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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 006-01-57(b), "Chapter 6 NNWSI CDSCP, 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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To: David Tiktinsky
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ITASCA DOCUMENT REVIEW

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

Document Title: Chapter 6 NNWSI CDSCP

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

Approved: M Board, Itasca

Date Approved: April 25, 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 6 of the NNWSI CDSCP describes "the basis for facility design, the completed facility conceptual design, the completed analytical work relating to the resolution of design issues, . . . and future design-related work" (p. 6-1). The design shown in Chapter 6 represents the design as of about mid-1986. Therefore, there are some differences between the design shown in Chapter 6 of the CDSCP and the current design (e.g., location of exploratory shafts, diameter of ES-2, etc.). Previously, Chapters 2 and 8 of the CDSCP have been reviewed and commented upon. 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. The last two comments included here were generated during review of Chapter 6, but provide bases for new comments in Chapter 8 and are written with primary reference to Chapter 8.

Section 6.1.2.3 — Geotechnical Data

COMMENT

The values cited for TSw2 intact rock unconfined compressive strength in Table 6-12 (p. 6-49) and joint wall compressive strength (JCSo), Table 6-13 (p. 6-53) may yield discontinuity normal stiffnesses which are unrealistically high.

BASIS

- Both the intact rock unconfined compressive strength and the joint wall compressive strength are used in the empirical joint constitutive model (Barton and Choubey, 1977) which forms part of the compliant joint model.
- The design value for intact rock unconfined compressive strength and the recommended value for JCSo are both 171 MPa. Typically, JCSo is somewhat less than the unconfined compressive strength, to account for filling, alteration, weathering, etc.

RECOMMENDATION

The SCP should justify using identical values for both unconfined compressive strength and JCSo.

REFERENCE

Barton, N., and V. Choubey. "The Shear Strength of Rock Joints in Theory and Practice," Rock Mechanics, 10, 1-54 (1977).

Section 6.1.2.3.3 — Strength Properties

COMMENT

This section provides many references describing potential effects of time and temperature on intact rock. It is unclear why Blacic et al. (1986) is not referenced.

BASIS

Blacic et al. (1986) describes laboratory testing aimed at quantifying the effects of long-term exposure of tuffs to anticipated repository temperatures and stresses.

RECOMMENDATION

The SCP should discuss the results of the study by Blacic et al. (1986).

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.

Section 6.1.2.4.3 — Thermal Capacitance

QUESTION

Why does Table 6-16 (p. 6-63) list the variability of evaluation values for saturated thermal capacitance for units TSw2 and TSw3 as being less than the dry thermal capacitance for the same units?

BASIS

The thermal capacitance of water is greater than that of air (p. 6-65) and, therefore, the saturated thermal capacitance should be greater than the dry thermal capacitance. See, also, Section 7.4.2.2.

RECOMMENDATION

The SCP should justify any values of saturated thermal capacitance which are less than the dry thermal capacitance for the same tuff unit.

Section 6.1.2.5.2 — Groundwater

QUESTION

What is the nature of groundwater flow into G-Tunnel?

BASIS

On p. 6-68, the CDSCP states that "Groundwater flowed from fractures at G-Tunnel following drift excavation, but flow eventually ceased" (Thordarson, 1983). In Section 2.8.2.4 (p. 2-107), it states that "An unmeasured but presumed small quantity is removed by the ventilation system. Observed water flow is limited to seepage from saturated faults or fractured zones oriented more or less vertically. The quantities of water are estimated to be approximately 15 gal/d (Fernandez and Freshley, 1984) and are removed by routine pumping of a small sump area."

RECOMMENDATION

The SCP should provide consistent and accurate information about the amount of water inflow into G-Tunnel.

REFERENCES

Fernandez, Joseph A. and Mark D. Freshley. "Repository Sealing Concepts for the Nevada Nuclear Waste Storage Investigations Project," Sandia National Laboratories Report SAND 83-1778, August 1984.

Thordarson, W. Geologic Data and Test Results from Well J-13, Nevada Test Site, Nye County, Neada. Water Resources Investigations Report, U.S.G.S., 1983.

Section 6.2.3.1.2.1 — Vertical Emplacement

QUESTION

Figures 6-27 through 6-30 show the basic operations required for the vertical emplacement for a waste package, including details of the shielding closure. To what extent might radiation leak through fracture networks in the rock mass which intersect the unlined portion of the waste emplacement hole?

BASIS

The distance from the top of the unlined emplacement hole to the drift floor is relatively short (about 2.5 meters). It is possible that fracture networks are such that there is a continuous path between the floor and the unlined portion of the emplacement hole.

RECOMMENDATION

The SCP should discuss methods to evaluate the shielding capacity of the rock mass, appropriate reliance to be placed on the shielding capacity, and to what extent fractures might allow radiation to leak from unlined emplacement holes to drifts. (See, also, comment on Section 6.4.10.3).

Section 6.2.6 — Subsurface Design

COMMENT

The CDSCP does not clearly present the location or definition of "the primary area" (p. 6-143).

BASIS

- On p. 6-143, the CDSCP erroneously states that "the boundaries of the primary area are illustrated in Fig. 6-12.
- Figure 6-87 (p. 6-228) shows the primary area for the underground repository. However, Fig. 6-88 shows a "reduced primary area" (p. 6-227). The reduced area deletes the southern portion.

RECOMMENDATION

The SCP should define clearly the location and significance of the "primary area".

Section 6.2.6.3 — Ventilation

COMMENT

This section contains several inconsistencies.

BASIS

- Pages 6-171, -172 and -174 all contain references to temperature distribution on ventilation diagrams. However, none of the diagrams show temperature distributions.
- Figure 6-76 (p. 6-175) shows an impossible flow direction for development return.

RECOMMENDATION

The SCP should eliminate inconsistencies in ventilation diagrams.

Section 6.2.6.3 — Ventilation

COMMENT

This section describes separate ventilation networks for development and emplacement. On p. 6-167, it is stated that "To ensure that leakage would occur from the development air circuit to the emplacement air circuit, pressure differentials are established between the air circuits." However, there is no discussion concerning the minimum required pressure differential.

BASIS

The thermal gradient is opposite the airflow gradient; therefore, some pressure differential is required simply to overcome the thermal gradient.

RECOMMENDATION

The SCP should define and justify the minimum pressure differential which should exist at various parts of the repository.

Section 6.4.7 — Issue 2.7: Repository Design Criteria for Radiological Safety

QUESTION

Why are site data not required to design the underground facility so that the flooding does not spread through the facility during the period of operations?

BASICS

Table 6-33 (p. 2-269) indicates that no site data are required to prevent flooding from spreading through the facility. However, site data likely are required to define flood magnitudes, sump volumes, etc.

RECOMMENDATION

The SCP should state that site data are required for this purpose, or explain why such data are not required.

Section 6.4.8.2.2 — Retrieval Conditions

COMMENT

The following statement (pp. 6-279 and -280) is not convincing:

> "As shown in Appendix J of the SCP-CDR, the goal to limit the temperature to 50°C at 50 years in the access drifts for vertical emplacement, and in the emplacement drifts for horizontal emplacement is met."

BASIS

Appendix J of the SCP-CDR references Appendix A, "Expected Temperatures for Borehole Walls and Drifts After Spent Fuel Emplacement". The expected temperature at 50 years in an unventilated vertical access drift can be found from Table 7 (p. A-10) as:

in-situ temperature	26 °C
temperature increase (rock conduction)	18.3°C
temperature increase (bulkhead)	4.5°C
Total	48.8°C

However, the calculations were based on a standoff distance of 112 feet (p. A-9). The standoff distances shown in pp. 4-115 and -116 of the CDR are less. The standoff distance for comingled waste is given as 85 feet, and for spent fuel is 92.5 feet. [The RIB value is even less, 77.5 feet (Mansure and Steinbaugh, 1985)].

RECOMMENDATIONS

The SCP should reference more recent calculations or discuss possible differences between referenced calculations and current design concepts.

REFERENCE

Mansure, A. J. and R. E. Stinebaugh. "Memorandum of Record of Instructions for Thermal Design, Analysis, and Performance Assessment of Layout, Version I," SNL Memo to R. Hill, April 18, 1985.

Section 6.4.8.2.2 — Retrieval Conditions

QUESTION

Why doesn't the 50°C limit at 50 years (see pp. 6-279 and -280) also apply to panel access drifts for horizontal emplacement?

BASIS

- Table 6-35 (p. 6-321) shows temperatures in excess of 50°C for panel access drifts located less than about 1100 meters from the repository centerline.
- Panel access drifts are as important to retrievability as emplacement drifts.

RECOMMENDATION

The SCP should discuss differences in retrievability requirements for panel access drifts and emplacement drifts.

Section 6.4.9.3 — Future Work

Question

Where is Section 6.4.10.3.1?

BASIS

Section 6.4.10.3.1 is identified on p. 6-294 as providing more details of underground ventilation system future work. However, this section could not be found. Future work in the area of ventilation should address the issue of thermally-induced air flow being opposite the air pressure differential. (See previous comment on Section 6.2.6.3).

RECOMMENDATION

The SCP should provide a clear indication of where future work in the area of ventilation can be found.

Section 6.4.10.2.6 — Design Analysis

QUESTION

On p. 6-337, it is stated that data from 12 peak-flow gaging stations adjacent to the Nevada Test Site were used to develop regression relations that would permit an estimation of the magnitude of the 100- and 500-year flood peaks. What confidence can be ascribed to projecting such data to 100 and 500 years?

BASIS

- Significant variability usually exists in desert environments, even between adjacent gaging stations.
- Extrapolation beyond three times the length of the data recording is usually considered to be invalid.

RECOMMENDATION

The SCP should consider other approaches, such as geomorphology, to confirm flood magnitude calculations.

Section 6.4.10.3 — Future Work

QUESTION

Will future work involve assessing the stability of boreholes which are transgressed by faults?

BASIS

Movement on faults may result from natural seismicity, UNEs, or induced thermal stresses. Analyses to date have only addressed cross-sections through boreholes. Movements on transgressing faults may form a more severe constraint than the "normal" conditions to date.

RECOMMENDATION

The SCP should discuss analyses aimed at evaluating consequences of boreholes which are cut by faults.

Section 6.4.10.3 — Future Work

QUESTION

Where are studies or investigations described which are aimed at determining the radiation shielding characteristics of the formation?

BASIS

The following statement appears on p. 6-339:

> "For the underground facility, there are three specific things that need to be determined and assessed: (1) the potential for radon gas, (2) the impact of seismic events on the underground design, and (3) the radiation shielding characteristics of the formations."

RECOMMENDATION

The SCP should clearly identify where the radiation shielding characteristics of the formation will be investigated.

Section 8.3.1.4.1.1.1 — Activity: Develop a Position on Drilling Within the Boundaries of the Repository Perimeter Drift (p. 8.3.1.4-24)

Section 8.3.1.4.3.1.1 — Activity: Systematic Drilling Program (pp. 8.3.1.4-89 to 8.3.1.4-95)

COMMENT

The sections listed above describe activities which are part of the investigation to develop an integrated drilling program. These activities are based, in part, on the location of the perimeter drift as described in the CDSCP. However, the constructed repository may necessarily extend beyond the bounds of the repository defined by the perimeter drift in the CDSCP.

BASIS

The layout described in Section 6.2 occupies 1,420 acres (p. 6-226). However, uncertainties about thermal loads and rock properties suggest that an additional 210 acres may be required (p. 6-227). As much as 300 additional acres may be required to ensure adequate flexibility (p. 6-227). Therefore, the final repository may encompass up to 1,930 acres, or 36% more area than shown by the CDSCP perimeter drift.

RECOMMENDATION

The SCP should consider uncertainties in thermal loading and thermal rock properties, as well as required flexibility in planning the site investigation program.

Section 8.3.1.15.— Performance and Design Parameters, Tentative Goals, and Characterization Parameters for Thermal and Mechanical Properties Program (Table 8.3.1.15-1, pp. 8.3.1.15-2 to 8.3.1.15-13)

QUESTION

This table lists design parameters, the issue requesting the parameter, and the associated SCP activity number. It is not clear which SCP activity will investigate the effects of radiation on thermal and mechanical rock properties.

BASIS

The CDSCP states that "the effects of radiation on thermal and mechanical rock properties have been identified as needed information in Issue 4.4" (p. 6-206).

RECOMMENDATION

The SCP should clarify how the effects of radiation on thermal and mechanical rock properties will be investigated.