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6 August 1987

David Tiktinsky - SS623
U.S. Nuclear Regulatory Commission
Division of Waste Management
Washington, D.C. 20555

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

Dear David:

Enclosed is Itasca's trip report for the 16-17 July meetings in Silver Spring and Washington, D.C. to develop strategy for review of the design/rock mechanics aspects of the NNWSI Site Characterization Plan. Please call me if you have any questions.

Sincerely,

Roger D. Hart
Project Manager

cc: R. Ballard, Engineering Branch
Office of the Director, NMSS
E. Wiggins, Division of Contracts
DWM Document Control Room

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ITASCA TRIP REPORT

DATES: 16-17 July 1987

LOCATION: NRC Offices — Silver Spring, Maryland (16 July)
DOE Headquarters — Washington, D.C. (17 July)

PURPOSE: To Develop Strategy for Review of the Design/Rock Mechanics Aspects of the NNWSI Site Characterization Plan

ATTENDEES: J. Daemen and L. Lorig (Itasca);
D. Gupta and J. Peshel (NRC)
R. Cummings (Engineers International)

PREPARED BY: J. Daemen and L. Lorig

SUMMARY

This two-day meeting to discuss strategies for reviewing design/rock mechanics aspects of the NNWSI SCP had four distinct parts (listed chronologically):

(1) a seismology meeting;

(2) the Itasca point paper on review strategy for the in-situ test plan;

(3) the Itasca point paper on major design components requiring site characterization; and

(4) a cursory review of Draft Chapter 8, NNWSI SCP.

The seismology meeting was part of a presentation by NRC geologists to Professor Trifunac (consultant from USC to ACRS). The general geology of the Yucca Mountain site was presented by Charlotte Abrams. Keith McConnel presented a discussion of structures/tectonics. Mike Blackford presented a discussion of seismicity of the Yucca Mountain region.

Several comments were received during presentation of the Itasca point papers. NRC agreed to provide written comments on the two papers. These comments will be incorporated into the final version of both point papers.

On Friday, 17 July, NRC personnel (D. Gupta and J. Peshel) and consultants went to DOE-HQ to quickly review the latest draft of Chapter 8 of the NNWSI SCP. Comments on this draft are given separately.

General Comments on Draft Chapter 8 SCP — Some sections are technically superficial and preliminary. Review will only be possible with respect to broad general approaches. Some sections use extensive referencing, notably to CDR and to earlier chapters (where supporting references are most likely to be found). Section 8.3 can not be reviewed as a stand-alone document.

The dichotomy between sealing and draining remains unresolved and continues to be reflected in contradictory statements and objectives.

Sections 8.3.3 and 8.4.2 differ considerably in the level of technical detail, referencing and linkage to regulatory requirements.

Quite a few subsections still appear to be rough drafts—i.e., fairly preliminary.

§8.3.1.15. Overview of Thermal and Rock Properties Program: Description of Thermal and Mechanical Properties by Performance and Design Issues (reviewed by L. J. Lorig)

This subsection addresses testing required to provide information for:

(1) repository design analysis;
(2) analysis of disturbed zone; and
(3) analysis of radiologic safety.

Several tests have been added which had not previously been discussed (e.g., Vieth et al., 1985). These include:

(1) the Heated Room Experiment;
(2) the Thermal Stress Test;
(3) the Intact Fracture Test;
(4) the Rock Mass Strength Test; and
(5) the In-Situ Design Verification.

The Slot Strength Test, which had been previously discussed (e.g., Vieth et al., 1985), has been dropped from consideration at this time.

Few details are provided for any of the tests described, especially these new tests. A few features of each of the new tests are given below.

Heated Room Test — This test may involve more than one excavation in order to satisfy thermal boundary conditions. The experiment is anticipated to continue into the performance confirmation period.

Thermal Stress Test — This test consists of a slot with a flatjack placed between two parallel heaters to measure thermally-induced stress changes. Slots and heaters are installed perpendicular to the excavation periphery. The tests are to be made in the crown as well as sidewalls. Insulation was shown as being applied to the excavated surface. The heated volume is reported to be greater than 36 cubic meters.

Intact Fracture Test — This test is essentially an integral sample which is taken back to the laboratory for testing. The laboratory testing was not specifically identified.

Rock Mass Strength Experiment — This test was described as being done in several areas and in several stages.

1. In the joint shear strength stage, (unspecified) tests are performed on field-scale samples, where field-scale is considered to be the in-situ joint length. (Note that the choice of the work "length" by DOE to characterize joints indicates two-dimensional rather than three-dimensional thinking. Real joints have area—not length.)

2. If random jointing is present, then another stage of the experiment will be performed in which a representative volume of randomly-jointed rock will be loaded to failure.

3. The final stage requires a block of jointed rock to be carefully characterized as to joint spacing, aperture, properties, etc. and then loaded to pre-determined stress levels. This stage is undoubtedly aimed at validating and evaluating the jointed rock model (i.e., JEM). Additionally, results may be used to determine Hoek-Brown empirical rock mass strength parameters.

In-Situ Design Verification — This testing consists of three parts:

(1) verifying design and operating procedures for construction;

(2) evaluating long-term behavior of ground support; and

(3) assessing the impact of ventilation.

In the list of required performance design parameters, it appears that the following may be missing: (1) direction of principal stresses; (2) joint tensile strength (if not assumed to be zero); and (3) joint dilation.

§8.3.3. Seal Systems (reviewed by J. Daemen)

This section is exceedingly well linked to 10CFR60 requirements. Specifically, it invokes 10CFR60.142(a),(b) to justify delaying in-situ seal testing until after LA—i.e., until performance confirmation. A comprehensive seal design, performance analysis, and laboratory investigation program are outlined, and these will form the basis for LA.

Extensive references are made to other sections—e.g., for definition of seal environment.

The write-up concentrates on two major aspects: (1) shaft and borehole sealing; and (2) fault sealing. The first part, notably shafts, pays only minimal attention to the treatment of the damaged zone, if any.

§8.4. Planned Site Preparation Activities (reviewed by L. J. Lorig)

It was clear from reading this section that only a general concept was being presented. The following statements summarize DOE's position:

> "Recent changes to the ESF are currently being developed into design criteria for preliminary design. Therefore, descriptions in Section 8.4.2 are conceptual and further details will be provided in semi-annual progress reports to the SCP and the Subsystem Design Requirements Document Designs will be available for review before the start of each construction activity." (p. 8.4-1)

The implication here is that specific issues, such as controlled blasting procedures, will be addressed in subsequent documents.

It is also clear that this section focused on construction aspects of the exploratory shaft (e.g., collar construction) rather than on long-term isolation issues.

The document indicated that little, if any, mapping would be done in ES-2. Essentially, any anomalies would be noted. The document stated, without justification, that the 300 ft separation distance between shafts was sufficient to avoid interference. It was also indicated that water used for dust suppression (and drilling?) would be "tagged" with a suitable tracer to permit identification.

The size of exploratory drifts was not discussed. However, it was stated that the exploratory drifts were designed not to "jeopardize future emplacement space" (p. 8.4-44). Drifting or drilling at the Calico Hills level to the Ghost Dance Fault is still being studied.

§8.4.2. Underground Test Facilities (reviewed by J. Daemen)

This section remains extremely superficial with regard to 10CFR60. As it presently stands, this section does not seriously address the NRC concerns about potential impact on waste isolation and does not resolve NRC/DOE ESF-related open items. However, this section should be reviewed more carefully, particularly with regard to its references.

Conclusions

The two days of meetings were extremely worthwhile and provided a valuable update to the current status of the NNWSI SCP. Two significant observations concerning the structure and content of the SCP were noted.

First, the SCP is not following the Annotated Outline for Site Characterization Plans (Rev. 4, February 15, 1985) but is, instead, following a new outline (dated April 1987). Second, a clearer picture was obtained concerning the level of detail contained in the SCP, which will apparently only treat "Programs" and "Investigations". "Studies", "Tests" and "Procedures" will follow in the post-SCP period.

A potential problem for reviewing the SCP relates to the level of detail in the SCP. Because detailed test plans will contain vital information (e.g., test duration) and will not be issued until the post-SCP period, it may be difficult, in some cases, to make a meaningful assessment of SCP plans.

Recommendations

In preparation for this trip, several potential study areas were identified as having on-going significance to rock mechanics/design aspects of the planned repository of Yucca Mountain. These study areas are included here for completeness.

Ground Motion Studies — To date, nor rigorous evaluation of potential damage at Yucca Mountain due to ground motion has been performed. It has been suggested that, because underground structures near the NTS are relatively undamaged by nuclear explosions, underground structures at the proposed Yucca Mountain repository (located at a greater distance from NTS) would not be damaged. However, devices with yields greater than those currently tested are possible. Recent estimates have shown that ground motion enhancements at Yucca Mountain may be four times or more the "normal" ground motion. Based on current yield limits and predicted ground motion, a small potential for minor damage is predicted by empirical damage criteria for conventional excavations. In addition to ground motion from nuclear tests, ground motion for seismic events is possible. It is recommended that analyses be performed to attempt to define the ground motion (e.g., velocity magnitude and wavelength) likely to cause significant damage to underground structures in tuff at the Yucca Mountain repository.

The results of such analyses would then be compared to predicted ground motions either from the NTS or a seismic event, to evaluate the potential for damage.

Evaluation of "Damaged Zone" — A series of numerical analyses are recommended to provide an understanding of effects of mechanical and thermal loading on "damaged zone" regions in the vicinity of repository excavations, including shafts. The analyses should incorporate explicitly the effect of discontinuities in the rock mass. An attempt should be made to define the expected mechanical characteristics of the damaged zone. The results of the analyses should provide an improved definition of damaged zone limits based on bounding conditions of material behavior. Additionally, such studies could be extended to include scoping calculations for the proposed Thermal Stress Experiment. The zone of influence for these proposed experiments will likely be limited to the damaged zone. The calculations could be used to evaluate both the proposed insulation and the test duration.

Independent Thermal/Mechanical Calculations — NRC should perform independent thermomechanical calculations using a consistent set of material properties (perhaps using the Reference Information Base) and the latest room configuration and thermal loadings. With this as a base case, sensitivity studies should be made to assess the relative importance of input parameters and assumptions inherent in other analyses. In preparation for the SCP review, it would be highly desirable to have the means for checking thermomechanical analyses (e.g., programs and data files) readily available. These analyses might be extended to include study of the proposed Heated Room Experiment.

Document Reviews — SCP review preparation also might include review of documents identified earlier for review (e.g., during EA review as well as a refresher EA and supporting document review). The latter might be particularly true with regard to the Climax emplaced waste experiments and G-Tunnel tests, as it appears that some NNWSI analyses might have been impacted significantly by the Climax and G-Tunnel experiences.

References

Vieth, D. L., M. B. Blanchard, J. L. Younker, and M. D. Voegele. "In Situ Testing from the Exploratory Shaft at Yucca Mountain, Nevada Test Site, Nevada," September 1985.

Respectfully submitted,

Loren J. Lorig

ljl/ks

COST BREAK-OUT

Labor

Jaak Daemen	15 hrs @ $57.75/hr	$ 866.25
Loren Lorig	15 hrs @ $21.15/hr	$ 317.25
	TOTAL LABOR	$ 1,183.50

Actual Expenses

Travel

Airfare

Daemen (Tucson-WDC)	$ 441.00
Lorig (Mpls-WDC)	298.00

Miscellaneous Travel Expenses

Daemen (taxi)	2.00
Lorig (car rental, gas, mileage)	128.84

Lodging

Daemen (2 nights at 53.35/night)	106.70
Lorig (2 nights at 68.20/night)	136.40

Meals

Daemen	66.00
Lorig	66.00
TOTAL EXPENSES:	$ 1,244.94

COST BREAK-OUT

Labor

Mark Board	16 hrs @ $23.56/hr	$ 376.96
	TOTAL LABOR	$ 376.96

Actual Expenses

Travel

Airfare Board (Mpls-WDC)	$ 388.00
Miscellaneous Travel Expenses Board (car rental)	90.00
Lodging Board (2 nights at $65.00/night)	130.00
Meals Board	66.00
TOTAL EXPENSES:	$ 674.00