	Model Error Resolution Document *Complete only applicable items.*	QA: QA Page 1 of 27

1. Document Number:	MDL-MGR-GS-000007 5 TRC 9/25/08	2. Revision/Addendum:	Rev 02	3. ERD:	ERD 02
4. Title:	Dike/Drift Interactions				
5. No. of Pages Attached:	26				

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

The following evaluations, changes, and corrections (attached) are posted to address the recommendations and associated issues identified in CR 11944, CR 11945, and CR 12546. Responses that include ERD revisions to the document provide corrections to specified reference citations, clarification to descriptions, or provide editorial corrections to typographical errors. None of the responses to the items identified in the three CRs adversely affect the results of the TSPA that supports the license application. Detailed responses to each recommendation and the associated issues are attached. Table ERD-1 provides an evaluation of the impacts of the ERD revisions on documents that referenced the report, *Dike/Drift Interactions* Rev 02.

7. CONCURRENCE			
	Printed Name	Signature	Date
Checker	Ronald H. Price	Ronald H Price	9/25/2008
QCS/QA Reviewer	Sounia Kassabian Darnell	Sounia K. Darnell	9/26/2008
8. APPROVAL			
Originator	Terry Crump/Cliff Howard	Terry R. Crump / for CH	09/26/2008
Responsible Manager	Jerry McNeish	Jerry A McNeish	9.29.08

CR 11944 and CR 11945 Condition Report Evaluation

Responses to Conditions Adverse to Quality and Recommendations from Lead Lab Internal Audit LQA-IA-08-001

I. Background Information:

The audit of three igneous activity technical products (Lead Lab Internal Audit LQA-IA-08-001), described information in MDL-MGR-GS-000005, Rev. 02, that was presented with technical errors in report details that were considered Conditions Adverse to Quality (CAQs) (See CAQ #1). Furthermore, it was determined that information was presented with incorrect cross-references; or without identifying the information source, or the wrong information sources were referenced in the Model Report MDL-MGR-GS-000005, Rev. 02 (CAQ #2). CR 11945 includes three recommendations for improvement. Recommendations #1 and #2 provide for more improvements in the description of the technical bases for models described in the report. Recommendation #3 corrects ambiguities in descriptions. CR 12546 describes the use of three cancelled documents (DIRS 178838, 176681, 178839) as indirect inputs for MDL-MGR-GS-000005, Rev 02.

II. Disposition of Major Issues/Descriptions of Changes

The following items describe the conditions adverse to quality as listed in CR 11944 and the recommendations to improve clarity listed in CR 11945, provide responses to each item in both CRs, and where appropriate provide revised text for the ERD.

CR 11944

CAQ #1

Requirement: In SCI-PRO-006, Rev. 09, the originator is designated to perform a model activity and to prepare the model documentation and assigned the responsibility for ensuring the adequacy, accuracy, and completeness of the model documentation.

Condition: Contrary to the requirement stated above, during Lead Lab Internal Audit LQA-IA-08-001, technical errors in report details were identified in the Model Report MDL-MGR-GS-000005, Rev. 02. See below for details:

(Issue 42)
Page 6-45, statement on tope of page. Delete the lead-in portion of the statement, "As expected from Equation 6-51" since this equation does not result in an increase in tip cavity length as magma viscosity increases.

Response: The sentence specified in the comment is as follows:

As expected from Equation 6-51, an increase in magma viscosity, μ, results in an increase in the tip cavity length.

For the ERD, the sentence is revised to read as follows:

"An increase in magma viscosity, μ, results in an increase in the tip cavity length."

Impact Evaluation: The ERD item clarifies the description of the effect of an increase in magma viscosity on tip cavity length, but has no impact on technical product output.

(Issue 59)
Section 6.3.4.6.2, Page 6-102, 2nd paragraph, states in part, "Their analysis of configuration:…." it should state "Their analysis of configurations:…." as the discussion is referring to two types of configurations, (1) a circular magma chamber beneath three relatively thick, flat-lying...and (2) a circular magma chamber in the lower levels of a thick section of relatively thin, sloping layers.

Response: The paragraph specified in the comment is as follows:

"Their analysis of configuration: found that the maximum principal stress direction tended to be vertical at the low-stiffness-over-high-stiffness interface, but tended to be horizontal at the high-stiffness-over-low-stiffness interface. Because a vertical orientation of maximum principal stress is favorable for dike formation, they concluded that alternating layers would discourage upward dike migration. The same effect resulted in a down dip migration of the center of maximum principal stress concentration above the magma chamber in the stack of tilted layers. They also reported field observations that supported their analysis."

For the ERD, the paragraph is revised to read as follows:

"Their analysis of configurations found that the maximum principal stress direction tended to be vertical at the low-stiffness-over-high-stiffness interface, but tended to be horizontal at the high-stiffness-over-low-stiffness interface. Because a vertical orientation of maximum principal stress is favorable for dike formation, they concluded that alternating layers would discourage upward dike migration. The same effect resulted in a down dip migration of the center of maximum principal stress concentration above the magma chamber in the stack of tilted layers. They also reported field observations that supported their analysis."

Impact Evaluation: The ERD item corrects a grammatical error but has no impact on technical product output.

Page 6-140, second line, states in part "...these purely convective calculations...." this is incorrect. The correct statement is "...these purely conductive calculations...."

Response: The text specified in the comment is as follows:

"Any advection of gases in the surrounding host rock, as well as the release of volatiles from the cooling magma will enhance the cooling rate; thus, these purely convective calculations will tend to underestimate magmatic and host-rock cooling rates with respect to the mass flow of hot gases."

For the ERD, the test is revised to read as follows:

"Any advection of gases in the surrounding host rock, as well as the release of volatiles from the cooling magma will enhance the cooling rate; thus, these purely conductive calculations will tend to underestimate magmatic and host-rock cooling rates with respect to the mass flow of hot gases."

Impact Evaluation: The ERD item clarifies the description of the combined effects of advection of gases and releases of volatiles on magma cooling rates as calculated using conductive equations. The ERD item has no impact on technical product output.

Page 6-213, last sentence on page states in part "...the hydrofracture pressure is only 6.5 MPa,...." this is incorrect. The correct statement is "...the hydrofracture pressure is only 5.8 MPa,...."

Response: The sentence specified in the comment is as follows:

"For case 3 where $h_2 = 0$ (Table 6-27), the hydrofracture pressure is only 6.5 MPa, almost equal to the 7 MPa required to displace the entire scoria plug."

For the ERD, the sentence is revised to read as follows:

"For case 3 where $h_2 = 0$ (Table 6-27), the hydrofracture pressure is 5.8 MPa, compared to the 7 MPa required to displace the entire scoria plug."

Impact Evaluation: The ERD item corrects an error in the hydrofracture pressure value but has no impact on technical product output.

Page 6-226, 1st paragraph states in part "...indicate 1,000 creep strengths...." the sentence should state "...indicate 1,000-hour creep strengths...."

Response: The sentence specified in the comment is as follows:

"Mechanical properties of the alloy comprising the main waste package external components, developed in BSC 2005 [DIRS 173802]), indicate 1,000 creep strengths of only 2 MPa (for Stainless Steel Type 316) to 3 MPa (for Alloy 22) at 1,100°C and that these strengths increase to only about 15 MPa to 33 MPa, respectively, at 900°C."

For the ERD, the sentence is revised to read as follows:

"Mechanical properties of the alloy comprising the main waste package external components, developed in BSC 2005 [DIRS 173802]), indicate 1,000-hour creep strengths of only 2 MPa (for Stainless Steel Type 316) to 3 MPa (for Alloy 22) at 1,100°C and that these strengths increase to only about 15 MPa to 33 MPa, respectively, at 900°C."

Impact Evaluation: The ERD item clarifies that the description of creep strengths is based on results of 1,000-hour tests. The ERD item has no impact on technical product output.

Page 6-262, 1st sentence in 1st paragraph under Eq. 6-119, states in part "...as measured from the x axis towards the z axis...." this is incorrect. The correct statement is "...as measured from the y axis towards the z axis...."

Response: The sentence specified in the comment is as follows:

"In these equations, θ is the angle around the drift as measured from the *x* axis towards the *z* axis, so $\sigma_\theta$is the hoop stress. Also, σ_r (not in the equations above) is the radial stress, but it is zero at the tunnel wall until pressurized by magma, which is considered next."

For the ERD, the sentence is revised to read as follows:

"In these equations, θ is the angle around the drift as measured from the *y* axis towards the *z* axis, so $\sigma_\theta$is the hoop stress. Also, σ_r (not in the equations above) is the radial stress, but it is zero at the tunnel wall until pressurized by magma, which is considered next."

Impact Evaluation: The ERD item corrects an error in the description of radial stress but has no impact on technical product output.

Section 7.2.1, Page 7-5, 2nd paragraph, line 3, parenthetical statement "(i.e., in situ stress conditions equal to gas pressure inside the tip cavity)." is incorrect and should be removed from sentence.

Response: The sentence specified in the comment is as follows:

"The dimensionless reference stress accounts for the effects of gas pressure inside the dike tip cavity and for changes in confining stress normal to the dike. Most of the simulations were carried out with a reference stress of zero (i.e., in situ stress conditions equal to gas pressure inside the tip cavity)."

For the ERD, the sentence is revised to read as follows:

"The dimensionless reference stress accounts for the effects of gas pressure inside the dike tip cavity and for changes in confining stress normal to the dike. Most of the simulations were carried out with a reference stress of zero."

Impact Evaluation: The ERD item corrects the description of which analysis items are accounted for in the dimensionless reference stress. The ERD item has no impact on technical product output.

Section 7.3.1.1.2, Page 7-13, discussion following question 2 (bottom of page), the sentence "The linear-elastic behavior assumption has been revised and does not state that this is always conservative." needs to be removed. The text needs to be modified to correspond to what was actually done.

Response: The sentence specified in the comment is as follows:

"The linear-elastic behavior assumption has been revised and does not state that this is always conservative."

For the ERD, remove the sentence in question.

Basis for Deletion: The sentence describes a change made to Rev 00 of *Dike Drift Interactions* in response to a comment from a review of an early drift by Dr. Michael Rubin. Dr. Rubin reviewed an early draft of *Dike/Drift Interactions* (Rev 00B, ICN 01). Dr. Rubin's report (SNL 2007 [DIRS 177430], Appendix F, Item 2(3), paragraph 2, page F-6), states that the following statement is untrue "Linear-elastic behavior would be a conservative assumption because anelastic behavior would serve to increase dike widths and reduce pressures at the repository." The text in the final draft was revised to remove the description of linear-elastic behavior as conservative, and the text in question was never incorporated in the final draft of Rev 00. Assumption 5.1 (*Dike/Drift Interactions* Rev 00, for Assumption 5.1, item 10) describes how linear-elastic behavior was incorporated into the dike propagation model.

Impact Evaluation: The ERD item deletes an ambiguous sentence and the background material explains the basis for the deletion. The ERD item has no impact on technical product output.

Section 7.3.1.3.1, Page 7-19, last paragraph, 3rd line from bottom, the value 0.1 MPa should actually be 0.1 MPa m1/2.

Response: The sentence specified in the comment is as follows:

"For a fracture toughness of 0.1 MPa to 1.0 MPa $m^{1/2}$, which Table 6-10 indicates is appropriate for tuff, the largest fractures in the hanging wall would have to be larger than 0.1 m to 1 m long to permit penetration of the hanging wall of a 60-degree fault."

For the ERD, the sentence is revised as follows:

"For a fracture toughness of 0.1 MPa $m^{1/2}$to 1.0 MPa $m^{1/2}$, which Table 6-10 indicates is appropriate for tuff, the largest fractures in the hanging wall would have to be larger than 0.1 m to 1 m long to permit penetration of the hanging wall of a 60-degree fault."

Impact Evaluation: The ERD item corrects an error in the units associated with the fracture toughness parameter described for tuff. The ERD item has no impact on technical product output.

Section 8.1.1, Page 8-3, second bullet, line 10, states in part "...vertical stress gradient...." this is incorrect. The correct statement is "...horizontal stress gradient...."

Response: The sentence specified in the comment is as follows:

"Once the dike passed through the region of increased horizontal stresses, the tip and magma front would be free to accelerate under the very large vertical stress gradient (Figure 6-79) above the repository."

For the ERD, the sentence is revised as follows:

"Once the dike passed through the region of increased horizontal stresses, the tip and magma front would be free to accelerate under the very large horizontal stress gradient (Figure 6-79) above the repository."

Impact Evaluation: The ERD item corrects the description of the stress regime above the repository but has no impact on technical product output.

Appendix C, Page C-14, the caption for Figure C-5 should state that the response is for a location at a radius of 10m.

Response: The caption specified in the comment is as follows:

"Figure C-5. Peak Temperatures for Variations in Key Inputs"

For the ERD, the caption is revised as follows:

"Figure C-5. Peak Temperatures at a radius of 10 m for Variations in Key Inputs"

Impact Evaluation: The ERD item clarifies the description of temperatures used in the analysis but has no impact on technical product outputs.

Appendix D, Page D-2, the captions for Figure D-1 (upper and lower) are in error and should be swapped. For example, the lower caption should state "Whole-Time Cylinder with no Latency (Table 2a).

Response: The caption specified in the comment is as follows:

"Figure D-1. Plot of Calculated Temperature Profiles for Various Cooling Times Comparing Results for a One-dimensional Slab-Like Geometry (upper plot) With Results for a Two-dimensional Cylindrical Drift Geometry (lower plot)"

For the ERD, the caption is revised as follows:

"Figure D-1. Plot of Calculated Temperature Profiles for Various Cooling Times Comparing Results for a Two-dimensional Cylindrical Drift Geometry (upper plot) With Results for a One-dimensional Slab-Like Geometry (lower plot)"

Impact Evaluation: The ERD item corrects the captions for two plots in Figure D-1. The ERD item has no impact on technical product output.

(Issue 61)
All references to "pyroclastic magma" should be removed. The models are investigating responses for temperature cases of 950 degrees C and 1150 degrees C, regardless of the type of magma.

Response: The term "pyroclastic magma" occurs twice in the text, as follows:

Section 1.4.3, paragraph 1: "The processes and effects associated with expansion of bubbly or pyroclastic flow into a drift were not modeled. Therefore, the interaction between compressible-phase (pyroclastic) magma and the drifts, and between the pyroclastic-phase magma and repository components, has not been evaluated."

Section 2, list item 4: "*Assess the effects of pyroclastic magma flow on EBS* (TWP, Section 2.2.2.4.3)." This work was not undertaken before this report was finalized, so it is not included in this report. There is no significant impact on model output or feeds to TSPA because all waste packages are assumed to be compromised during an intrusive igneous event.

Since each occurrence of the term is in a description of work that was not done, the reviewer's comment is rejected. No changes to text are needed.

Impact Evaluation: None

(Issue 64)
Section 6.5.1.3.3. The state of stress described is prior to magma arrival, and, therefore, does not apply. Delete the misleading statement in regards to overcoming tensile stress.

Response: For the ERD, delete the sentence: "This stress is the minimum pressure required to start a secondary dike at that position." which is found on page 6-271.

Impact Evaluation: The ERD item corrects the description associated with the analysis of dike propagation but has no impact on technical product output.

(Issue 65)
Section 8.1.3, Page 8-5, second bullet: This whole paragraph should be revised. Specifically, usage of "never will be able…" and the term "effusively" is not proper in the present text.

Response: The sentence specified in the comment is as follows:

"Even under the most favorable assumptions for growth, a subsidiary dike will never be able to propagate effusively more than a few meters from the drift because the magma will be halted by solidification (Section 6.5.1.4)."

For the ERD, the sentence is revised as follows:

"Even under the most favorable assumptions for growth, a subsidiary dike with effusive flow characteristics would not be expected to propagate more than a few meters from the drift because the magma would be halted by solidification (Section 6.5.1.4)."

Impact Evaluation: The ERD item clarifies the description of the potential for propagation of a secondary dike but does not alter the conclusion that propagation would be halted within a few meters of a drift. Therefore, the ERD item has no impact on technical product output. Propagation of secondary dikes under effusive flow conditions is described correctly in SAR 2.3.11.

(Issue 69)
Appendix D, Page D-11, Equation D-17. Add the missing Θ term (Θm?). Correct the text where Θci is shown as a ratio.

Response: Equation D-17 was checked against the same equation in Delaney 1987 [DIRS 102776] and found to be correct as written. No missing θ_m term was identified in Delaney 1987. The only changes were to subscripts, but the changes are consistent with the subscripts used in Delaney 1987. θci is shown as a ratio in equation D-17. No changes to the text are needed.

Impact Evaluation: None

CAQ #2

Requirement: SCI-PRO-006, Revision 9, Section 6.2.1, Paragraph C, states: "[Originator] Document the model using the annotated outline in Attachment 2, Model Documentation Outline. Information presented in the model documentation shall be transparent, traceable, and reproducible to other qualified individuals."

Condition: Contrary to the requirement stated above, during Lead Lab Internal Audit LQA-IA-08-001, it was discovered that information was presented in the Model Report MDL-MGR-GS-000005, Rev. 02, with incorrect cross-references; or without identifying the information source, or the wrong information source was referenced. See examples documented below:

(Issue 58)
Section 6.2.3, Page 6-8 references Jaeger and Cook 1979 [DIRS 106219] this is an incorrect reference. The correct reference is Aadnoy and Chenevert 1987 [DIRS 178340] (see page 6-262).

Response: For the ERD, the reference to Jaeger and Cook 1979 on page 6-8 is changed to Aadnoy and Chenevert (1987) [DIRS 178340) as described on p. 6-262. No revision to DIRS is needed.

Impact Evaluation: The ERD item corrects the reference in Section 6.2.3 to be consistent with the description on p 6-262. The reference correction has no impact on technical product output.

Page 6-32, under the “Limitations” paragraph, the reference to Section 6.3.8.2 (pp. 6-137) is incorrect, the correct reference is Section 6.3.6 (pp. 6-117).

Response: For the ERD, the reference is changed to Section 6.3.6 (pp. 6-117).

Impact Evaluation: The ERD item corrects the reference on page 6-32 to Section 6.3.6. The reference correction has no impact on technical product output.

Page 6-103, first sentence references Figure 6-45, this is incorrect. The correct reference is Figure 6-46 on page 6-89.

Response: For the ERD, the reference is changed to Figure 6-46 (pp. 6-89).

Impact Evaluation: The ERD item corrects the reference on page 6-103 to Figure 6-46 (pp. 6-89). The reference correction has no impact on technical product output.

Page 6-143, Top paragraph, last sentence, references Section 6.4.5 and Appendix C for details of grid discussion, this is incorrect. The correct references are 6.4.7.2.2; Figure 6-91; Figure 6-92; and Figure 6-93.

Response: For the ERD, the references are changed to Section 6.4.7.2.4; Figure 6-91; Figure 6-92; and Figure 6-93.

Impact Evaluation: The ERD item corrects the reference on page 6-143 to Section 6.4.7.2.2; Figure 6-91; Figure 6-92; and Figure 6-93. The reference correction has no impact on technical product output.

Page 6-218, 2nd paragraph, and Page 6-217, 1st paragraph, 1st sentence, references Figure 6-142c, this is incorrect. The correct Figure number is 6-142.

Response: For the ERD, the reference is changed to Figure 6-142.

Impact Evaluation: The ERD item corrects the reference on page s 6-217 and 6-218 to Figure 6-142. The reference correction has no impact on technical product output.

Page 6-216, last paragraph, line 3, and Page 6-217, 1st paragraph, 1st sentence, makes a reference to Figure 6-142b, this is incorrect. The correct reference is Figure 141.

Response: For the ERD, the reference is changed to Figure 6-141.

Impact Evaluation: The ERD item corrects the reference on page 6-216 to Figure 6-141. The reference correction has no impact on technical product output.

Section 6.5.1.5, Page 6-275, the paragraph below the second bullet in that section references Section 6.3.7.3 in the first sentence, that reference is incorrect. The correct reference is Section 6.3.3.5.6. The second sentence in that paragraph references Figure 6-75 as the snapshot taken just after magma first encounters a drift, that figure is incorrect. The correct figure is Figure 6-31. The third sentence references Figure 6-78 as showing the effects, this is an incorrect reference, the correct figure is Figure 6-33. And the final figure in that paragraph references Figure 6-7, which is incorrect. The correct figure is Figure 6-34.

Response: For the ERD, the text on p. 6-275 in the first sentence following the second bullet in that section is revised to change the reference from Section 6.3.7.3 to Section 6.3.3.5.6. The text in the second sentence is revised to change the reference from Figure 6-75 to Figure 6-31. The reference in the third sentence is changed from Figure 6-78 to Figure 6-33. The final figure reference in the paragraph is changed from Figure 6-7 to Figure 6-34.

Impact Evaluation: The ERD item corrects a section reference and various figure references on page 6-275. The reference corrections have no impacts on technical product output.

Section 8.1, Page 8-1, last bullet, cites Section 1.3 as the limitations on the use of this model, the section cited is incorrect. The correct Section is 1.4.

Response: For the ERD, the reference for the discussion of limitations in Section 8.1, page 8-1 is changed from Section 1.3 to Section 1.4.

Impact Evaluation: The ERD item corrects the reference for the limitations discussion. The correction has no impact on technical product output.

Section 8.3.1, Page 8-8, the references to tables 7-9 and 7-10 in the paragraph are incorrect. The correct tables are 7-7 and 7-8, respectively.

Response: For the ERD, the references to Tables 7-9 and 7-10 in Section 8.3.1, Page 8-8 are revised to specify Tables 7-7 and 7-8. The ERD item corrects errors in the table number references that show rock mass temperatures for the a scenario that considers the effects of heat from emplaced waste packages on rock mass temperatures following intrusion and a scenario that considers intrusion into a rock mass at ambient temperature.

Impact Evaluation: The ERD item corrects the table number references and does no change any of the analysis results. Therefore, the ERD item has no impact on technical product output.

CR 11945

Recommendation #1

Based on the following issues identified in Lead Lab Audit LQA-IA-08-001, it is recommended that the information presented in MDL-MGR-GS-000005 be clarified to include a more complete description of the technical basis:

(Issue 39)
Section 5.3, page 5-3. L. A. design does not have backfill in the drifts. However, analyses are included in the report that pertain to backfilled (or partially backfilled) drifts. The report should recognize early (e.g., in Section 1.4.3) that backfill is not an element of the repository design and should clarify the basis for including such analyses in this report.

Response: The assumption specified in the comment is as follows:

Assumption: The analysis of magma flow over backfill in access drifts assumes that the gaps above the backfill are initially unobstructed by rubble or rockfall.

The discussion in Section 1.1, bullet 3 describes the basis for the analysis. The results of the analysis "of magma chilling in backfilled drifts (Section 6.4.8.4) supports [sic] the conclusion that backfill would be ineffective in stopping the flow of the low-viscosity magma from one drift to another."

For the ERD, the following text is added to the bullet 3:

"Note: The current repository design does not include backfilled drifts. Since backfill, if present, would be expected to act as a limit to flow of magma within and between drifts when compared to flow in non-backfilled drifts, and since the analysis results showed no such effect, the results support the abstraction used for TSPA that once intersection of the repository occurs, all drifts are inundated by magma (SNL 2007 [DIRS 177432], Section 5.1)."

Note: Add DIRS 177432 Section 5.1 to DIRS as indirect input.

Impact Evaluation: The ERD item clarifies that backfilled drifts are not part of the current repository design and describe why that design supports the TSPA assumption. The ERD item has no impact on technical product output.

(Issue 44)
Page 6-85. Provide explanatory text regarding the anomalous behavior of the top curve on the graph of Figure 6-43.

Response: The reason for the kink is that the curve is a combination of two different solutions, based on different approximations strictly valid for asymptotic conditions. Consequently, when two different curves (or two different solutions) are pieced together, the composite function is continuous but the first derivative is not. The kink is consequence of approximation and assumptions used, not due to an error. No changes to the text are needed.

Impact Evaluation: None

(Issue 45)
Page 6-95. The discussion of results should clarify "conditions of interaction," particularly in the context of the green data points identified on Figure 6-51.

Response: The sentence specified in the comment is as follows:

"The conditions of interaction between the potential dike and the Bow Ridge Fault are indicated as green squares (for depths of 3,300 and 5,250 m) in Figure 6-51."

From the text it is clear that the expected depth at which an ascending dike would intersect the Bow Ridge fault is between 3300 m and 5250 m. Figure 6-51 shows variations in stress with depth and fault angle needed to open pre-existing fractures in the hanging wall of the Bow Ridge fault to magma flow. The figure shows that conditions at the projected intersection depth favor continued vertical propagation of the dike unless fracture toughness is greater than 10 $MPa \cdot m^{1/2}$ or fracture lengths are less than 0.1 m. Figure 6-59 shows the effects of several fracture toughnesses and fracture length on dike propagation. This result is summarized in the last paragraph of the section as follows:

"For the conditions below Yucca Mountain, where the Bow Ridge Fault is the block-bounding fault extending below the repository, a simple analysis indicates that the dike will most likely continue propagating vertically upward after it intersects the Bow Ridge Fault. Even if magma were diverted into the Bow Ridge Fault (e.g., in the unlikely event that the fault hanging wall has only fractures much shorter than 0.1 m or the fracture toughness exceeds 10 MPa $m^{1/2}$), the

magma would flow along the Bow Ridge Fault until it reaches another steeply dipping structure, at which point magma would turn again along the steeply dipping structure."

No changes to the text are needed.

Impact Evaluation: None

(Issue 60)
Page 137, describe what is meant by "Base Model." (Base model is the case without the repository or heat generating waste.) Include other assumptions such as: compressible magma, no leakage into repository, etc.

Response: Section 6.3.8.1 describes the base case for incompressible magma. The base model is the model which does not account for effect of existing faults, topography, non-uniform thermally induced stresses or magma compressibility.

For the ERD, the beginning of paragraph 1 of Section 6.3.8.1 is revised as follows:

"Dike ascent driven by incompressible magma was analyzed in terms of a base model for a variety of conditions. The base model does not account for effects of existing faults, topography, non-uniform thermally induced stresses or magma compressibility."

Impact Evaluation: The ERD item clarifies the meaning of the term "base model," but has no impact on technical product output.

(Issue 66)
Appendix A, Page A-1, last paragraph, the reference to heating of neighboring drifts may add unnecessary confusion given that the assumption of simultaneous magma inundation rules that out. Either remove this analysis or preface the discussion to make clear the relevance at the time of analysis.

Response: The sentence specified in the comment is as follows:

"The second model describes heating of neighboring drifts from cooling of the emplaced magma (Section 6.4.1)."

For the ERD, the sentence is revised as follows:

"The second model describes heating of the repository host rock from cooling of the emplaced magma (Section 6.4.1)."

Impact Evaluation: The ERD item clarifies the description of thermal effects from cooling magma and eliminates ambiguities that could result from consideration of heating effects on neighboring drifts. The ERD item has no impact on technical product output.

(Issue 67)
Appendix C, Table C-5, Provide additional discussion on the construction of this table. Better explain the variance calculation and the sources of mean values.

Response: A description of the Table C-5 is provided on pages C-12 and C-13, as follows:

"Table C-5 presents the evaluation of the system variance. The values for mean and standard deviation were obtained from *Ventilation Model and Analysis Report* (BSC 2004 [DIRS 169862], Section 6.11).

The method of moments provides information as to the source of uncertainty from the individual variables. In Equation C-16, the variance of each individual variable, x_i, is multiplied by the square of the derivative of the system function for that parameter. The square of the derivative represents the sensitivity of the system variance to the individual parameter. If the sensitivity, and the variance to an individual parameter are large, then the system variance is dominated by this contribution. Conversely, if the sensitivity and the variance to an individual parameter are small, then the system variance is not influenced by this individual contribution.

Table C-5 represents the results of the analysis using the method of generating system moments. The analysis is performed by calculating the first-order partial derivatives of temperature to the solids thermal conductivity (k_s); the solids specific heat capacity (Cp); the solids grain density (ρ_g); matrix porosity (ϕ_m); the matrix saturation (S_m); and the lithophysal porosity (ϕ_l). Each component is perturbed from its mean value by plus or minus one standard deviation while the other components are evaluated at their mean value. The rock mass thermal conductivity and the thermal diffusivity are then calculated based upon the relations for thermal conductivity and thermal diffusivity presented previously. The finite-difference calculations are then performed, and the peak temperature at a radius of 10 m is evaluated for the parameters. The first-order partial derivatives are approximated for the mean values plus or minus one standard deviation for each component and then substituted into Equation C-17."

The first paragraph clearly indicates the source for the values for mean and standard deviation (BSC 2004 [DIRS 169862], Section 6.11). The second and third paragraphs describe the variance analysis.

No change to text needed.

Impact Evaluation: None

(Issue 68)
Appendix D, recommend establishing the case (slab or cylinder) and clarifying labels for Figures D-3, D-4, and D-5.

Response: Figures D-3, D-4 and D-5 represent cylindrical geometry. For the ERD, the notes on the figures are revised as follows:

Figure D-3, NOTES: Cylindrical drift geometry. These calculations are valid only for early times when the temperature of the magma at the drift center is above the assumed solidus at 900°C.

Figure D-4, NOTES: Cylindrical drift geometry. These calculations are valid only for early times when the temperature of the magma at the drift center is above the assumed solidus at 900°C.

Figure D-5, NOTES: Cylindrical drift geometry. Dashed curves are the whole-time solutions from Figure D-2; solid curves are early time solutions from Figure D-4.

Impact Evaluation: The revisions for the ERD clarify the drift geometry but have no impact technical product outputs.

(Issue 83)
It is recommended that the many sections labeled "assumptions and simplifications" in sections outside of Section 5 be labeled "Model assumptions and simplifications". For example, Sections 6.4.2 and 6.4.7.2.1.

Response: For the ERD, the following revisions are made:

In the Table of Contents, the section titles are changed as follows:

Title of Section 6.3.2 is revised to read Modeling Assumptions and Simplifications

Title of Section 6.4.2 is revised to read Modeling Assumptions and Simplifications

Title of Section 6.4.7.2.1 is revised to read Modeling Assumptions and Simplifications

Title of Section 6.6.2 is revised to read Modeling Assumptions and Simplifications

The same revisions are made to the titles of Sections 6.3.2, 6.4.2, 6.4.7.2.1, and 6.6.2 in the body of the report.

Table 6-1, FEP 1.2.04.03.0A Text in column 2 is revised to read as follows:

Section 6.3 contains the overall model description, and descriptions of assumptions and simplifications used to implement the model.

Section 6.3, paragraph 2, line 1 is revised to read as follows:

The model is described in Section 6.3.1, while the assumptions and simplifications ~~involved~~ used to implement the model are listed in Section 6.3.2.

Section 6.4.1.1, paragraph 2, line 1 is revised to read as follows:

Section 6.4.2 presents the assumptions and simplifications ~~of~~ used to implement the model, while the mathematical description is found in Section 6.4.3.

Section 7.2.2, paragraph 1 is revised as follows:

Confidence in the post-intrusion submodel was developed by the selection of input data, by calibration activities, by assessment of the impacts of uncertainties, by use of appropriate assumptions and simplifications needed implement the model, and by ensuring consistency with physical principles.

The description in Section 7.3.1.1.2, item 2, paragraph 2, lines 1 and 2 is revised as follows:

Section 6.3.2, which deals with assumptions and simplifications used to implement the dike propagation model, has been extensively revised in response to Dr. Rubin's comments.

Impact Evaluation: The ERD items clarify that the assumptions and simplifications described are associated with implementation of the model. The ERD items have no impacts on technical product outputs.

(Issue 84)
(Table 6-34, page D-12, etc.). It is recommended that a literature search be conducted for other discussions and possible equations concerning the latent heat of crystallization.

The phenomena should be discussed with experimental petrologists. Further discussion in the text might be appropriate.

Response: The discussion and equations concerning latent heat of crystallization effects are adequate to support the technical product outputs that are used in TSPA. No changes needed.

Impact Evaluation: None

Recommendation #2

Based on the following issues identified in Lead Lab Audit LQA-IA-08-001, it is recommended that additional information supporting the viability of the technical discussion be added to MDL-MGR-GS-000005. See below for details:

(Issue 41)
Page 6-9. Vertical stress is modified, near the excavations, as a result of heating and/or the excavation process. Whereas the vertical stress may not change on average, it does change in the vicinity of the repository. This should be clarified in the text.

Response: The comment requests clarification of effects on vertical stress of excavation and heating of drifts. The text related to excavation effects is as follows:

"Stress changes from the drift excavation are of limited spatial extent and decay quickly into the pillars separating drifts as a function of distance from the drift wall. The stress becomes almost equal to unperturbed, far-field stress state at a distance of three drift radii from the drift wall. Repository stresses will have an insignificant effect on dike propagation."

The description clearly says stress changes from excavation are of limited spatial extent and become nearly equal to the far-field stress at distances of three drift diameters. No change to text is needed.

The text related to effects associated with drift heating is as follows:

"On average, the vertical stresses (statically determined) would not change as a result of heating. If heating increases the magnitude of the horizontal principal stresses such that both become larger than the vertical principal stress, the repository could be shielded from potential volcanic intrusion for a period of time (while the conditions of such stress "inversion" exist)."

The statement reflects information that describes non-significant increase in vertical stress in the wall (BSC 2004 [DIRS 166107], p. 6-51) and substantiated in a subsequent report that described limiting changes in vertical stress associated with thermal effects (SNL 2008 [DIRS 179962], p. 6-81).

The system is statically determined in the vertical direction. Consequently, the average vertical stress at any level has to be equal to the weight of the overburden irrespective of the drift excavation or temperature change. Only the average stress in the horizontal section through the drifts will increase proportional to the ratio 81/(81-5.5) = 1.07. No additional clarification is required and no change to text is needed.

Impact Evaluation: None

(Issue 43)
Page 6-55. Reconcile seemingly contradictory statements regarding the utility/appropriateness of Equations 6-79 and 6-80 and comparison with model results. No such comparison was made because of reasons provided late on the same page.

Response: The sentence specified in the comment is as follows:

"Because the dike propagation modeling being performed here is applying the two-dimensional approximation used by Geertsma and de Klerk (1969 [DIRS 163624]), these equations are most appropriate for direct comparison with the model results."

No comparison was made because the model was considered not appropriate. The next sentence in paragraph (SNL 2007 [DIRS 177430], Section 6.3.3.5.1) says:

"Although such analytic conceptual models are useful for parameter estimation, they are not appropriate for the dike propagation problem near the free surface and with a sink point at some single location. Thus, these models cannot be used to provide the detail needed for understanding magma flow into a shallow repository due to an intersecting dike."

No change to text needed.

Impact Evaluation: None

Recommendation #3

Based on the following issues identified in Lead Lab Audit LQA-IA-08-001, it is recommended that some of the wording presented in MDL-MGR-GS-000005 that may be misleading or result in an incomplete interpretation be changed. See below for details:

(Issue 62)
It is recommended that the author rephrase the statement on pp. 6-206 below Eq. 6-111 as follows: Reposition "plus the tensile strength of the rock" from the parentheses to immediately after "at Yucca Mountain, to 7.2 MPa."

Response: The sentence specified in the comment is as follows:

"Assuming that the horizontal principal stresses are equal and using values consistent with the discussion of the previous paragraph, this would limit pressures in an isolated vertical cylinder, such as a conduit at a depth of 300 m at Yucca Mountain, to 7.2 MPa, assuming the horizontal confining stress is isotropic and equal to half the vertical overburden stress (i.e., $\sigma n=\sigma_N$ = 3.6 MPa plus the tensile strength of the rock)."

For the ERD, the sentence is revised as follows:

"Assuming that the horizontal principal stresses are equal and using values consistent with the discussion of the previous paragraph, this would limit pressures in an isolated vertical cylinder, such as a conduit at a depth of 300 m at Yucca Mountain, to 7.2 MPa plus the tensile strength of the rock, assuming the horizontal confining stress is isotropic and equal to half the vertical overburden stress (i.e., $\sigma n=\sigma_N$ = 3.6 MPa)."

Impact Evaluation: The ERD item clarifies the magnitude of the stress on a vertical cylinder of rock but has no impact on technical product output.

(Issue 63)
Section 6.5.1.3.3 equivalence of terms "dike tip" "crack tip" "tip" needs to be acknowledged to make their random use in the text and figures easier to understand and consistent in this section.

Response: The terms 'tip,' 'fracture tip,' 'crack tip,' and 'dike tip' are synonymous, but the usage of the terms in this section is not consistent.

For the ERD, a parenthetical note is added to Section 6.5.1.3.3 following the first usage of the "tip" as follows:

"(Note: The terms 'tip,' 'fracture tip,' 'crack tip,' and 'dike tip' are synonymous and are used interchangeably in Section 6.5.1.3.3)."

Impact Evaluation: The ERD item adds clarification about usages of the terms 'tip,' 'fracture tip,' 'crack tip,' and 'dike tip' but has no impact on technical product output.

CR 12546

I. Background Information:

A cancelled engineering drawing (BSC 2006 [DIRS 178838]) was listed as a source for dimensions for the Naval Long waste package. The reference error was described in CR 12546, and an impact analysis was initiated to resolve the CR.

II. Disposition of the Issue:

The reference to DIRS 178838 was incorrect. The reference should be to [DIRS 179567].

For the ERD, the first paragraph on page E-3 is revised to add the following sentence to the end of the paragraph:

"For a description of the Naval Long waste package dimensions, see Total System Performance Assessment Data Input Package for Requirements Analysis for DOE SNF.HLW and Naval SNF Waste Package Physical Attributes Basis for Performance Assessment (SNL 2007 [DIRS 179567], Sheets 2 and 3 and Tables 4-6 and 4-7)."

Note: Add the following reference as indirect input to DIRS:

SNL (Sandia National Laboratories) 2007. *Total System Performance Assessment Data Input Package for Requirements Analysis for DOE SNF/HLW and Naval SNF Waste Package Physical Attributes Basis for Performance Assessment.* TDR-TDIP-ES-000009 REV 00. Las Vegas, Nevada: Sandia National Laboratories. ACC: DOC.20070921.0009. [DIRS 179567]

Impact Evaluation:

The ERD revision deletes the reference to a cancelled document and corrects the reference for dimensions of the Naval Long waste package. Since the dimensions are not changed by the ERD revision, no impact on technical products results from the ERD revision.

III. Conclusion:

The audit team and line organization reviewed the issues associated with CR 11944, CR 11945, and CR 12546 and determined them to be opportunities for improvement to add clarity and improve transparency, not conditions adverse to quality and therefore, to have no impact on the results or conclusions of the AMR or to the License Application. The changes contained in the ERD provide specified reference citations, clarification to descriptions, or provide editorial corrections to typographical errors. The changes in the ERD have no effects on the conclusions of, or technical product outputs from, the analysis. According to procedure MGR-PRO-004, Rev 00, the ERD revisions also have been evaluated for potential effects on the Safety Analysis Report (SAR). No potential impacts were identified for SAR Sections 2.3.11, and 2.4, which discuss the consequences of disruption of the repository by future igneous activity at the site (See Table ERD-1).

IV. Inputs and/or Software

No changes to input values or software used in the analysis resulted from the responses to CR 11944, CR 11945, and CR 12546.

Table ERD-1. MDL-MGR-GS-000005 ERD 1 IMPACT EVALUATION		
Document ID	Document Title	Data Used and Impact
ANL-DS0-NU-000001 Rev. 00	SCREENING ANALYSIS OF CRITICALITY FEATURES, EVENTS, AND PROCESSES FOR LICENSE APPLICATION	Indirect: Basis for description of extent of damage to drip shield and waste package following intrusion; magma velocities needed to move waste packages compared to expected velocities; volatile content of basalt; summary of dike ascent processes; WP temperatures following contact by magma; damage to cladding following contact by magma; drip shield and WP failure fractions; constituents of corrosive atmosphere associated with magma intrusion; description of conditions leading to plastic deformation of WP pallet and drift invert. Impact Evaluation: The ERD changes do not affect the results of the analyses or product outputs. Therefore the ERD has no impact on the screening analysis of Criticality FEPs, on TSPA, or on the SAR.
ANL-EBS-GS-000001 Rev. 02	GEOCHEMISTRY MODEL VALIDATION REPORT: MATERIAL DEGRADATION AND RELEASE MODEL	Indirect: Description of effect of intrusion on WP void space; description of thermal and pressure effects on WPs following intrusion; summary of damage to WP internals following intrusion. Impact Evaluation: The ERD changes do not affect the results of the analyses or product outputs. Therefore the ERD has no impact on ANL-EBS-GS-000001, on TSPA, or on the SAR.
ANL-EBS-MD-000003 Rev. 03	GENERAL CORROSION AND LOCALIZED CORROSION OF WASTE PACKAGE OUTER BARRIER	Indirect: description of location of analysis of WP damage following intrusion. Impact Evaluation: The ERD changes do not affect the results of the analyses or product outputs. Therefore the ERD has no impact on ANL-EBS-MD-000003, on TSPA, or on the SAR.

Table ERD-1. MDL-MGR-GS-000005 ERD 1 IMPACT EVALUATION		
Document ID	Document Title	Data Used and Impact
ANL-EBS-MD-000037 Rev. 04, Addendum 01	IN-PACKAGE CHEMISTRY ABSTRACTION	Indirect: Identifies CR related to use of basalt water in Dike/Drift Interactions. Impact Evaluation: The ERD changes do not affect the results of the analyses or product outputs. Therefore the ERD has no impact on ANL-EBS-MD-000037, on TSPA, or on the SAR.
ANL-EBS-NU-000009 Rev. 00	COMMERCIAL SPENT NUCLEAR FUEL IGNEOUS SCENARIO CRITICALITY EVALUATION	Direct: Weight percent of soluble UO2 that may be dissolved in basalt; description that magma transport of fissionable material outside WP is not expected. Indirect: Summary of in-drift environment following intrusion; description of WP damage following intrusion; description of cooling of magma as a process to increase volatile content of residual fluid; description of temperature conditions that must exist for seepage to occur into drifts. Impact Evaluation: The ERD changes do not affect the results of the analyses or product outputs. Therefore the ERD has no impact on ANL-EBS-NU-000009, on TSPA, or on the SAR.
ANL-MGR-GS-000003 Rev. 03	NUMBER OF WASTE PACKAGES HIT BY IGNEOUS EVENTS	Indirect: description of conditions associated with waste packages immersed in magma during conduit development; description of analysis showing that repository does not influence conduit formation; identification of analyses of dike propagation and DS/WP damage in MDL-MGR-GS-000005. Impact Evaluation: The ERD changes do not affect the results of the analyses or product outputs. Therefore the

Table ERD-1. MDL-MGR-GS-000005 ERD 1 IMPACT EVALUATION		
Document ID	Document Title	Data Used and Impact
		ERD has no impact on ANL-MGR-GS-000003, on TSPA, or on the SAR.
ANL-WIS-MD-000024 Rev. 01	POSTCLOSURE NUCLEAR SAFETY DESIGN BASES	Indirect: description that following cooling of basalt, water chemistry in the emplacement drifts could be altered by basalt-water Interactions, which provides part of the basis to include FEP 1.2.04.04.0B. Changes in water chemistry for the igneous intrusion modeling case are described in ANL-EBS-MD-000037 Rev. 04, Addendum 01 not MDL-MGR-GS-000005. No impact on ANL-WIS-MD-000024, TSPA, or on the SAR.
ANL-WIS-MD-000027 Rev. 00	FEATURES, EVENTS, AND PROCESSES FOR THE TOTAL SYSTEM PERFORMANCE ASSESSMENT: ANALYSES	FEP: 1.2.04.03.0A. Indirect: Description of damage to EBS components following intrusion; description of scope of analyses in MDL-MGR-GS-000005. FEP 1.2.04.04.0A. Indirect: Description of magma interactions with EBS, including WP damage processes; flow of magma through WPs is not expected; movement of WPs by magma is not expected; description of damage to CSNF and glass waste forms; description of thermal regime in drifts following magma cooling. FEP 1.2.04.04.0B. Indirect: Description of analysis of effects of magmatic volatiles on in-drift chemistry; description of time needed for temperatures to decrease to less than boiling point of water following intrusion. FEP 1.2.04.06.0A. Indirect: Conclusions related to various conceptual models for magma flow in drifts; main dike is preferred flow path.

Table ERD-1. MDL-MGR-GS-000005 ERD 1 IMPACT EVALUATION		
Document ID	Document Title	Data Used and Impact
		FEP: 1.2.10.02.0A. Direct: Simple conduction-only cooling model. Indirect. Description of magma cooling and extent of above-boiling temperatures. FEP: 2.1.11.09.0B. Direct: Description of in-drift environment and waste package failure following intrusion. FEP: 2.1.14.24.0A. Direct. Description of heating of waste package, the canister internals, and the SNF will heat up to near-magma temperatures in days to weeks; description of loss of waste protection function following return of seepage; description of corrosive atmosphere produced by magmatic gases. FEP: 2.1.14.25.0A. Direct. Description of the physical and chemical environment around the waste package and waste form materials in contact with active magma; description of damage resulting in loss of function in isolating waste packages and waste forms from groundwater when seepage returns. FEP: 2.1.14.26.0A. Direct. Description of EBS component temperatures following intrusion and duration of period of elevated temperatures. FEP: 2.2.14.12.0A. Indirect. Description of in-drift environment following intrusion. Impact Evaluation: The ERD changes do not affect the

Table ERD-1. MDL-MGR-GS-000005 ERD 1 IMPACT EVALUATION		
Document ID	Document Title	Data Used and Impact
		results of the analyses or product outputs. Therefore the ERD has no impact on ANL-WIS-MD-000027, on TSPA, or on the SAR.
ANL-WIS-PA-000001 Rev. 03	EBS RADIONUCLIDE TRANSPORT ABSTRACTION	Indirect. Description of locations of analyses that show disruption of the barrier capability by igneous events. Impact Evaluation: The ERD changes do not affect the results of the analyses or product outputs. Therefore the ERD has no impact on ANL-WIS-PA-000001, on TSPA, or on the SAR.
MDL-MGR-GS-000002 Rev. 03	ATMOSPHERIC DISPERSAL AND DEPOSITION OF TEPHRA FROM A POTENTIAL VOLCANIC ERUPTION AT YUCCA MOUNTAIN, NEVADA	Indirect. Description of extent of damage to WPs following intrusion; description of damage to WPs intersected by conduits. Impact Evaluation: The ERD changes do not affect the results of the analyses or product outputs. Therefore the ERD has no impact on MDL-MGR-GS-000002, on TSPA, or on the SAR.
MDL-MGR-GS-000006 Rev. 00	REDISTRIBUTION OF TEPHRA AND WASTE BY GEOMORPHIC PROCESSES FOLLOWING A POTENTIAL VOLCANIC ERUPTION AT YUCCA MOUNTAIN, NEVADA	Indirect: Description of location of analyses of damage to WPs following intrusion. Impact Evaluation: The ERD changes do not affect the results of the analyses or product outputs. Therefore the ERD has no impact on MDL-MGR-GS-000006, on TSPA, or on the SAR.
MDL-WIS-PA-000005 Rev. 00, MiscId 01	TOTAL SYSTEM PERFORMANCE ASSESSMENT MODEL/ANALYSIS FOR THE LICENSE APPLICATION - Volume I	Direct. Table 6.5-1. Waste Form Temperatures Inside Intrusive Body Indirect: description of basis for assumption about degradation of glass waste; description of igneous scenario class; description of analysis that produces post-
MDL-WIS-PA-000005 Rev. 00, MiscId 02	TOTAL SYSTEM PERFORMANCE ASSESSMENT MODEL/ANALYSIS FOR THE LICENSE APPLICATION - Volume II	

Table ERD-1. MDL-MGR-GS-000005 ERD 1 IMPACT EVALUATION		
Document ID	Document Title	Data Used and Impact
		intrusion, in-drift temperature abstraction; description of location of analyses of ACMs for dike propagation; description of analysis of effusive flow of magma into drifts and ACMs for magma flow; description of thermal hydrologic effects on drifts in zones 1 and 2; description of filling of drifts by magma following intrusion; description of assumptions about WP and DS damage from contact by magma, loss of WP and DS function following intrusion and post-cooling hydrologic conditions in basalt; potential for movement of WPs outside conduit circumference; ACMs for propagation of secondary dikes; description of duration of thermal-hydrologic perturbation following intrusion; description of the methods used to validate and build confidence in the two submodels: dike propagation during intrusion and basalt cooling and solidification. Impact Evaluation: The ERD changes do not affect the results of the analyses or product outputs. Therefore the ERD has no impact on TSPA or on the SAR.
TDR-WIS-PA-000014 Rev. 00	TSPA INFORMATION PACKAGE FOR THE DRAFT SEIS	Indirect: Description of conclusion that ACMs for dike propagation are not appropriate for analysis of dike propagation near underground repository; description of conclusion that ACMs for effusive or pyroclastic flow from a dike into a drift are not suitable for not practical for implementation within the TSPA model; description of conclusion that including latent heat effects has negligible effect on temperature histories for intruded drifts; description of damage to DSs, WPs, and cladding following intrusion; description of results of survey of analog data about water chemistry resulting from basalt-

Table ERD-1. MDL-MGR-GS-000005 ERD 1 IMPACT EVALUATION		
Document ID	Document Title	Data Used and Impact
		water interactions; description of drift temperature history following intrusion; description that filling of the drifts with magma does not consider the presence of the EBS components, rubble, etc; assumptions that cooled basalt provides no impediment to water flow and thermal properties of the basalt-filled drift are assumed to be the same as the surrounding host rock; potential for WPs located outside the conduit diameter to be mobilized by magma and moved toward the conduit. Impact Evaluation: The ERD changes do not affect the results of the analyses or product outputs. Therefore the ERD has no impact on TSPA, the SAR, or on the SEIS.
ANL-EBS-PA-000011 Rev. 00	POSTCLOSURE DESIGN INPUT PARAMETERS FOR ENGINEERED BARRIER SYSTEM IN-DRIFT CONFIGURATION	The only control parameter used by this technical product was 05-03, Waste Package Thermal Limits. Parameter 05-03 did not change. No impact.
ANL-EBS-PA-000012 Rev. 00	POSTCLOSURE DESIGN INPUT PARAMETERS FOR SUBSURFACE FACILITIES	Drift input coordinates: For the purposes of the interface between BSC and SNL, subsurface endpoint coordinates and elevations and have been established as nominal values with a ± tolerance of 10 meters; ± tolerance of 20 meters for available emplacement drift lengths. Minor changes in endpoint and elevation values do not impact this technical product (ANL-EBS-PA-000012).
LASAR-2.03.11	LA SAFETY ANALYSIS REPORT SECTION 2.3.11	Indirect: General description of dike propagation modeling; description of abstraction supporting TSPA assumption that all WPs fail following intrusion; characteristics of intrusion modeling case; Paricutin as appropriate analog; typical magma far-field velocity and viscosity; description of temperature of emplacement drifts as a function of time following intrusion; description

Table ERD-1. MDL-MGR-GS-000005 ERD 1 IMPACT EVALUATION		
Document ID	Document Title	Data Used and Impact
		of conditions for fault-capture of dikes; host rock is treated as a homogeneous, isotropic medium; time for magma to fill drift; description of time for centerline temperatures in intruded drifts to return to pre-intrusion temperatures; description of pH and ionic strength of basalt-equilibrated waters from analog studies; description of models and analyses that provide the basis for the igneous intrusion modeling case; description of prerepository compressive stress conditions; description of dike propagation model; description of analysis of magma-drift-volcano system if the volcanic vent were blocked; effect of magma flow in drift(s) on dike propagation; effects of magma on waste packages and waste forms; secondary dike propagation; description of heat flow and magma cooling; effects of natural and induced stresses at the repository. Impact Evaluation: The ERD changes do not affect the results of the analyses or product outputs. Therefore the ERD has no impact on TSPA or on the SAR.
LASAR-2.04	LA SAFETY ANALYSIS REPORT SECTION 2.4	Indirect: Time to fill intersected drift with magma; description of assumption about WPs and DSs contacted by magma; time for intruded drifts to cool to ambient temperature. Impact Evaluation: The ERD changes do not affect the results of the analyses or product outputs. Therefore the ERD has no impact on TSPA or on the SAR.