BSC

Design Calculation or Analysis Cover Sheet

Complete only applicable items.

1. QA: N/A

3. System	4. Document Identifier
Generic	800-S0C-SS00-00200-000-00A

5. Title

Design Response Spectrum for Conventional Subsurface Facilities Utilizing Updated Soil Data

6. Group

Engineering, CSA

7. Document Status Designation

☐ Preliminary ☒ Committed ☐ Confirmed ☐ Cancelled/Superseded

8. Notes/Comments

This calculation uses the design response spectra issued in 2007 and, therefore, supersedes Calculation 800-S0C-SS00-00100-000-000

Attachments	Total Number of Pages
None	

RECORD OF REVISIONS

9. No.	10. Reason For Revision	11. Total # of Pgs.	12. Last Pg. #	13. Originator (Print/Sign/Date)	14. Checker (Print/Sign/Date)	15. EGS (Print/Sign/Date)	16. Approved/Accepted (Print/Sign/Date)
00A	Initial Issue	10	10	Surendra K. Goel [signature] 11/29/07	Sushil Kothari [signature] 11/29/2007	Thomas Frankert [signature] 11/29/07	R. Rajagopal [signature] 11/29/07

DISCLAIMER

1. PURPOSE

The purpose of this calculation is to develop a design response spectrum for conventional subsurface facilities classified as Non-ITS (Non-Important to Safety) utilizing site-specific data obtained from North Portal, Yucca Mountain Project (YMP), described in the Project Design Criteria (PDC) Document (Reference 2.2.1) Section 6.1.10.1.2. Site-specific seismicity has been determined for the North Portal, YMP at annual exceedance frequency (AEF) of 10^{-3} (Reference 2.2.2), $5x10^{-4}$ (Reference 2.2.3), and 10^{-4} (Reference 2.2.4). In this calculation, the site-specific horizontal design response spectrum at 5% damping is developed and is presented in Figure 3.

2. REFERENCES

2.1 PROCEDURES/DIRECTIVES

2.1.1 EG-PRO-3DP-G04B-00037, Rev. 10. *Calculations and Analyses.* Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20071018.001.

2.1.2 IT-PRO-0011, Rev. 007. *Software Management.* Las Vegas, Nevada: Bechtel SAIC Company. ACC: DOC.20070905.0007.

2.2 DESIGN INPUTS

2.2.1 BSC (Bechtel SAIC Company) 2007. *Project Design Criteria Document.* 000-3DR-MGR0-00100-000-007, for Updated Soil Data. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20071016.0005.

2.2.2 MO0707DSRB1E3A.000. *5%-damped Seismic Design Spectra for the Repository Block at 1E-3 APE.* Submittal date: 07/23/2007. (DIRS 183128) (TBV-9136)

2.2.3 MO0707DSRB5E4A.000. *5%-damped Seismic Design Spectra for the Repository Block at 5E-4 APE.* Submittal date: 07/24/2007. (DIRS 183130) (TBV-9137)

2.2.4 MO0707DSRB1E4A.000. *5%-damped Seismic Design Spectra for the Repository Block at 1E-4 APE.* Submittal date: 07/24/2007. (DIRS 183129) (TBV-9138)

2.2.5 ICC (International Code Council) 2003. *International Building Code 2000, with Errata to the 2000 International Building Code.* Falls Church, Virginia: International Code Council. TIC: 251054, 257198, ISBN 1-892395-25-8

2.2.6 BSC (Bechtel SAIC Company) 2007. *Basis of Design for the TAD Canister-Based Repository Design Concept*. 000-3DR-MGR0-00300-000-001. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20071002.0042.

2.3 DESIGN CONSTRAINTS

None

2.4 DESIGN OUTPUTS

2.4.1 000-3DR-MGR0-00200-000-001 Seismic analysis and Design Approach Document

This calculation will be used as input for other calculations.

3. ASSUMPTIONS

3.1 ASSUMPTIONS REQUIRING VERIFICATION

None

3.2 ASSUMPTIONS NOT REQUIRING VERIFICATION

None

4. METHODOLOGY

4.1 QUALITY ASSURANCE

This calculation was prepared in accordance with EG-PRO-3DP-G04B-00037, *Calculations and Analyses* (Ref. 2.1.1).

The development of this document is for the design of conventional subsurface facilities that are classified as not Important To Safety (ITS) or not Important To Waste Isolation (ITWI) as shown in the *Basis of Design for the TAD Canister-Based Repository Design Concept* (Ref. 2.2.6), Section 8.1.2. However, portions of the facility are classified as ITWI. None of the structural items belong to the ITWI classification. Therefore, the approved version of this calculation is designated as QA: N/A.

4.2 USE OF SOFTWARE

The commercial off-the-shelf software Microsoft Word 2003, as well as Microsoft Office Excel 2003 spreadsheet code, which are components of Microsoft Office 2003 Professional, were used to prepare this calculation. This software tool is classified as Level 2 software usage as defined in IT-PRO-0011, *Software Management* (Reference 2.1.2) Section 4.1. The calculation process and equations are documented in section 6 of this document for checking by manual calculation. Microsoft Office 2003 Professional is listed on the current Software Controlled Software Report and is identified with Software Tracking Numbers 610236-2003-00

4.3 DESCRIPTION OF CALCULATION APPROACH

The following equations and referenced sections are from the IBC 2000 (Reference 2.2.5).

Five-percent damped design spectral response acceleration at short period (0.2 sec.) S_{DS}, and at 1 second period, S_{D1}, shall be determined from Equations 16-18 and 16-19, (note: In this calculation all accelerations are horizontal unless noted otherwise.)

$$S_{DS} = \frac{2}{3} S_{MS} \qquad \text{(Equation 16-18)}$$

$$S_{D1} = \frac{2}{3} S_{M1} \qquad \text{(Equation 16-19)}$$

Where:

S_{MS} = the maximum considered earthquake spectral response accelerations for short period from site-specific seismic data.

S_{M1} = the maximum considered earthquake spectral response accelerations for 1 second period from site-specific data.

S_{DS} = the design spectral response acceleration at short periods (0.2 Sec.) as determined in Section 1615.1.3

S_{D1} = the design spectral response acceleration at 1 second period as determined in Section 1615.1.3

The general design response spectrum curve shall be developed as indicated in Figure 1615.1.4 of the IBC (Ref.2.2.5) and as follows:

1. For periods less than or equal to T_0, the design spectral response acceleration, S_a, shall be given by Equation 16-20.

2. For periods greater than or equal to T_0 and less than or equal to the T_S, the design spectral response acceleration, S_a, shall be taken equal to S_{DS}.

3. For periods greater than T_S, the design spectral response acceleration, S_a, shall be given by Equation 16-21.

$$S_a = 0.6 \frac{S_{DS}}{T_0} T + 0.4 S_{DS} \qquad \text{(Equation 16-20)}$$

$$S_a = \frac{S_{D1}}{T} \qquad \text{(Equation 16-21)}$$

Where

T = Fundamental period (in seconds) of the structure (Sections 1615.1.4 and 1617.4.2)

$$T_0 = 0.2 \frac{S_{D1}}{S_{DS}}$$

$$T_S = \frac{S_{D1}}{S_{DS}}$$

5. LIST OF ATTACHMENTS

None

6. BODY OF CALCULATION

6.1 INPUTS

According to the Project Design Criteria (Reference 2.2.1), Section 6.1.10.1.2, Site-specific seismicity values for the YMP subsurface location (Point B) are as follows:

For 10^{-3} AEF: (Reference 2.2.2) (1000 Year Return Period at 5% Damping)
S_{AS} = 0.254g at T = 0.2 sec.
S_{A1} = 0.14g at T = 1 sec.

For 5 x 10^{-4} AEF: (Reference 2.2.3) (2000 Year Return Period at 5% Damping)
S_{AS} = 0.363g at T = 0.2 sec.
S_{A1} = 0.197g at T = 1 sec.

For 10^{-4} AEF: (Reference 2.2.4) (10000 Year Return Period at 5% Damping)
S_{AS} = 0.758g at T = 0.2 sec.
S_{A1} = 0.402g at T = 1 sec.

Where

S_{AS} = Short period (0.2 seconds) spectral acceleration
S_{A1} = One-second period spectral acceleration

The plots of AEF versus the S_{AS} and S_{A1} are shown in Figures 1 and 2.

6.2 PROCEDURE

Site-specific seismicity has been developed for the North Portal, YMP corresponding to 10^{-3} AEF (Reference 2.2.2), 5x10^{-4} AEF (Reference 2.2.3), and 10^{-4} AEF (Reference 2.2.4). Design Response Spectra are determined in accordance with the site-specific procedure of Section 1615.2 of the International Building Code (IBC 2000) (Reference 2.2.5). It is required or permitted by Section 1615.2.1 that the maximum considered earthquake ground motion shall be taken as that motion represented by an acceleration response spectrum having a 2-percent probability of exceedance within a 50-year period (2,500 Year Return Period). Since site-specific accelerations are available for 1,000; 2,000; and 10,000-year return periods, a graphical approximation for the 2,500-year return period will be made.

6.3 CALCULATIONS

Site Specific Data	T	S_A (5% Damped)
AEF = 10^{-3} (Reference 2.2.2) (1,000 Year Return Period)	0.2 sec.	0.254 g
	1 sec.	0.14 g

AEF = 5 x 10^{-4} (Reference 2.2.3) (2,000 Year Return Period)	0.2 sec.	0.363 g
	1 sec.	0.197 g
AEF = 10^{-4} (Reference 2.2.4) (10,000 Year Return Period)	0.2 sec.	0.758 g
	1 sec.	0.402 g

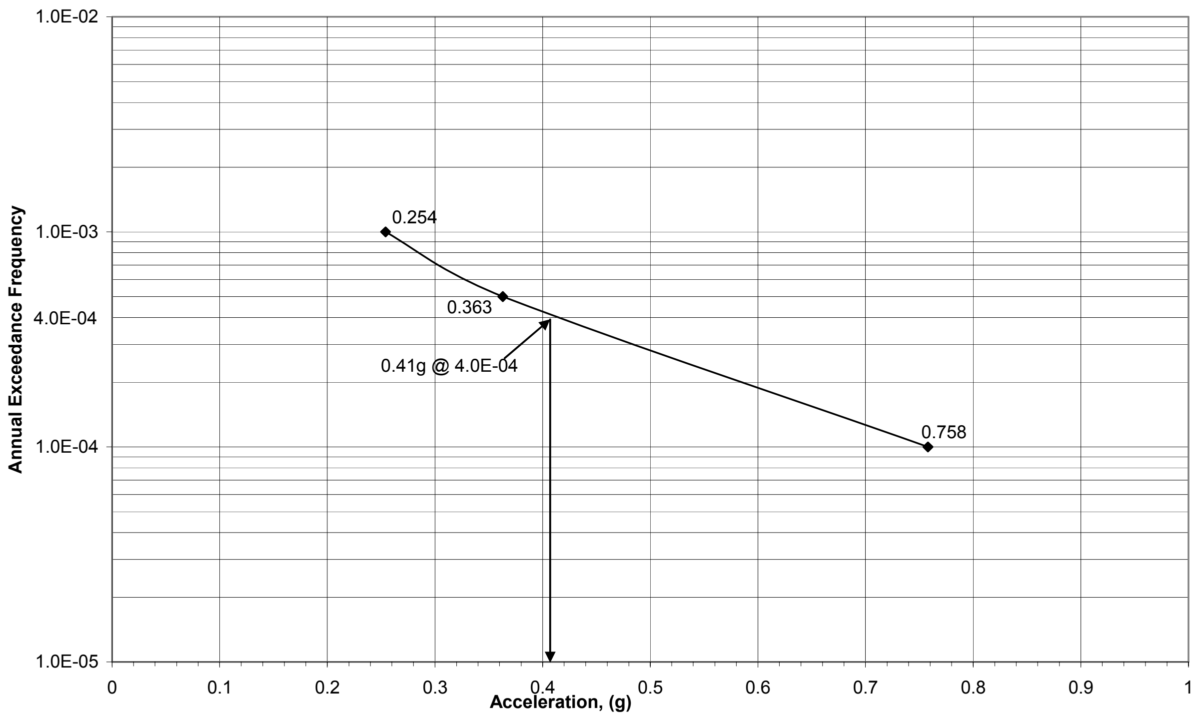

Fig. 1 Plot of AEF vs. S_{As} Accelerations

(Reference 2.2.2, 2.2.3, and 2.2.4)

Unknown 2,500 Year S_{MS} interpolated from the graph in Fig. 1 is,

2,500 Year S_{MS} = 0.41 g

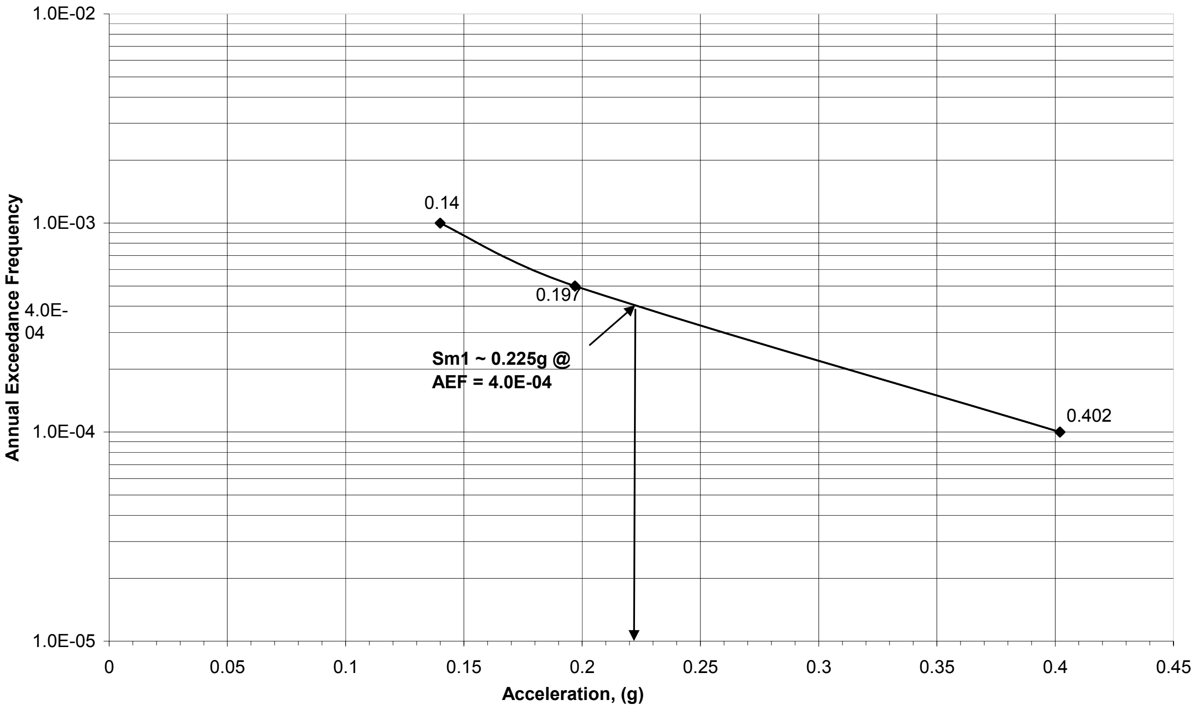

Fig. 2. Plot of AEF vs. S_{A1} Accelerations

(Reference 2.2.2, 2.2.3, and 2.2.4)

Unknown 2,500 Year S_{M1} interpolated from the graph in Fig. 2 is,

2,500 Year S_{M1} = 0.0.225, say 0.23 g

∴ For AEF = 4 x 10^{-4} (2,500 Year Return Period):

T	S_A
0.2 sec.	0.41 g
1 sec.	0.23 g

<u>Design Spectral Response Acceleration Parameters</u>:

$$S_{DS} = \frac{2}{3} S_{MS} = \left(\frac{2}{3}\right)(0.41) = 0.27g$$ (IBC, Ref. 2.2.5, Section 1615.1.3, Eq. 16-18)

$$S_{D1} = \frac{2}{3} S_{M1} = \left(\frac{2}{3}\right)(0.23) = 0.15g$$ (IBC, Ref. 2.2.5, Section 1615.1.3, Eq. 16-19)

$$T_O = 0.2\frac{S_{D1}}{S_{DS}}$$ (IBC, Ref. 2.2.5, Section 1615.1.4)

$$= (0.2)\frac{0.15}{0.27} = 0.11\sec.$$

$$T_S = \frac{S_{D1}}{S_{DS}} = \frac{0.15}{0.27} = 0.56\sec.$$ (IBC, Ref. 2.2.5, Section 1615.1.4)

Using $S_a = 0.6\frac{S_{DS}}{T_0}T + 0.4S_{DS}$ (IBC, Ref. 2.2.5, Section 1615.1.4, Eq. 16-20)

1. For Periods (T) ≤ T_0, the Design Spectral Response Acceleration (S_a), shall be given by Equation 16-20.

   For T=0 sec., S_a=0.11g and for T=0.11 sec., S_a=0.27g

Above step provides conservative results compared to step 3, Section 6.1.3.2.1 of PDC (Ref. 2.2.1)

2. For Periods (T) $\geq T_O \leq T_S$, the Design Spectral Response Acceleration, S_a, shall be taken equal to S_{DS}. Therefore,

   For periods T_o = 0.11sec. to T_s = 0.56 sec., S_a = 0.27g.

3. For Periods (T) > T_S, the Design Spectral Response Acceleration, S_a, shall be given by the Equation.

   $$S_a = \frac{S_{D1}}{T}$$ (IBC, Ref. 2.2.5, Section 1615.1.3, Eq. 16-21)

   T= 0.75 sec., $S_a = \frac{0.15}{0.75} = 0.20$g   T= 2 sec., S_a = 0.075g

   T= 1 sec., $S_a = \frac{0.15}{1} = 0.15$g   T= 5 sec., S_a = 0.03g

   These values are plotted on Figure 3 “Horizontal Design Response Spectrum for Non-ITS Subsurface Facilities at 5% Damping.” The results have been verified by visual inspection.

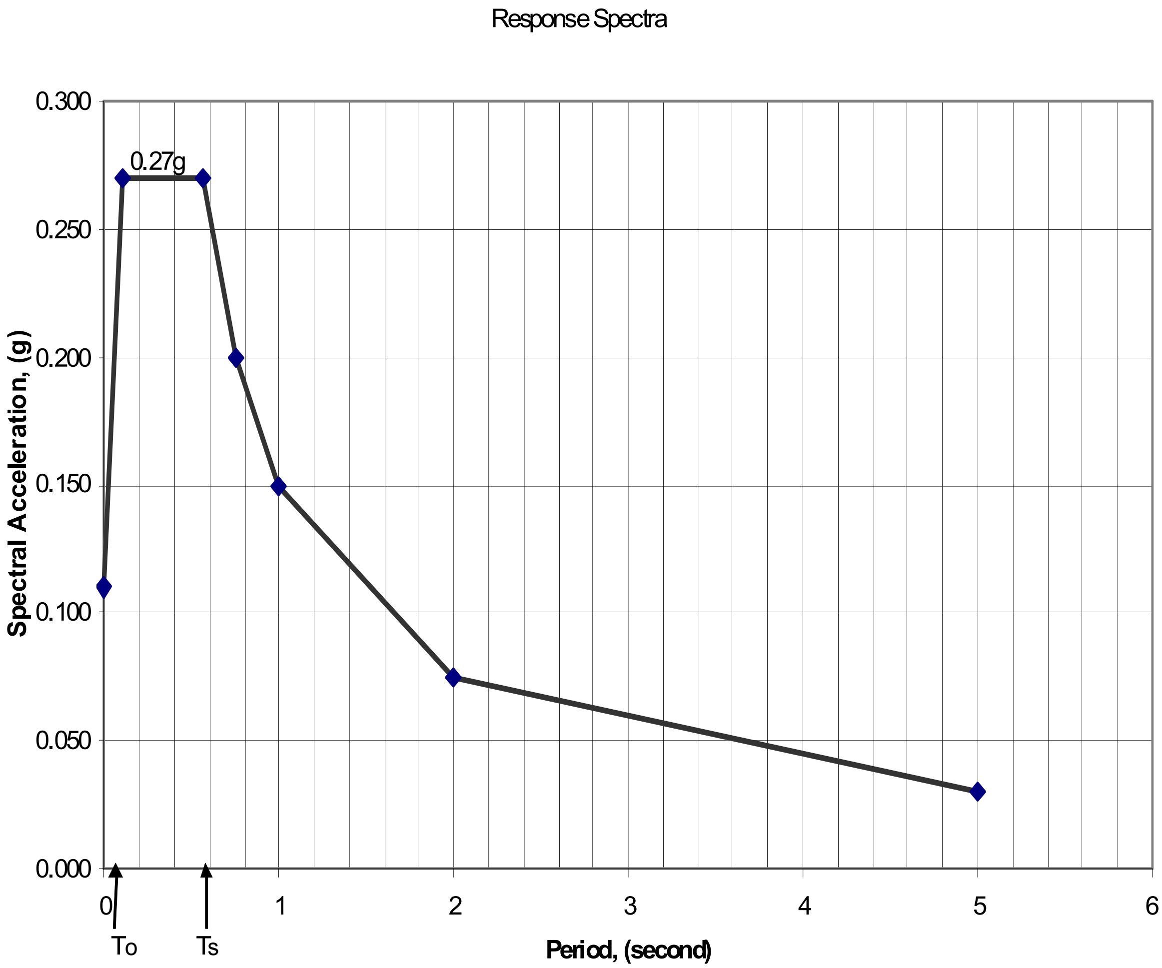

Figure 3. Horizontal Design Response Spectrum for Non-ITS Subsurface Facilities at 5% Damping (Plot of Spectral Accelerations vs. Periods)

7. RESULTS AND CONCLUSIONS

A design response spectrum was constructed using the updated site-specific soils data obtained from North Portal, YMP to be used for the design of conventional subsurface facilities. The design response spectrum is provided as Fig. 3 in this calculation.