations.

As part of the evaluation any downstream direct input users of this report were evaluated for impact as well. The following documents used this subject report as direct input but not any of the affected information:

Screening Analysis of Criticality Features, Events, and Processes for License Application (ANL-DS0-NU-000001 REV 00)

Postclosure Nuclear Safety Design Bases (ANL-WIS-MD-000024 REV 01)

Postclosure Modeling and Analyses Design Parameters (TDR-MGR-MD-000037 REV 02)

U.S. Department of Energy Spent Nuclear Fuel and High-Level Radioactive Waste to the Monitored Geologic Repository (DOE/RW-0511 REV 04)

Three reports did use direct input information that was corrected by this ERD. Those reports were evaluated and each determined to have no impact upon their conclusions (justification is included in attached documentation):

Features, Events, and Processes for the Total System Performance Assessment: Analyses (ANL-WIS-MD-000027 REV 00)

Total System Performance Assessment Model/Analysis for the License Application (MDL-WIS-PA-000005 REV 00)

Waste Package Flooding Probability Evaluation (CAL-DN0-NU-000002 REV 00C)

CONCURRENCE

	Printed Name	Signature	Date
7. Checker	Jim Kam	[signature]	4/8/08
8. QCS/QA Reviewer	Sounia Darnell	[signature]	4/8/08
APPROVAL			
9. Originator	Russell Jarek / Cliff Howard	[signature]	4/8/08
10. Responsible Manager	Paul Dixon	[signature]	4-10-08

Attachment to MDL-WIS-PA-000003 ERD 01

Applicable to: MDL-WIS-PA-000003 REV 03, *Seismic Consequences Analysis*

CR 11477

I. Background Information Summary:

Section 6.12.2 of Seismic Consequence Analysis MDL-WIS-PA-000003 Rev 03 provides written instruction to the TSPA for implementing that model results generated in the Seismic Consequence Analysis. These are written as steps, and these steps should have been numbered, but in the final version of the report they are not. This omission of step numbers resulted in the final stages of production as the step identifiers were apparently part of the Draft H of this report. A recommended fix is to ACN this section with appropriate step numbers consistent with Draft H of the report.

This ERD portion will describe the appropriate numbering as it should have appeared. In addition to this editorial correction identified by CR 11477, the extent of condition has uncovered other editorial corrections and the need for clarification of spatial variability discussions.

II. Inputs and/or Software

No inputs relevant to this issue were changed from those in the original report.

No software was used to generate the changes presented here.

III. Analysis and Results

Here is the description of the missing step numbers for Section 6.12.2. These step numbers were originally intended and contained up to Draft H of MDL-WIS-PA-000003 REV 03.

Page 6-223: Add step numbers to the following sentences:

1. Determine the RST for Alloy 22 for the *i*th realization.
2. Determine the time of the *j*th event in this realization.
3. Determine the annual exceedance frequency, λ_j, for the *j*th event in this realization.
4. Determine the corresponding value of the horizontal peak ground velocity, PGV_j, on the bounded hazard curve, $\lambda = \lambda(PGV)$, for the *j*th seismic event in this realization.

Page 6-224: Add a step number to the following sentence:

5. Determine the volume of lithophysal rock that collapses due to the *j*th seismic event, $RV_{LITH,j}$, and calculate the fraction of drift filled with lithophysal rubble from the first through *j*th seismic events.

Page 6-226: Add a step number to the following sentence:

6. Determine the volume of nonlithophysal rockfall from the *j*th seismic event, $RV_{NL,j}$, and calculate the fraction of drift filled with nonlithophysal rubble from the first through *j*th seismic events.

Page 6-228: Add a step number to the following sentence:

7. Determine drip shield plate fragility in response to the peak vertical acceleration for the *j*th seismic event. The plate fragility is defined as .....

Page 6-230: Add a step number to the following sentence:

8. The fragility of the drip shield framework in response to the peak vertical acceleration is determined for the *j*th seismic event. The framework fragility is defined as .....

Page 6-232: Add a step number to the following sentence:

9. The rupture of a codisposal waste package that can move freely beneath the drip shield is conceptualized to occur from the accumulation of severe deformation due to multiple impacts. Multiple impacts to a codisposal waste package are considered as follows:

Page 6-234: Add a step number to the following sentence:

10. Determine the probability of damage for a codisposal waste package that can move freely beneath a drip shield. The probability of damage ......

Page 6-236: Add a step number to the following sentence:

11. If the codisposal waste packages are damaged by the *j*th seismic event (see Step 10), then damaged area (in units of m2) is defined by gamma distributions whose parameters are functions of *PGV* and *RST*. Separate gamma distributions are defined .....

Page 6-238: Add a step number to the following sentence:

12. The rupture of a TAD-bearing waste package that can move freely beneath the drip shield is conceptualized to occur from the accumulation of severe deformation due to multiple impacts. Multiple impacts to a TAD-bearing waste package are considered as follows:

Page 6-240: Add a step number to the following sentence:

13. The probability of damage is determined for a TAD-bearing waste package that can move freely beneath a drip shield. The probability of damage .....

Page 6-242: Add a step number to the following sentence:

14. If the TAD-bearing waste packages are damaged by the *j*th seismic event (see Step 13), then the conditional damaged area (in units of m2) is represented by gamma distributions that are defined in Sections 6.5.1.3 and 6.5.2.3. Separate gamma distributions are defined ......

Page 6-244: Add a step number to the following sentence:

15. The probability of rupture for a waste package surrounded by rubble is conceptualized to occur from puncture by sharp internal fragments when there is severe deformation of the OCB. The probability of puncture ....

Page 6-245: Add a step number to the following sentence:

16. Determine the probability of damage for a waste package that is surrounded by rubble for the *j*th seismic event. The probability of damage for the *j*th seismic event, $PD_{RUB,j}$, is defined in Section 6.9.2 as a function of the value of *PGV* for the *j*th seismic event and of the OCB thickness.

Page 6-247: Add a step number to the following sentence:

17. If the waste package surrounded by rubble is damaged by the *j*th seismic event (see Step 16), then the conditional damaged area is represented by gamma distributions that are defined in Section 6.9.3. The parameters for these gamma

distributions ......

Page 6-248: Add a step number to the following sentence:

18. Two determinations are required: (1) the damaged area on drip shield plates and (2) the probability of plate failure in response to rock block impacts in an unfilled or partly filled drift in the nonlithophysal units. The damaged area and plate failures are ......

Page 6-252: Add a step number to the following sentence:

19. The damaged area on the drip shield is determined in response to the static rockfall load from lithophysal rubble and the dynamic vertical load for the *j*th seismic event. The damaged area occurs ......

Page 6-254: Add a step number to the following sentence:

20. There is no damage abstraction for cladding failure because the compliance case for the license application is not taking credit for the cladding as a barrier to radionuclide release.

Page 6-255: Add a step number to the following sentence:

21. The percent failed area on the waste packages due to fault displacement is determined. This damage abstraction is appropriate for ......

The following seven (7) descriptions compile the other editorial items that have been identified:

1. There is an editorial correction to Table 6-24, which is highlighted in the corrected version below. This error is editorial because the probability calculations in Tables 6-25 and 6-26 are correct, and only the entry in the lower right corner of Table 6-24 is incorrect.

Table 6-24. Reinterpretation of Nonzero Damage for a Codisposal Waste Package with 17-mm-Thick OCB and Degraded Internals at the 0.4 m/s PGV Level

Real. No.	WP ID	Kinematic Damaged Area (m^2)			Damage State Based on Single WP Results			Rationale
		90% RST	100% RST	105% RST	90% RST	100% RST	105% RST	
3	H	0.059	0.030	0	0.0222	0	0	Calculated results from single package model (see Table 6-23)
	L	0.061	0.018	0	0.0154	0	0	
4	H	0.192	0.057	0.003	0	0	0	Calculated results from single package model (see Table 6-23)
	L	0.099	0.038	0	0.0026	0	0	
8	H	0.022	0.007	0	0	0	0	Damaged areas < 0.057 m^2 from kinematic approach are reset to zero based on results in Table 6-23
	L	0.013	0.006	0	0	0	0	
10	H	0.251	0.064	0.007	> 0	> 0	0	Damaged areas < 0.057 m^2 from kinematic approach are reset to zero based on results in Table 6-23.
	L	0.7	0.251	0.0589	> 0	> 0	>0	

Source: Output DTN: MO0703PASDSTAT.001, worksheet "Prob of Damage Anal. 17-mm OCB" in the file *CDSP Kinematic Damage Abstraction 17-mm Degraded.xls*. Kinematic data have been rounded to three decimal places.

NOTE: WP = waste package; H and L identify specific waste packages.

2. In Figure 6-5, the label on the abscissa should be changed from "Uniaxial Strain" to "Uniaxial Strain (%)".

3. In Figure 6-65, the label on the ordinate should be changed from "Residual of Ln(A)(A in g's)" to "Residual of Ln(A)". A note should also be added to this figure as: "NOTE: *A* is defined as *PGA-V/g*, where *PGA-V* is the vertical component of *PGA* and *g* is the acceleration of gravity."

4. In Figure 6-66, the label on the ordinate should be changed from "A(g's)" to "A(-)" and a NOTE should be added to the figure:

   NOTE: *A* is defined as *PGA-V/g*, where *PGA-V* is the vertical component of *PGA* and *g* is the acceleration of gravity.

5. Table B-3, page B-40, 11th row under Description of Output. Change " Table Documenting Fault Displacement at the 10-4, 105, 106, 107, and 108 Annual Exceedance Frequencies" to "Table Documenting Fault Displacement at the 10^{-4}, 10^{-5}, 10^{-6}, 10^{-7}, and 10^{-8} Annual Exceedance Frequencies"

6. Section 6.11.2.2, first paragraph, sixth and seventh lines. Change "As discussed in Section 3.10.3 of that document," to "As shown in Figures 8-8 through 8-13 of that document,". This change is necessary because Section 3.10.3 does not exist in the PSHA report.

7. The DIRS number for DTN: MO0401MWDRPSHA.000 should be changed from 183046 to 185267 globally in the document. This change occurs in many places and each one is not specified here. Update the reference callout to DIRS 183046 in Section 9.4 to the following:

   185267 MO0401MWDRPSHA.000. Results of the Yucca Mountain Probabilistic Seismic Hazard Analysis (PSHA). Submittal date: 03/13/2008.

Clarification is provided in the following items all related to discussions of spatial variability.

Section 1.2, starting from the second paragraph in second bullet on page 1-5, text beginning "Lack of spatial variability is not important ...." Replace this paragraph with the following text:

> Lack of spatial variability produces an unbiased estimate of the mean damaged area over all realizations and overestimates the coefficient of variation (i.e., the variability about the mean damaged area) over all realizations because lack of spatial variability makes an extreme response for all waste package groups more likely than for a model with spatial variability. If damage to waste package or drip shield is constant and perfectly correlated everywhere in the repository, realizations with very high or very low damaged areas produce a more extreme dose history than a realization with damaged areas that varies spatially between the high and low values.

Section 6.5.5, second paragraph. Replace this paragraph with the following:

> Lack of spatial variability produces an unbiased estimate of the mean damaged area over all realizations and overestimates the coefficient of variation (i.e., the variability about the mean damaged area) over all realizations because lack of spatial variability makes an

> extreme response for all waste package groups more likely than for a model with spatial variability.

Section 6.6.5, second paragraph. Replace this paragraph with the following:

> Lack of spatial variability produces an unbiased estimate of the mean damaged area over all realizations and overestimates the coefficient of variation (i.e., the variability about the mean) over all realizations because lack of spatial variability makes an extreme response for all waste package groups more likely than for a model with spatial variability.

Replace the paragraph in Section 6.9.9 with the following:

> Damage to or puncture of the waste package surrounded by rubble is constant throughout the repository, for each seismic event in the TSPA. That is, there is no spatial variability of damage or rupture for the waste package groups within the TSPA. Lack of spatial variability produces an unbiased estimate of the mean damaged area over all realizations and overestimates the coefficient of variation (i.e., the variability about the mean) over all realizations because lack of spatial variability makes an extreme response for all waste package groups more likely than for a model with spatial variability.

Section 6.13, second paragraph in second bullet. Delete the existing paragraph and replace it with the following:

> Lack of spatial variability produces an unbiased estimate of the mean value over all realizations and overestimates the coefficient of variation (i.e., the variability about the mean) over all realizations because lack of spatial variability makes an extreme response for all waste package groups or drip shields more likely than for a model with spatial variability.

Section 7.1, last paragraph on page 7-2 beginning "Lack of spatial variability ...".

> Lack of spatial variability produces an unbiased estimate of the mean damaged area over all realizations and overestimates the coefficient of variation (i.e., the variability about the mean) over all realizations because lack of spatial variability makes an extreme response for all waste package groups more likely than for a model with spatial variability.

Section 8.1, second paragraph in second bullet on page 8-2. Delete the existing paragraph and replace it with the following:

> Lack of spatial variability produces an unbiased estimate of the mean damaged area over all realizations and overestimates the coefficient of variation (i.e., the variability about the mean) over all realizations because lack of spatial variability makes an extreme response for all waste package groups or drip shields more likely than for a model with spatial variability.

IV. Impact Evaluation

There has been no impact to any downstream users due to these missing instruction step numbers. TSPA had taken its instructions from the output DTN: MO0703PASEISDA.002 [DIRS 183156], which has always contained these step numbers.

None of the editorial changes (items 1 to 5) have impact on the product output or conclusions of the subject report. The editorial citation correction in item 6 does not affect any discussions based on that input. The updated DTN citation in item 7 has no impact as the fault displacement damage abstraction is consistent with the inputs form this latest DTN and none of the inputs used from this source were changed.

The clarifications provided regarding spatial variability eliminate a technical argument that is correct for 10,000 years, but incorrect for 1,000,000 years. The new text for Items 7 through 12 provides a modified rationale for not representing spatial variability in TSPA. The changes in Items 7 through 12 are consistent with the current TSPA model, which does not represent spatial variability in seismic-induced damage.

CR 11320, 11522 and CR 11758

I. Background Information Summary:

There are three CRs that all relate to the same DTN and the text related to that DTN. They will all be addressed together as they affect each other.

According to CR 11320: *Incorrect units found in DTN MO0703PASTAT.001 Statistical Analyses for Seismic Damage Abstraction: Workbook DS Damaged Areas with Rubble.xls Worksheets: 1.05 ms PGV - Case 1 BCs, 1.05 ms PGV - Case 2 BCs, 2.44 ms PGV - Case 1 BCs, 2.44 ms PGV - Case 2 BCs, 4.07 ms PGV - Case 1 BCs, and 4.07 ms PGV - Case 2 BCs. The EXCEL workbook presents calculations of the nonexceedance probability relationship with damaged area in square meters for various boundary conditions, and peak ground velocities. The calculations support the Seismic Consequence Abstraction (SNL, 2007 [DIRS 176828]). These relationships are plotted on Worksheet Summary. For each of the EXCEL worksheets listed above, the cells that contain damaged areas in square meters are incorrectly labeled as "g's". This label is inconsistent with the correct units given on the plots as "m^2". Note that the units are inconsistent on six worksheets within the EXCEL workbook.*

According to CR 11522: *An error was identified in the probability calculations for the 5.35 m/s PGV level during the checking of the SAR. The original probability calculation presented in Seismic Consequence Abstraction (SNL 2007 [DIRS 176828] Section 6.10.2.4) included six 3DEC simulations that did not complete due to numerical difficulties (BSC 2007 [DIRS 166107] Section 6.3.1.2.5). The revised probability calculation, which eliminates these six simulations, is given as 43/44 = 0.977 ~ 0.98, as shown here. The original value is 0.86, as was calculated in Nonlith Damage Abstraction for DS.xls in DTN:MO0703PASDSTAT.001.*

The [revised] *probabilities have no impact on dose (i.e., no impact to TSPA) because damage from rock block impacts in the nonlithophysal units has been excluded from TSPA via excluded FEP 1.2.03.02.0B, Seismic-Induced Rockfall Damages EBS Components.* [The probabilities in the relevant] *SAR section* [have] *already* [been] *corrected, but will need the AMR and DTN updated in order to validate the values in Table 2.3.4-38.*

Affected items:

1. MDL-WIS-PA-000003, Seismic Consequence Abstraction AMR. Change three numbers in the last line in Table 6-53, three numbers in the last line in Table 6-83, and three numbers for parameter PD_DSNL in Table 6-91.

2. DTN: MO0703PASDSTAT.001, spreadsheet Nonlith Damage Abstraction for DS.xls. Change the probability calculation in three Worksheets: 5.35 ms PGV 15-mm Plate, 5.35 ms PGV 10-mm Plate, and 5.35 ms PGV 5-mm Plate. The change is simple - there are 44 realizations of rockfall at the 5.35 m/s PGV level rather than 50. These changes will automatically propagate into the Worksheet: "Summary".

3. DTN: MO0703PASEISDA.002 [DIRS 183156], *file Seismic Damage Abstractions for TSPA Compliance Case.doc. Change three numbers in the last line of Table 1-10. Change three numbers for parameter PD_DSNL in Table 1-15* [CR should indicate Table 1-18].

According to CR 11758: *In MDL-WIS-PA-000003, there is an error referring to the number of realizations ran for the drift degradation model in the following section: "6.10.2.1 Rockfall Calculations Rockfall calculations for the nonlithophysal units were performed for ground motions at the 0.4 m/s, 1.05 m/s, 2.44 m/s, and 5.35 m/s PGV levels. There were a total of 50 rockfall calculations at each of the 1.05 m/s, 2.44 m/s, and 5.35 m/s PGV levels." For the 5.35 m/s realizations, there were only 44 realizations (not 50). This has been previously recognized and calculational impacts* [are being] *addressed as part of CR 11522.*

This ERD portion will evaluate the revised DTNs, and present corrections that would result in the text. The output DTNs that were revised for these issues were MO0703PASDSTAT.001 (CR 11320 and 11522) and MO0703PASEISDA.002 (CR 11522). Affected portions of the original report includes the three 5.35 m/s PGV level values in Tables 6-53, 6-83 and 6-91 (CR 11522) and text in Section 6.10.2.1 (CR 11758); the corrected tables and text are presented here.

II. Inputs and/or Software

No inputs relevant to this issue were changed from those in the original report.

No software was used to generate the changes presented here. However, some Excel cell formulas were corrected in the affected DTNs.

III. Analysis and Results

Both output DTNs identified earlier (MO0703PASDSTAT.001 [original DIRS 182878, revised DIRS 185275] and MO0703PASEISDA.002 [original DIRS 183156, revised DIRS 185278]) have been revised to correct the probability calculation issue identified by CR 11522.

The correction identified in CR 11522 is reflected in Tables 6-53, 6-83 and 6-91 (only the corrected parameter PD_DSNL is shown), with the modified values at the 5.35 m/s PGV level highlighted in yellow. This is consistent with the revised output DTN: MO0703PASDSTAT.001 [DIRS 185275]. While these DTN issues were being addressed, it was discovered (CR 9781) that usage of information from the updated source DTN: MO0401MWDRPSHA.000 was incorrectly rounded off for Site 4 and Site 5 in Table 6-61; the correction to this table is presented here.

Table6-53. Probability of Damage/Plate Failures from Rock Block Impacts

PGV Level (m/s)	Probability of Damage/Failure			
	Plate Thickness (mm)			
	15	10	5	0
0.40	0.5	0.5	0.56	1
1.05	0.78	0.78	0.88	1
2.44	0.96	0.96	0.98	1
5.35	0.98	0.98	0.98	1

Source: Output DTN: MO0703PASDSTAT.001, File *Nonlith Damage Abstraction for DS.xls,* worksheet "Summary."

NOTE: Probability of damage/failure for the 0-mm plate thickness has been set to 1. See discussion of the probability of damage/failure at the 1.05 m/s PGV level with 15-mm- and 10-mm-thick plates below.

Table 6-61. Fault Displacement from Mean Hazard Curves

	Mean Annual Exceedance Frequency (1/yr)				
	10^{-4}	10^{-5}	10^{-6}	10^{-7}	10^{-8}
Site Number and Fault Name	**Displacement (cm)**				
2 - Solitario Canyon	<0.1	32	180	490	1300
3 - Drill Hole Wash [a]	<0.1	<0.1	15	75	240
4 - Ghost Dance [b]	<0.1	<0.1	15	69	210
5 - Sundance	<0.1	0.1	6	40	140
7a - Small fault with 2-m offset	<0.1	<0.1	2	18	73
7b - Shear with 10-cm offset	<0.1	<0.1	1	6	9
7c - Fracture with no displacement	<0.1	<0.1	0.1	0.5	0.6
7d - Intact rock	<0.1	<0.1	<0.1	<0.1	<0.1
8a - Small fault with 2-m offset	<0.1	<0.1	2	18	78
8b - Shear with 10-cm offset	<0.1	<0.1	0.9	6	9
8c - Fracture with no displacement	<0.1	<0.1	0.1	0.5	0.6
8d - Intact rock [c]	<0.1	<0.1	<0.1	<0.1	<0.1

[a] Also representative of Pagany Wash and Sever Wash Faults.

[b] Representative of West Ghost Dance Fault.

[c] Data for Site 8d are based on the observation that the fault displacements for Sites 7a, 7b, and 7c are essentially identical with the fault displacements for Sites 8a, 8b, and 8c, respectively. In this situation, the fault displacements at Site 8d are anticipated to be very similar to the fault displacements at Site 7d considering that both generic locations involve intact rock within the repository block. This observation is corroborated by information in *Probabilistic Seismic Hazard Analyses for Fault Displacement and Vibratory Ground Motion at Yucca Mountain, Nevada* (CRWMS M&O 1998 [DIRS 103731], Section 8.2.1, first paragraph), which indicates that displacements at Site 8d are below 0.1 cm down to 10^{-8} per year annual exceedance frequency.

Sources: DTN: MO0401MWDRPSHA.000 [DIRS 185267]; data files associated with Sites 2, 3, 4, 5, 7a-7d, and 8a-8c are listed in Table 4-1 of this report. Displacements are calculated in the output DTN: MO0703PASDSTAT.001, worksheet "Hazard Calcs" in the file *Fault Displacement Abstraction.xls*.

NOTE: Displacements between 1 cm and 10 cm are rounded to one significant figure, and displacements above 10 cm are rounded to two significant figures.

The fault displacement hazard curves for Sites 4 and 5 are being modified as this document is being completed. The fault displacement damage abstraction is based on the data in the existing DTN.

Table 6-83. Probability of Damage/Plate Failure for Drip Shields in Nonlithophysal Units

	Plate Thickness (mm)			
PGV Level (m/s)	**15**	**10**	**5**	**0**
0.4	0.5	0.5	0.56	1
1.05	0.78	0.78	0.88	1
2.44	0.96	0.96	0.98	1
5.35	0.98	0.98	0.98	1

Source: Output DTN: MO0703PASDSTAT.001, File *Nonlith Damage Abstraction for DS.xls*, worksheet "Summary."

NOTE: Probability of damage/failure for the 0-mm thick plate is set to 1.

Table 6-91. Definition of Parameters for the Drip Shield Damage Abstractions

<table>
<tr><th>Parameter Name</th><th>Description/Definition</th><th>Type</th><th>Parameter Value</th></tr>
<tr><td>PD_DSNL</td><td>Probability of damage to the drip shield or failure of the drip shield plates in the nonlithophysal units
Units: unitless</td><td>Lookup table as a function of PGV and of the plate thickness at the time of the seismic event</td><td>Bilinear function of PGV and plate thickness:
<table>
<tr><th>PGV</th><th colspan="4">Plate Thickness mm)</th></tr>
<tr><th>(m/s)</th><th>15</th><th>10</th><th>5</th><th>0</th></tr>
<tr><td>0.4</td><td>0.5</td><td>0.5</td><td>0.56</td><td>1</td></tr>
<tr><td>1.05</td><td>0.78</td><td>0.78</td><td>0.88</td><td>1</td></tr>
<tr><td>2.44</td><td>0.96</td><td>0.96</td><td>0.98</td><td>1</td></tr>
<tr><td>5.35</td><td>0.98</td><td>0.98</td><td>0.98</td><td>1</td></tr>
</table>
NOTE: if PGV is less than 0.40 m/s, then use the value at the 0.4 m/s PGV levels</td></tr>
</table>

Source: Output DTN MO0703PASEISDA.002.

Text changes that clarify this item affect the first paragraph in Section 6.10.2.1 is shown here (CR 11758). Changes are shown in red typeface, with strikethrough indicating that existing text should be deleted:

> Rockfall calculations for the nonlithophysal units were performed for ground motions at the 0.4 m/s, 1.05 m/s, 2.44 m/s, and 5.35 m/s PGV levels. There were a total of 50 rockfall calculations at each of the 1.05 m/s~~,~~ and 2.44 m/s~~, and 5.35 m/s~~ PGV levels. A total of 50 calculations were begun at the 5.35 m/s PGV level, but only 44 calculations ran to completion because of numerical difficulties with 6 of the calculations. Each of these PGV levels was represented by 15 sets of ground motion time histories. There were a total of 32 rockfall calculations at the 0.4 m/s PGV level, based on a single preclosure ground motion time history. Within the rockfall calculations, the drip shield was represented as a simplified, rectangular structure for the purposes of determining block impacts. The rockfall calculations are described in detail in *Drift Degradation Analysis* (BSC 2004 [DIRS 166107], Sections 6.3.1.2.3 through 6.3.1.2.6).

An additional analysis is performed here to examine the potential impact on a downstream user of the affected information in DTN MO0703PASEISDA.002 that was corrected. The direct input use was in *Waste Package Flooding Probability Evaluation* (SNL 2008a). The direct input used was the probability of drip shield damage/failure due to rockfall in nonlithophysal units (DTN: MO0703PASEISDA.002 [DIRS 183156], Table 1-10), which is equivalent to the data corrected above in Table 6-83 for the 15 mm plate thickness. This same input was used in two of that report's DTNs: MO0712PANLNNWP.000 and MO0712PBANLNWP.000. The affected Mathcad files have been extracted from those DTNs, with their supporting input files, and the corrected information placed in them (as from Table 6-83). These results are shown here in Table 1 and captured in DTN: MO0803PAEXINPC.000.

Table 1. Comparison of Probability Change in Downstream Product SNL 2008a

	Waste Package Type		
	CDSP	CSNF	Navy
Original[a]	$9.55\ 10^{-6}$	$2.17\ 10^{-5}$	$7.75\ 10^{-6}$
Revised[b]	$9.57\ 10^{-6}$	$2.18\ 10^{-5}$	$7.76\ 10^{-6}$

Sources: [a] DTN: MO0712PANLNNWP.000 (CDSP and CSNF) and MO0712PBANLNWP.000 (Navy), same filenames: *Mathcad – NonLith LC Calculation Rev03.pdf*, p. 72.

[b] DTN: MO0803PAEXINPC.000, same filenames: *Mathcad – NonLith LC Calculation Rev03.pdf*, p. 72.

IV. Impact Evaluation

There is no impact to any TSPA model results due to this change in the probability of drip shield failure due to nonlithophysal rockfall. Primarily, this process was excluded from the TSPA per *Features, Events, and Processes for the Total System Performance Assessment: Analyses* (SNL 2008b, Appendix E) as summarized in its excluded FEP 1.2.03.02.0B (Seismic-Induced Rockfall Damages EBS Components). This FEP report did cite as direct input the original source DTN: MO0703PASEISDA.002 [DIRS 183156] to produce its output in DTN: MO0707NONLITHO.000, however it used values that agree with the updated output DTN [DIRS 185278] presented here and is therefore not impacted. This usage of data before its submittal to TDMS is being addressed by CR 11873. The text changes make the paragraph consistent with the underlying results as presented in the corrected tables. Secondarily, while an affected file in DTN MO0712PBANLNWP.000 [DIRS 184664] was cited by *Total System Performance Assessment Model/Analysis for the License Application* (SNL 2008c, p. 6.7-7 and p. 8.1-22), the result representing the frequency of rupture of one or more drip shields ($1.17\ 10^{-6}$ per year) has not changed. This is verified by comparison of page 61 of the Mathcad files *NonLith LC Calculation Rev03.pdf* in cited DTN MO0712PBANLNWP.000 [DIRS 184664] against the revised DTN MO0803PAEXINPC.000.

The affected downstream product *Waste Package Flooding Probability Evaluation* (SNL 2008a) was explicitly evaluated for impact. As demonstrated in Table 1 of the previous section, the affect on these probabilities due to the correction of DTN MO0703PASEISDA.002 are very small, on the order of 0.1%. This is considered to be insignificant and justified as having no material impact.

None of the other corrections presented in this section affected any downstream users and by default result in no impact.

TBV-8734

I. Background Information Summary:

During the ongoing SCI-PRO-008 process to resolve TBV-8734 (use of canceled document) it was determined that further justification regarding the appropriateness of the direct input usage of *21-PWR Waste Package Side and End Impacts* (BSC 2003) is warranted because it did not utilize the current waste package design. The input document (BSC 2003) provides data for the damaged areas from end-on and side-on impacts of a 21-PWR waste package on a flat, elastic surface for a residual stress threshold of 90% with material properties for Alloy 22 at 150°C. These data are used to provide the basis for not including side-on damage from waste-package-to-drip-shield impacts in the seismic damage abstractions, as documented in Section 6.5.6 of the subject report.

II. Inputs and/or Software

No inputs relevant to this issue were changed from those in the original report.

No software was used to generate the changes presented here.

III. Analysis and Results

Further discussion that justifies the usage of BSC 2003 results is provided here and is directly relevant to Section 6.5.6 of the subject report.

The calculations for Table 6-13 of the subject report are based on a 21-PWR waste package with intact internals from Table 5 of BSC 2003 [DIRS 162293]. However, the conclusion that damage from side-on impacts is much less than the damage from end-on impacts or from waste package-to-pallet impacts also applies to the TAD-bearing and codisposal waste package types. More specifically, the damaged area from side-on impacts will be much smaller than from end-on impacts or from waste package-to-pallet impacts for these other types of waste packages. The rationale for this conclusion is as follows:

- The damaged area from side-on impacts of a TAD-bearing waste package with intact internals will be very small in comparison to waste package-to-pallet impacts because: (1) the expected damaged area for waste package-to-pallet impacts of the TAD-bearing waste package with intact internals is extremely small, as shown in Figure 6-10, and (2) deformation and strains from the impact of a TAD-bearing waste package with degraded internals onto the vertical edge of the pallet will be much greater than from a side-on impact (at low angle) onto a flat surface. Since the more severe impact mode (waste package-to-pallet) already produces negligible damage, it follows that the damaged area from side-on impact of a TAD-bearing waste package with intact internals will also be negligible.

- For the TAD-bearing waste package with degraded internals, the magnitude of the damaged area increases for both waste package-to-pallet and side-on impacts, but the more severe impact mode (waste package-to-pallet) will continue to produce significantly greater deformation, strains, and damaged areas than side-on impacts. The potential for severe deformation from waste package-to-pallet impacts with degraded internals is clearly illustrated by (SNL 2007 [DIRS 178851], Figures 6-32, 6-33, 6-35, 6-36, and 6-37). The severe deformation from waste package-to pallet impacts with degraded internals is expected to produce larger damaged area than for side-on impact onto a flat surface as low impact angle.

- The response of the codisposal waste package will be similar to the response of the 21-PWR waste package because the main load bearing elements of these waste packages are very similar. The main load bearing components of the 21-PWR and codisposal waste packages are the Alloy 22 OCB and its lids and, if internals are intact, the stainless steel inner vessel and its lid. The dimensions and thicknesses of these components are similar for either type of waste package. Similarly, the thickness of the stainless steel inner vessel is 2 inches for either waste package type. Given the similar diameters and thicknesses for either waste package type, the structural response of the codisposal waste package will be similar to the response of the 21-PWR waste package.

IV. Impact Evaluation

Direct use of the BSC 2003 (Table 5) input is further discussed and justified here. Its use continues to be appropriate for the purpose of excluding the consequences of side-on waste package impacts from the output of the subject report.

REFERENCES

NOTE: These references are used internally to this ERD and are not related to or included as inputs to the main document. Rather, these are only used to reference the potentially impacted documents that were evaluated.

BSC (Bechtel SAIC Company) 2003. *21-PWR Waste Package Side and End Impacts.* 000-00C-DSU0-01000-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20030227.0067; ENG.20050829.0004.

SNL (Sandia National Laboratories) 2007. *Mechanical Assessment of Degraded Waste Packages and Drip Shields Subject to Vibratory Ground Motion.* MDL-WIS-AC-000001 REV 00. Las Vegas, Nevada: Sandia National Laboratories. ACC: DOC.20070917.0006.

SNL 2008a. *Waste Package Flooding Probability Evaluation.* CAL-DN0-NU-000002 REV 00C. Las Vegas, Nevada: Sandia National Laboratories. ACC: DOC.20080222.0002.

SNL 2008b. *Features, Events, and Processes for the Total System Performance Assessment: Analyses.* ANL-WIS-MD-000027 REV 00. Las Vegas, Nevada: Sandia National Laboratories. ACC: DOC.20080307.0003.

SNL 2008c. *Total System Performance Assessment Model/Analysis for the License Application.* MDL-WIS-PA-000005 REV 00. Las Vegas, Nevada: Sandia National Laboratories. ACC: DOC.20080204.0003.