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Consulting Group, Inc.

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"NRC Technical Assistance
for Design Reviews"
Contract No. NRC-02-85-002
FIN D1016

Dear David:

Enclosed is Itasca Document Review 006-0157(a), "Chapter 2 NNWSI CDSCP". This review was prepared under NRC Contract NRC-02-85-002, Task Order No. 006, Task 1.

Please call me if you have any questions.

Sincerely,

Roger D. Hart
Program Manager

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ITASCA DOCUMENT REVIEW

File No.: 006-01-57(a)

Document Title: Chapter 2 NNWSI CDSCP

Reviewer: Itasca Consulting Group, Inc.
(L. Lorig)

Approved: M Board

Date Approved: April 19, 1988

Significance to NRC Waste Management Program

The Department of Energy issued the NNWSI Consultation Draft Site Characterization Plan (CDSCP) in early January 1988 for review and comment by the NRC. DOE plans to conduct consultations with the NRC to discuss comments on the CDSCP. (NRC will transmit comments to DOE in the form of point papers.) Following considerations of the comments received and consultative workshop discussions, DOE will prepare and issue the statutory SCP required by the Nuclear Waste Policy Act (NWPA) and 10CFR60.

Chapter 2 of the NNWSI CDSCP "summarizes the available information on the geoengineering properties that contribute to the demonstration that performance objectives and design criteria will be met" (p. 2-1). An earlier draft ("pink" draft) of this chapter was reviewed previously (1 October 1986, File No. 001-02-24). The document summary, comments and recommendations presented in the earlier review remain valid and are not repeated here. In addition, review of Chapter 8 of the CDSCP resulted in some comments which referenced, directly or indirectly, areas of concern in Chapter 2. These comments are also not repeated here. Consequently, only new technical comments, reflecting more recent information and concerns are presented here. The format presented on p. 25 of "Administrative Plan and Procedures for NRC Staff Review of DOE's CDSCPs," 18 December 1987, has been used for all comments.

Chapter 2 Geoengineering

Comment

Property values presented in Chapter 2 of the CDSCP do not agree with property values used in the Site Characterization Plan Conceptual Design Report (MacDougall et al., 1987).

Basis

- Differences in elevation and thickness of thermomechanical units are evident between Fig. 2-5 (CDSCP) and Fig. 2-6 (SCP-CDR). Both figures are taken from the same source (Ortiz et al., 1985).
- The SCP-CDR uses discontinuity values of $\tan\phi = 0.8$ and cohesion = 1.0 MPa, whereas Figs. 2-11 and 2-12 of the CDSCP give $\tan\phi = 0.59$ to 0.64 and cohesion = 0 to 0.18 MPa.
- For rock mass properties, the SCP-CDR uses $\tan\phi = 0.8$ and cohesion = 0.8 MPa, whereas the CDSCP gives $\tan\phi = 0.54$ and cohesion = 0.2 MPa.
- The "recommended" values for thermal conductivity, coefficient of thermal expansion and volumetric heat capacity given in Table 2-4 (p. 2-79) do not agree with values used in the SCP-CDR. Furthermore, the thermal expansion coefficients given in Table 2-13 (p. 2-76) for non-zeolitized, densely welded, devitrified Topopah Spring Member tuff do not agree with recommended values for TSw2 in Table 2-14 (p. 2-79).

Recommendation

The SCP should discuss reasons for using property values which are outside the range of available information.

References

MacDougall, Hugh R., Leo W. Scully and Joe R. Tillerson (compilers). Site Characterization Plan Conceptual Design Report. Sandia National Laboratories, SAND84-2641, September 1987.

Ortiz, T. S., R. L. Williams, F. B. Nimick, B. C. Whittet and D. L. South. A Three-Dimensional Model of Reference Thermal/Mechanical and Hydrological Stratigraphy at Yucca Mountain, Southern Nevada. Sandia National Laboratories, SAND84-1076, October 1985.

Chapter 2 Geoengineering

Comment

It is not clear why the Reference Information Base (Zeuch and Eatough, 1986) is not discussed in this chapter. It is also not clear how the resultant geologic model or reference base will be updated.

Basis

- The current data base is discussed on pp. 2-16 and 2-18 without specifically mentioning the Reference Information Base.
- The third paragraph on p. 2-16 presents a vague commitment to update and maintain an information base. This updating process should be well defined and allow for (demand) regular model review. The ease and correctness of these necessary model updates will be dictated by the design and documentation behind this initial model. If thought is not given to this issue, the initial model will either be an unsupportable burden on the entire project or it may be discarded.

Recommendation

The SCP should discuss uses of the Reference Information Base and procedures for updating various models and analyses.

Reference

Zeuch, D. H. and M. J. Eatough. "Draft Reference Information Base for the Nevada Nuclear Waste Storage Investigations Project," Sandia National Laboratories, April 1986.

Chapter 2 Geoengineering

Comment

It is unclear why analyses of rock temperatures are discussed as needed to evaluate the potential for thermally-induced water movement, and not discussed as needed to evaluate the potential for thermally-induced air movement also.

Basis

- Item 7 (p. 2-3) states that analyses of rock temperature are needed to evaluate the potential for thermally-induced water movement.
- The last sentence on p. 2-4 states that heat transfer also could occur by the convection of water in the pores and fractures.
- Thermally-induced air movement is important in several areas of concern, including air-borne radionuclide transport, ventilation, and thermal analysis (see, for example, St. John, 1987, p. 19).

Recommendation

The SCP should discuss the need for thermal analyses in evaluating both thermally-induced air movement and thermally-induced water movement.

Reference

St. John, C. M. Reference Thermal and Thermal/Mechanical Analyses of Drifts for Vertical and Horizontal Emplacement of Nuclear Waste in a Repository in Tuff. Sandia National Laboratories, SAND86-7005, May 1987.

Chapter 2 Geoengineering

Comment

The CDSCP attempts to justify the use of equivalent near-elastic continuum analysis methods (pp. 2-18 to 2-20), partially on the basis that large stress changes are required to produce inelastic and non-linear behavior on joints. This justification is not fully warranted.

Basis

- The extent to which non-linear behavior is expressed depends on numerous factors, including the constitutive relation and the amount of stress change, and, also on the existing in-situ stress state. For example, the compliant joint model discussed on p. 2-20 uses a normal stress-displacement relation which is hyperbolic and non-linear behavior results for all stress changes. Discontinuities which are near limiting equilibrium under in-situ stresses require only small stress changes to produce slip.
- The phrase "large stress changes" (p. 2-18) is not defined.
- It is not obvious that only small stress changes are predicted in the vicinity of underground openings (pp. 2-18 and 2-19). See, for example, St. John (1987).

Recommendation

The SCP should evaluate the extent to which stress change magnitudes should be used in justifying the use of linear elastic material models.

Reference

St. John, C. M. Reference Thermal and Thermal/Mechanical Analyses of Drifts for Vertical and Horizontal Emplacement of Nuclear Waste in a Repository in Tuff. Sandia National Laboratories, SAND86-7005, May 1987.

Section 2.1 Mechanical Properties of Rock Units — Intact Rock

Comment

It is not clear where comparative compression testing on samples of various L/D ratios is discussed.

Basis

The statement in the third paragraph of this section (p. 2-22) indicates that "comparative tests on samples with a ratio of 2.5:1 or greater will be undertaken as discussed in 8.3.1.5.2." However, the referenced section does not discuss this issue. Presumably, Section 8.3.1.15.1.3 might discuss this issue, but no discussion of this specific topic is evident.

Recommendation

The SCP should provide clear reference indicating where comparative testing of samples with various L/D ratios is discussed. The SCP should also discuss how the results of such testing will be used in formulating constitutive models for use in design analysis and performance assessment.

Section 2.1.2.3.12 Effects of Confining and Fluid Pressure on Compressive Strength

Comment

- The Coulomb criteria is widely used in describing the results of triaxial tests. However, it does have several limitations, and the definition given on p. 2-32 is not commonly used.

Basis

- Coulomb's criterion is not a particularly satisfactory peak strength criteria for the following reasons (Brady and Brown, 1985):

  (a) It implies that a major shear fracture exists at peak strength. Test observations show that this is not always the case;

  (b) It implies a direction of shear failure which does not always agree with experimental observations; and

  (c) Experimental peak strength envelopes are generally non-linear. They can be considered linear only over limited ranges of σ_n (resultant normal stress on failure surface) or σ_3 (minor principal stress).

  For these reasons, other peak strengths are preferred for intact rock.

- The Coulomb definition on p. 2-32 implies that stresses are evaluated at the onset of inelastic deformation. However, maximum stresses are normally used.

Recommendation

The SCP should discuss the uses and limitations of the Coulomb strength criterion and/or it should discuss how the onset of inelastic deformation is determined.

Reference

Brady, B.H.G., and E. T. Brown. Rock Mechanics for Underground Mining. London: George Allen and Unwin, 1985.

Section 2.3.2 Mechanical Properties of Rocks At the Site

Comment

The initial unloading curve obtained from Fig. 2-19 indicates an elastic modulus for the rock mass of up to 40 GPA, which is higher than both the average intact rock elastic modulus (24.7 to 26.0 GPa) reported for laboratory testing and the field deformation modulus reported in Table 2-9 (p. 2-65).

Basis

Elastic rock mass properties can be evaluated using the initial unloading results from block tests (Brady et al., 1985).

Recommendation

The SCP should discuss the use of the initial unloading slope of block test results in evaluating the rock mass modulus for analysis and the apparent consistency of the data.

Reference

Brady, B.H.G., M. L. Cramer, and R. D. Hart. "Preliminary Analysis of a Loading Test on a Large Basalt Block," Int. J. Rock Mech., 22(5), 345-348 (1985).

Section 2.7.1 Rock Mass Degradation
2.7.1.1 Near-Field Decrepitation

Comment

The arguments leading to the conclusion that no additional tests to study thermal degradation are necessary (p. 2-92) are not convincing.

Basis

- The term "degradation", as used in this sense, is not defined.* Consequently, it is not entirely clear what is being discussed. Statements such as the last sentence in Section 2.7.1 ("No additional tests are planned specifically for obtaining data on thermal degradation, but the response of the Topopah Spring Member to elevated temperatures will be observed during exploratory shaft facility testing.") are confusing.

- Section 2.7.1 states that "The potential for, and the effects of, rock mass decrepitation and thermal dewatering are summarized in the following sections." However, there is only one subsection which follows (Section 2.7.1.1, Thermal Decrepitation).

- There is no discussion of results presented by Blacic et al. (1986). The authors reported decreases in Topopah Spring Member tensile and compressive strengths (p. 4) after exposure to "simulated repository conditions".

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*The glossary defines degradation in terms of erosional processes causing lowering of the land surfaces.

Recommendation

- The term "degradation" should be defined for use in this context.
- The SCP should discuss the report of Blacic et al. (1986) and indicate how information in the report applies or does not apply to rock mass degradation.

Reference

Blacic, J. D., D. T. Vaniman, D. L. Bish, C. J. Duffy and R. C. Gooley. Effects of Long-Term Exposure of Tuffs to High-Level Nuclear Waste Repository Conditions: Final Report. Los Alamos National Laboratory, Report LA-9330-MS, August 1986.