Stand Alone DR 39 Package for ANL-EBS-MD-000027 REV 01
"DRIFT DEGRADATION ANALYSIS"

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The following four items were identified in the course of the review and evaluation of the analysis and modeling report (AMR), ANL-EBS-MD-000027 REV 01, *Drift Degradation Analysis*, in response to Deficiency Report LVMO-00-D-039 (DR 39). All of the items either correct minor errors or provide clarifications. The response to each is included with the error item to clarify the AMR text.

Item 1. The text on page 19 states that Mathcad 7 Professional was used. On page II-2 it states that Mathcad Version 8 was used.

Item 1 Response – The subject AMR contains a typographical error on p. 19, indicating Mathcad 7 was used. The text should state Mathcad 8.

Item 2. Table II-6 on page II-6 states that Mathcad 8 was used to calculate the K factor for joint orientations, and this same statement is made at the bottom of page III-2 where table III-3 is referenced. Table III-3 on page III-9 states that the K factor was calculated in Excel worksheet Orient-Tptpll.xls, though the table title includes in parentheses "(New-Tptpll V1.mcd)" which appears to be a Mathcad file but is not explained.

Item 2 Response – Attachment III provides a sample calculation of joint parameters, including documentation for both Excel and Mathcad calculations. Table III-3 documents a Mathcad calculation, and includes a parenthetical statement that certain components were calculated using the Excel file, Orient-Tptpll.xls. This Excel file name should be Orient-Tptpll V1.xls, which is documented in Table III-2.

Item 3. Table II-6 indicates that Excel was used extensively in the report and that MathCad was used to a lesser degree. On page 19 it indicates that additional information on Excel and Mathcad files is provided in section 6.3.2 and 6.3.3, and attachments II and III. However, sections 6.3.2 and 6.3.3 do not identify any software, nor do they discuss how any calculations were done.

Item 3 Response – Sections 6.3.2 and 6.3.3 of the subject AMR refer to Attachment II, which provides software identification. Attachment III discusses how joint parameter calculations were done. The text on p. 19 of the subject AMR should also refer to Attachments I, XI, and XIII. Attachment I discusses joint cohesion reduction calculations; Attachment XI documents the volume of failed rock calculation; and Attachment XIII documents the calculation of mean rock property values. Additional discussion of calculations is provided below in the response to Item 4.

Item 4. The electronic files in attachment II provide all the specific information necessary to address DR-39 issues (traceability narrative, formulas used for each calculation, cell contents, which built in functions were used, etc). However, the printed text of the AMR does not provide enough information on the use of commercial software.

Item 4 Response – Table II-6 in Attachment II should be modified as presented below to identify the location within the AMR that provides discussion of the calculations that were done using commercial software. Additional printed text is provided for some calculations as appropriate in the discussion below. This additional text is formatted as additional attachments to supplement the *Drift Degradation Analysis*, beginning with Attachment XV. The text on p. 19 of the subject AMR should be further revised to refer to these calculations.

Table II-6. List of the Calculation Files

File Name	Software	Brief Description	Location of Details[1]
Cohesion Degradation V1 .xls	EXCEL 97	Cohesion degradation due to time and thermal effect	Attachment I
Exca vectors V1.xls	EXCEL 97	Calculation of the plane equations to describe the 5.5-m-diameter excavation opening	Attachment XV
Exca vectors-backfill V1.xls	EXCEL 97	Calculation of the plane equations to describe the 5.5-m-diameter excavation opening with backfill	Attachment XV
New_Beta_Tptpll V1.xls	EXCEL 97	Beta Distribution Parameters (a, b, p, q) for joint spacing, trace length, and location for Tptpll	Attachment III
New_Beta_Tptpln V2.xls	EXCEL 97	Beta Distribution Parameters (a, b, p, q) for joint spacing, trace length, and location for Tptpln	Attachment III
New_Beta_Tptpmn V1.xls	EXCEL 97	Beta Distribution Parameters (a, b, p, q) for joint spacing, trace length, and location for Tptpmn	Attachment III
New_Beta_Tptpul V1.xls	EXCEL 97	Beta Distribution Parameters (a, b, p, q) for joint spacing, trace length, and location for Tptpul	Attachment III
New-K-Tptpll V1.mcd	MathCAD 8	Calculation of K factor of joint orientation for Tptpll	Attachment III
New-K-Tptpln V2.mcd	MathCAD 8	Calculation of K factor of joint orientation for Tptpln	Attachment III
New-K-Tptpmn V1.mcd	MathCAD 8	Calculation of K factor of joint orientation for Tptpmn	Attachment III
New-K-Tptpul V1.mcd	MathCAD 8	Calculation of K factor of joint orientation for Tptpul	Attachment III
Orient-Tptpll V1.xls	EXCEL 97	Calculation of the components for the Orientation Matrix for Tptpll	Attachment III
Orient-Tptpln V2.xls	EXCEL 97	Calculation of the components for the Orientation Matrix for Tptpln	Attachment III
Orient-Tptpmn V1.xls	EXCEL 97	Calculation of the components for the Orientation Matrix for Tptpmn	Attachment III
Orient-Tptpul V1.xls	EXCEL 97	Calculation of the components for the Orientation Matrix for Tptpul	Attachment III
Res sum V2.xls	EXCEL 97	Summary of maximum key block size results	Attachment XVI
Thermal curve V1.xls	EXCEL 97	Ratio of effective shear stress for thermal effect	Attachment I
Time thermal cohesion degradation V1.mcd	MathCAD 8	Cohesion degradation due to time and thermal effect	Attachment I

Table II-6. List of the Calculation Files (Continued)

File Name	Software	Brief Description	Location of Details[1]
Total vol tm 75 v2.xls	EXCEL 97	Total key block volume calculation, time-dependent and thermal, 75° Azimuth, Without Backfill	Attachment XVII
Total vol seis 75 v2.xls	EXCEL 97	Total key block volume calculation, seismic, 75° Azimuth, Without Backfill	Attachment XVII
Total vol tm 105 backfill v2.xls	EXCEL 97	Total key block volume calculation, time-dependent and thermal, 105° Azimuth, With Backfill	Attachment XVII
Total vol tm 105 v2.xls	EXCEL 97	Total key block volume calculation, time-dependent and thermal, 105° Azimuth, Without Backfill	Attachment XVII
Total vol seis 105 v2.xls	EXCEL 97	Total key block volume calculation, seismic, 105° Azimuth, Without Backfill	Attachment XVII
Tpllaa res V1.xls	EXCEL 97	Processed key block size distribution output file, Tptpll, Static	Attachment XVIII
Tpllse res V1.xls	EXCEL 97	Processed key block size distribution output file, Tptpll, Seismic	Attachment XVIII
Tplltm res V1.xls	EXCEL 97	Processed key block size distribution output file, Tptpll, Time-dependent and thermal	Attachment XVIII
Tplnaa res V2.xls	EXCEL 97	Processed key block size distribution output file, Tptpln, Static	Attachment XVIII
Tpln seismic 105 res V2.xls	EXCEL 97	Processed key block size distribution output file, Tptpln, Seismic	Attachment XVIII
Tpln tm 105 res V2.xls	EXCEL 97	Processed key block size distribution output file, Tptpln, Time-dependent and thermal	Attachment XVIII
Tpmnaa res V1.xls	EXCEL 97	Processed key block size distribution output file, Tptpmn, Static	Attachment XVIII
Tpmnse res V1.xls	EXCEL 97	Processed key block size distribution output file, Tptpmn, Seismic	Attachment XVIII
Tpmntm res V1.xls	EXCEL 97	Processed key block size distribution output file, Tptpmn, Time-dependent and thermal	Attachment XVIII
Tpulaa res V1.xls	EXCEL 97	Processed key block size distribution output file, Tptpul, Static	Attachment XVIII
Tpulse res V1.xls	EXCEL 97	Processed key block size distribution output file, Tptpul, Seismic	Attachment XVIII
Tpultm res V1.xls	EXCEL 97	Processed key block size distribution output file, Tptpul, Time-dependent and thermal	Attachment XVIII
tpul tm 75 res v1.xls	EXCEL 97	Rock blocks accumulated percentage of occurrence, Tptpul, 75 degree azimuth, time-dependent and thermal, no backfill	Attachment XVIII
tpmn tm 75 res v1.xls	EXCEL 97	Rock blocks accumulated percentage of occurrence, Tptpmn, 75 degree azimuth, time-dependent and thermal, no backfill	Attachment XVIII
tpll tm 75 res v1.xls	EXCEL 97	Rock blocks accumulated percentage of occurrence, Tptpll, 75 degree azimuth, time-dependent and thermal, no backfill	Attachment XVIII

Table II-6. List of the Calculation Files (Continued)

File Name	Software	Brief Description	Location of Details[1]
tpln tm 75 res v2.xls	EXCEL 97	Rock blocks accumulated percentage of occurrence, Tptpln, 75 degree azimuth, time-dependent and thermal, no backfill	Attachment XVIII
tpul tm 105 res v1.xls	EXCEL 97	Rock blocks accumulated percentage of occurrence, Tptpul, 105 degree azimuth, time-dependent and thermal, no backfill	Attachment XVIII
tpmn tm 105 res v1.xls	EXCEL 97	Rock blocks accumulated percentage of occurrence, Tptpmn, 105 degree azimuth, time-dependent and thermal, no backfill	Attachment XVIII
tpll tm 105 res v1.xls	EXCEL 97	Rock blocks accumulated percentage of occurrence, Tptpll, 105 degree azimuth, time-dependent and thermal, no backfill	Attachment XVIII
tpln tm bf 105 res v2.xls	EXCEL 97	Rock blocks accumulated percentage of occurrence, Tptpln, 105 degree azimuth, time-dependent and thermal, no backfill	Attachment XVIII
tpul seismic 75 res v1.xls	EXCEL 97	Rock blocks accumulated percentage of occurrence, Tptpul, 75 degree azimuth, seismic, no backfill	Attachment XVIII
tpmn seismic 75 res v1.xls	EXCEL 97	Rock blocks accumulated percentage of occurrence, Tptpmn, 75 degree azimuth, seismic, no backfill	Attachment XVIII
tpll seismic 75 res v1.xls	EXCEL 97	Rock blocks accumulated percentage of occurrence, Tptpll, 75 degree azimuth, seismic, no backfill	Attachment XVIII
tpln seismic 75 res v2.xls	EXCEL 97	Rock blocks accumulated percentage of occurrence, Tptpln, 75 degree azimuth, seismic, no backfill	Attachment XVIII
z-length cal v1.xls	EXCEL 97	Basis for z-length calculation formula	Attachment XVII
pmn-rock volume per mcs v2.xls	EXCEL 97	Calculation of block volume, 75 degree azimuth, Tptpmn	Attachment XI
pll-rock volume per mcs v2.xls	EXCEL 97	Calculation of block volume, 75 degree azimuth, Tptpll	Attachment XI
pln-rock volume per mcs v2.xls	EXCEL 97	Calculation of block volume, 75 degree azimuth, Tptpln	Attachment XI
Summary of rock volume per mcs V1.xls	EXCEL 97	Summary of block volume results	Attachment XI
Joint strength.xls	EXCEL 97	Calculation of mean joint cohesion and friction angle	Attachment XIII

[1]Attachments XV through XVIII are supplemental text to the subject AMR and are included with this stand alone DR 39 package. All other attachments are provided in the subject AMR (*Drift Degradation Analysis*, ANL-EBS-MD-000027 REV 01).

ATTACHMENT XV

CALCULATION OF THE PLANE EQUATIONS TO DESCRIBE THE EXCAVATION OPENING AS INPUT TO DRKBA

CALCULATION OF THE PLANE EQUATIONS TO DESCRIBE THE EXCAVATION OPENING AS INPUT TO DRKBA

The method employed by the DRKBA code to represent excavation openings involves specification of sets of infinite planes that approximate the opening geometry. The infinite planes are defined using unit normal vectors and the shortest distance from the origin. For a circular opening without backfill (*Exca vectors V1.xls*), a total of 20 planes were used to represent an 80-ft long cylinder as shown in Figure XV-1. As for the backfill case (*Exca vectors-backfill V1.xls*), the opening geometry of the drift with backfill was simplified and approximated with 17 planes as shown in Figure XV-2.

A total of 12 spreadsheets are contained in both *Exca vectors V1.xls* and *Exca vectors-backfill V1.xls*. The twelve spreadsheets cover the range of tunnel axis directions. Inputs for the calculation include the azimuth of tunnel axis (Cell D1 for both *Exca vectors V1.xls* and *Exca vectors-backfill V1.xls*) and angle measured from horizontal axis for each plane (Cells P5 to P22 for Exca vectors V1.xls, Cells P6 to P19 for *Exca vectors-backfill V1.xls*).

The equations for the rotation of unit vectors and axes presented in Fisher et al. (1987, p. 32) were used to calculate the unit normal vector for each plane. The rotation matrix A is shown below:

$$A(\theta,\phi)=\begin{pmatrix} a11 & a12 & a13 \\ a21 & a22 & a23 \\ a31 & a32 & a33 \end{pmatrix}=\begin{pmatrix} \cos\theta\cos\phi & \cos\theta\sin\phi & -\sin\theta \\ -\sin\phi & \cos\phi & 0 \\ \sin\theta\cos\phi & \sin\theta\sin\phi & \cos\theta \end{pmatrix} \qquad \text{Eq.XV-1}$$

where (θ, ϕ) is the polar coordinates of a unit vector measured relative to a pole in the direction (0,0). The rotation of the tunnel axis sets ϕ equal to the azimuth and θ as 0. Cells contained in Columns F to N are the elements of the rotation matrix. Calculation of the unit vector of the infinite plane on the local coordinate (coordinate axes shown in Figure XV-1) is based on the following equation:

$$u_i=\begin{pmatrix} x \\ y \\ z \end{pmatrix}=\begin{pmatrix} \sin\alpha_i \\ 0 \\ \cos\alpha_i \end{pmatrix} \qquad \text{Eq. XV-2}$$

The x, y, and z components of the unit vector are calculated in Columns Q to S. Finally, the rotated unit normal vector on the global coordinate (East as x' axis and North as y' axis) are computed using the equation

$$\begin{pmatrix} x' \\ y' \\ z' \end{pmatrix}=A(\theta,\phi)\begin{pmatrix} x \\ y \\ z \end{pmatrix} \qquad \text{Eq. XV-3}$$

The x', y', and z' components are calculated in Columns U to W. The last two rows in Columns U to W are for the end plane (shown in Figures XV-1 and XV-2). The end plane normal vector is in the horizontal direction with x' equal to sinϕ and y' equal to cosϕ. For the backfill case, an additional bottom plane is also required (Figure XV-2). The unit normal vector for bottom plane is parallel to the z axis and pointed downward.

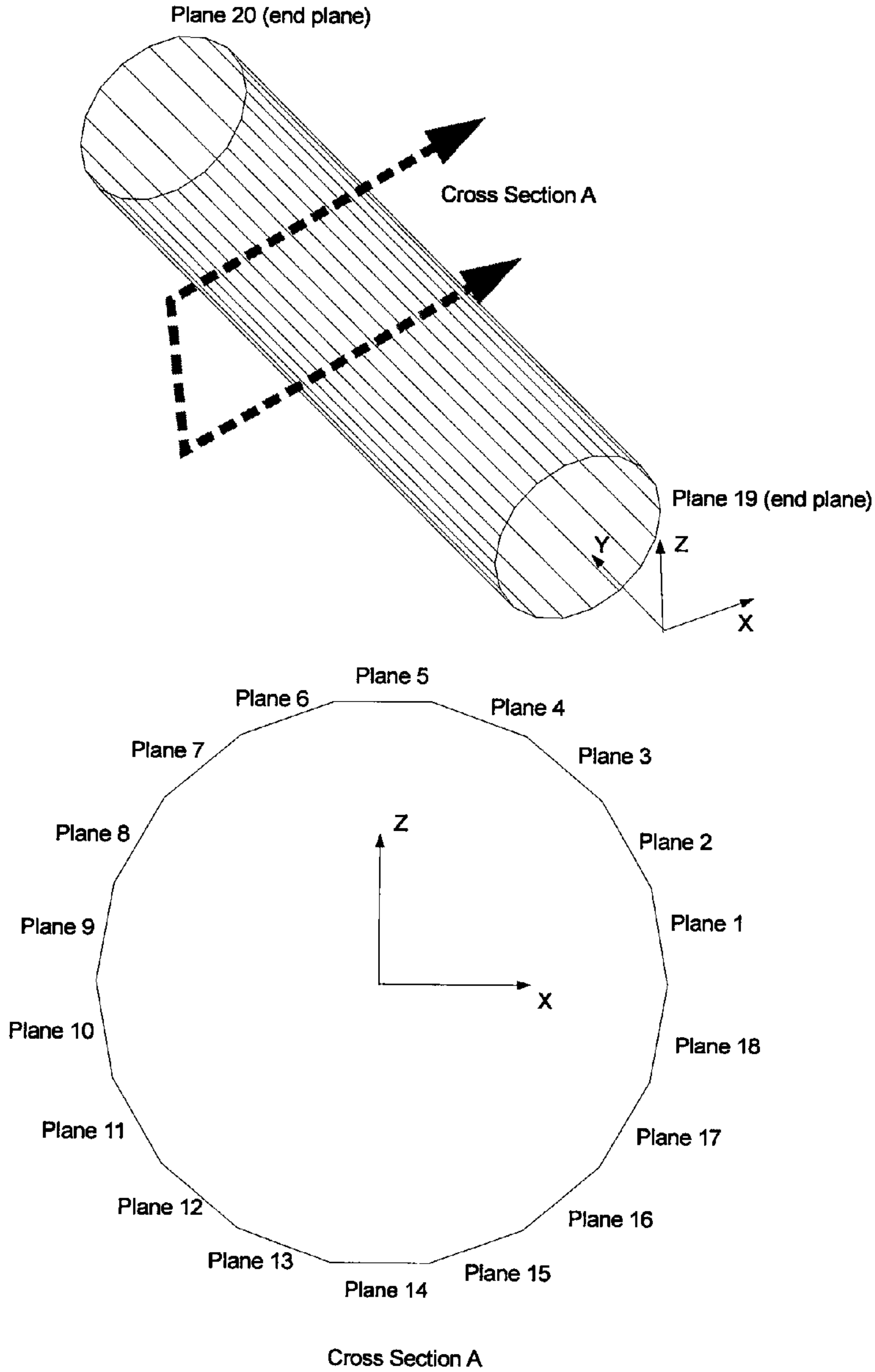

Figure XV-1. Opening Representation – No Backfill Case

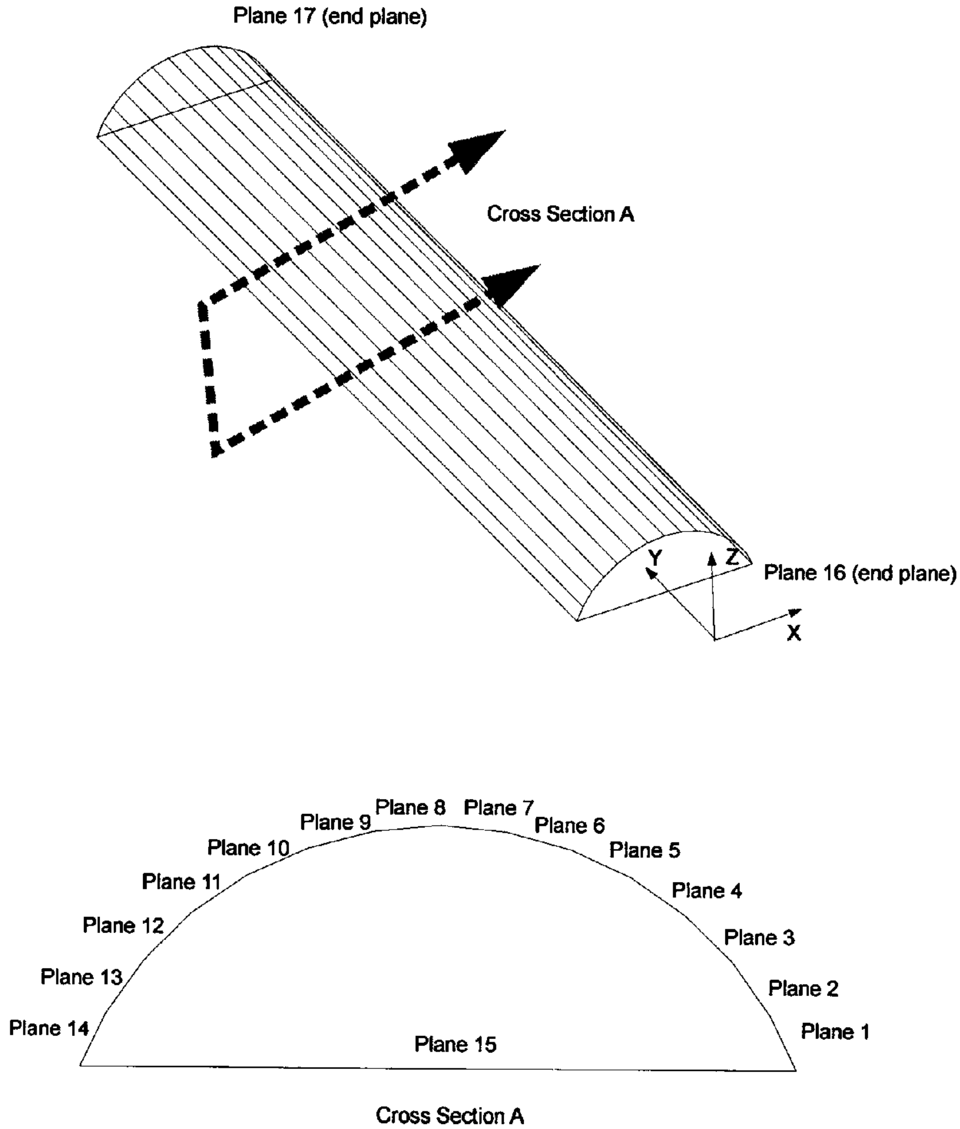

Figure XV-2. Opening Representation – Backfill Case

ATTACHMENT XVI

SUMMARY OF MAXIMUM KEY BLOCK SIZES AND CALCULATION OF THE NUMBER OF KEY BLOCKS PER UNIT LENGTH (KM)

SUMMARY OF MAXIMUM KEY BLOCK SIZES AND CALCULATION OF THE NUMBER OF KEY BLOCKS PER UNIT LENGTH (KM)

Summary of maximum key block sizes and calculation of the number of key blocks per km are contained in the spreadsheet file *res sum v2.xls*. The maximum key blocks predicted for the four lithostratigraphic units for the static condition are listed in Cells B5 to Cells N8. The information was retrieved from four spreadsheet files: *Tpulaa res V1.xls, Tpmnaa res V1.xls, Tpllaa res V1.xls,* and *Tplnaa res V2.xls* (Attachment XVIII). The combined information is used to present the maximum key blocks with respect to drift orientation for all units as provided in Figure 17.

The predicted total number of key blocks from the Monte Carlo simulation were calculated in the spreadsheet files contained in Attachment XVIII. They are compiled in the spreadsheet*res sum v2.xls* as the input to calculate the number of key blocks per km. Table XVI-1 provides the cell locations and the source files for the input of the total number of key blocks.

Table XVI-1. Information on the Predicted Total Number of Key Blocks

Condition	Cell Locations	Source Files
Static Condition	B38 – M44	*Tpulaa res V1.xls, Tpmnaa res V1.xls, Tpllaa res V1.xls,* and *Tplnaa res V2.xls*
Seismic Condition, 105° azimuth	B63 – E66	*Tpulse res V1.xls, Tpmnse res V1.xls, Tpllse res V1.xls,* and *Tpln seismic 105 res V2.xls*
Time-dependent and Thermal Condition, 105° azimuth, with backfill	B82 – E85	*Tpultm res V1.xls, Tpmntm res V1.xls, Tplltm res V1.xls,* and *Tpln tm 105 bf res V2.xls*
Time-dependent and Thermal Condition, 105° azimuth, no backfill	B100 – E103	*Tpul tm 105 res V1.xls, Tpmn tm 105 res V1.xls, Tpll tm 105 res V1.xls,* and *Tpln tm 105 res V2.xls*
Seismic Condition, 75° azimuth	B117 – E120	*Tpul seismic 75 res V1.xls, Tpmn seismic 75 res V1.xls, Tpll seismic 75 res V1.xls,* and *Tpln seismic 75 res V2.xls*
Time-dependent and Thermal Condition, 75° azimuth, no backfill	B135 – E138	*Tpul tm 75 res V1.xls, Tpmn tm 75 res V1.xls, Tpll tm 75 res V1.xls,* and *Tpln tm 75 res V2.xls*

The total length of tunnel simulated was calculated and converted to km in Cells B46 to D49 based on the 80-ft simulation length. The predicted key blocks per unit length were then obtained by dividing the total number of key blocks to the total simulated length. Table XV-2 provides the Cell locations for the predicted key blocks per unit length.

Table XVI-2. Cell Locations for the Predicted Number of Key Blocks per km

Condition	Cell Locations
Static Condition	B54 – M57
Seismic Condition, 105° azimuth	B72 – E75
Time-dependent and Thermal Condition, 105° azimuth, with backfill	B91 – E94
Time-dependent and Thermal Condition, 105° azimuth, no backfill	B109 – E112
Seismic Condition, 75° azimuth	B126 – E129
Time-dependent and Thermal Condition, 75° azimuth, no backfill	B144 – E147

ATTACHMENT XVII

CALCULATIONS OF THE VOLUME OF ROCK FALL PER UNIT LENGTH AND THE PERCENTAGE OF DRIFT AFFECTED BY ROCK FALL

CALCULATIONS OF THE VOLUME OF ROCK FALL PER UNIT LENGTH AND THE PERCENTAGE OF DRIFT AFFECTED BY ROCK FALL

Calculations of the volume of rock fall per unit length and the percentage of drift affected by rock fall are included in six spreadsheet files. A summary of these six files is provided in Table XVII-1.

Table XVII-1. Summary of Spreadsheet Files for the Calculations

Spreadsheet Files	Description
z-length cal v1.xls	Basis for the z-length calculation formula
Total vol tm 75 v2.xls	Time-dependent and thermal, 75° azimuth, no backfill
Total vol seis 75 v2.xls	Seismic, 75° azimuth, no backfill
Total vol tm 105 backfill v2.xls	Time-dependent and Thermal Condition, 105° azimuth, with backfill
Total vol tm 105 v2.xls	Time-dependent and thermal, 105° azimuth, no backfill
Total vol seis 105 v2.xls	Seismic, 105° azimuth, no backfill

The z-length (the maximum extent of block along tunnel axis) of the predicted block is not directly available in DRKBA. To calculate the drift length affected by rock fall, an approach was developed in *z-length cal v1.xls*. This approach uses the linear fit of the rock fall volume verses z-length data obtained from the UNWEDGE analyses (Attachment IX, Table IX-2). Cells B6 to D15 in *z-length cal v1.xls* are the data from Table IX-2. Cells E6 to F15 contain the calculation for the initial attempt (approaches 1 and 2) of using the tetrahedron volume formula to back calculate the z-length. The back-calculated results do not agree with the UNWEDGE analyses results, therefore, a linear fit of the UNWEDGE results using the Excel formula *slope* and *intercept* was adopted. The following relationship of block volume and z-length was developed from the linear fit:

z-length (m) = 1.74894 + 1.814654 * rock volume (m^3) Eq. XVII-1

This formula is used in the other five spreadsheet files to calculate the affected drift length by rock fall.

The spreadsheet files *Total vol tm 75 v2.xls, Total vol seis 75 v2.xls, Total vol tm 105 backfill v2.xls, Total vol tm 105 v2.xls,* and *Total vol seis 105 v2.xls* contain similar format and formula, with each file including five worksheets: *"Summary", "Tptpul", "Tptpmn", "Tptpll",* and *"Tptpln"*. Key block information from the DRKBA output files **.kbo* (Attachment II, Table 2-1) are the inputs for the worksheets *"Tptpul", "Tptpmn", "Tptpll",* and *"Tptpln"*. Data presentation is identical for these four worksheets. For the time-dependent and thermal condition cases, Columns B to H are for Static results, Columns K to Q are for Year 200 results, Columns T to Z are for Year 2000 results, and Columns AC to AI are for Year 10,000 results. For the seismic cases, Columns B to H are also for Static results, Columns K to Q are for Seismic level 1 results, Columns T to Z are for Seismic level 2 results, and Columns AC to AI are for Seismic level 3 results. Estimated length (z-length, ft) in Columns I, R, AA, and AJ are obtained using Equation XVII-1 and the volume data (ft^3) listed in Columns H, Q, Z, and AI. Notice that the inputs from DRKBA are in English units. Unit conversion is made in the calculation. By summing up the volume and the z-length, the total volume and total cover length in each unit are calculated in Cells C4 to F5 and Cells J4 to M4 respectively.

The total volume and total cover length calculated in each unit are grouped in the *"Summary"* worksheet. Cells B13 to F34 are the total volume data and Cells O13 to S34 are the total cover length data. The total simulated length data is required to calculate the volume and cover length per unit length. The total simulated length for each unit is calculated in Cells C39 to E42 based on 80-ft simulation length per Monte Carlo simulation. The predicted key block volume per unit length was then obtained by dividing the total volume of key blocks by the total simulated length (Cells B5 to F9). This same procedure was applied to attain the rock fall cover length per unit length (Cells O5 to S9).

ATTACHMENT XVIII

CALCULATIONS OF KEY BLOCK SIZE DISTRIBUTION

CALCULATIONS OF KEY BLOCK SIZE DISTRIBUTION

The key block output files **.bsd* (Attachment II, Table II-1) from DRKBA contain the information on key block size distribution in a histogram format which provides the number of blocks in each bin the user specified in the DRKBA input files. Spreadsheet files were generated to provide the key block distribution in cumulative frequency of occurrence format presented in Section 6.4. These spreadsheet files are listed in Table XVIII-1 in three groups with a total of 24 files. The first group is for the static cases in which twelve drift orientations with the drift azimuth varied in 15° increments are included. The second group is for the seismic cases, with each spreadsheet file including static, seismic level 1, seismic level 2, and seismic level 3 results. The third group is for the time-dependent and thermal consideration including static, year 200, year 2000, and year10,000 in each spreadsheet file.

Table XVIII-1. Summary of Spreadsheet Files for Key Block Size Distribution

Group	Spreadsheet Files	Description
Group 1, Static	*Tpulaa res V1.xls*	Rock blocks accumulated percentage of occurrence, Tptpul, Static
	Tpmnaa res V1.xls	Rock blocks accumulated percentage of occurrence, Tptpmn, Static
	Tpllaa res V1.xls	Rock blocks accumulated percentage of occurrence, Tptpll, Static
	Tplnaa res V2.xls	Rock blocks accumulated percentage of occurrence, Tptpln, Static
Group 2, Seismic	*Tpulse res V1.xls*	Rock blocks accumulated percentage of occurrence, Tptpul, 105 degree azimuth, seismic, no backfill
	Tpmnse res V1.xls	Rock blocks accumulated percentage of occurrence, Tptpmn, 105 degree azimuth, seismic, no backfill
	Tpllse res V1.xls	Rock blocks accumulated percentage of occurrence, Tptpll, 105 degree azimuth, seismic, no backfill
	Tpln seismic 105 res V2.xls	Rock blocks accumulated percentage of occurrence, Tptpln, 105 degree azimuth, seismic, no backfill
	tpul seismic 75 res v1.xls	Rock blocks accumulated percentage of occurrence, Tptpul, 75 degree azimuth, seismic, no backfill
	tpmn seismic 75 res v1.xls	Rock blocks accumulated percentage of occurrence, Tptpmn, 75 degree azimuth, seismic, no backfill
	tpll seismic 75 res v1.xls	Rock blocks accumulated percentage of occurrence, Tptpll, 75 degree azimuth, seismic, no backfill
	tpln seismic 75 res v2.xls	Rock blocks accumulated percentage of occurrence, Tptpln, 75 degree azimuth, seismic, no backfill
Group 3, Time-dependent and thermal	*Tpultm res V1.xls*	Rock blocks accumulated percentage of occurrence, Tptpul, 105 degree azimuth, time-dependent and thermal, with backfill
	Tpmntm res V1.xls	Rock blocks accumulated percentage of occurrence, Tptpmn, 105 degree azimuth, time-dependent and thermal, with backfill
	Tplltm res V1.xls	Rock blocks accumulated percentage of occurrence, Tptplll, 105 degree azimuth, time-dependent and thermal, with backfill

Table XVIII-1. Summary of Spreadsheet Files for Key Block Size Distribution (Continued)

Group	Spreadsheet Files	Description
Group 3, Time-dependent and thermal	*tpln tm bf 105 res v2.xls*	Rock blocks accumulated percentage of occurrence, Tptpln, 105 degree azimuth, time-dependent and thermal, with backfill
	tpul tm 105 res v1.xls	Rock blocks accumulated percentage of occurrence, Tptpul, 105 degree azimuth, time-dependent and thermal, no backfill
	tpmn tm 105 res v1.xls	Rock blocks accumulated percentage of occurrence, Tptpmn, 105 degree azimuth, time-dependent and thermal, no backfill
	tpll tm 105 res v1.xls	Rock blocks accumulated percentage of occurrence, Tptpll, 105 degree azimuth, time-dependent and thermal, no backfill
	Tpln tm 105 res V2.xls	Rock blocks accumulated percentage of occurrence, Tptpln, 105 degree azimuth, time-dependent and thermal, no backfill
	tpul tm 75 res v1.xls	Rock blocks accumulated percentage of occurrence, Tptpul, 75 degree azimuth, time-dependent and thermal, no backfill
	tpmn tm 75 res v1.xls	Rock blocks accumulated percentage of occurrence, Tptpmn, 75 degree azimuth, time-dependent and thermal, no backfill
	tpll tm 75 res v1.xls	Rock blocks accumulated percentage of occurrence, Tptpll, 75 degree azimuth, time-dependent and thermal, no backfill
	tpln tm 75 res v2.xls	Rock blocks accumulated percentage of occurrence, Tptpln, 75 degree azimuth, time-dependent and thermal, no backfill

There are three calculation worksheets contained in each of the 24 spreadsheet files. The worksheets are entitled "*results*", "*cum*", and "*percentile*". The first worksheet "*results*" includes the imported block size data from DRKBA output files and the calculated percentage results within each block size bin. The second worksheet "*cum*" calculates the cumulative percentage corresponding to the various block sizes. The third worksheet "*percentile*" provides the results for the 50 percentile, 75 percentile, 90 percentile, 95 percentile, 98 percentile, and maximum size blocks.

Column A of the "*results*" worksheet lists the bin value for the block volume in cubic meter. These values are the converted values from the English unit outputs of DRKBA. The number of blocks predicted in DRKBA for each block volume bin is listed in the columns of the "*results*" worksheet identified in Table XVIII-2. The values are imported from the **.bsd* output files of the DRKBA analysis. The total number of blocks was calculated in Row 6 using the Excel *sum* function for each case. The percentage columns adjacent to the input block number columns listed in Table XVII-2 were then calculated using the individual block number in each bin and the total number of blocks. The values in the percentage columns represent the probabilistic density of rock fall within each block size bin.

Table XVIII-2. Summary of Spreadsheet Files for Key Block Size Distribution

Group	Column*											
	B	D	F	H	J	L	N	P	R	T	V	X
Group 1, Static	Az. 0°	Az. 15°	Az. 30°	Az. 45°	Az. 60°	Az. 75°	Az. 90°	Az. 105°	Az. 120°	Az. 135°	Az. 150°	Az. 165°
Group 2, Seismic	Static	Level 1	Level 2	Level 3	NU	NU	NU	NU	NU	NU	NU	NU
Group 3, Time-dependent and thermal	Static	Year 200	Year 2000	Year 10000	NU	NU	NU	NU	NU	NU	NU	NU

* Az. = azimuth; NU = not used.

Worksheet "*cum*" was constructed from worksheet "*results*" by changing the columns identified in Table XVIII-2 from number of blocks to cumulative number of blocks. The iterative formula to calculate the cumulative number of block is given below:

$$CNB_i = CNB_{i-1} + NB_I \qquad \text{Eq. XVIII-1}$$

where CNB_i = the cumulative number of block at block size bin i,
CNB_{i-1} = the cumulative number of block at block size bin i-1, and
NB_i = the number of block at block size bin i.

The cumulative percentage was then obtained from the cumulative number of blocks and the total number of blocks. Same as in worksheet "*results*", the total number of blocks is recorded in Row 6.

In order to locate the 50 percentile, 75 percentile, 90 percentile, 95 percentile, 98 percentile, and maximum size blocks efficiently, the Excel *vlookup* function was used in worksheet "*percentile*". Cells C8 to Z2509 for Group 1 file (static) and Cells C8 to I2509 for Group 2 and 3 (seismic and time-dependent) were set up as the *table_array* for the *vlookup* function. The cumulative percentage values in these cells are the replicate of cells in the worksheet "*cum*". The block sizes are expressed in cubic feet in the *table_array*. The blocks for the cumulative frequency of occurrence at 50%, 75%, 90%, 95%, 98% and the maximum blocks (in cubic feet) are calculated in Cells C2518 to N2523 for Group 1 files and Cells C2518 to F2528 for Groups 2 and 3 files. The block sizes were converted to cubic meter in Cells C2527 to N2532 for Group 1 files and Cells C2527 to F2532 for Groups 2 and 3 files.