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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 the review of "NNWSI Repository Design Presentation and Issues Resolution Strategy — Document handed out at February 11-13, 1986, Albuquerque, NM Meeting". Please call me if you have any questions.

Sincerely,

Roger D. Hart
Roger D. Hart
Program Manager

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

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ITASCA DOCUMENT REVIEW

<u>File No.</u>: 001-02-12

<u>Document</u>: "NNWSI Repository Design Presentation and Issues Resolution Strategy — Document handed out at February 11-13, 1986, Albuquerque, NM Meeting"

<u>Reviewer</u>: Itasca Consulting Group, Inc. (J. Daemen, K. Wahi, L. Lorig)

<u>Date Approved</u>:

<u>Date Review Completed</u>: 22 April 1986

<u>Significance to NRC Waste Management Program</u>

The document presents current NNWSI repository conceptual designs, identifies issues, and outlines an issue resolution strategy.

The document establishes meeting 10CFR60 requirements as a top priority for NNWSI, in this case specifically with regard to design requirements.

NNWSI continues to consider several fundamentally different emplacement options (horizontal or vertical emplacement; short (200-300') or long (600-700') horizontal holes and intends to keep these options open for an extended period of time. NNWSI is evaluating the feasibility of increasing substantially the maximum waste temperature and the average areal power density.

It appears that very little if any thermomechanical analysis presently is in progress. If this impression is confirmed, it suggests that already available documents might constitute the complete analytical reference basis for the foreseeable future (e.g., for the final EA and for the SCP).

Significant differences exist between the reference emplacement configuration proposed in this conceptual design when compared to emplacement geometries (particularly hole spacing) used in earl-

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ier analysis documents. This will complicate interpretation of thermomechanical results already available from earlier analysis with regard to the present design. This suggests the desirability of NRC performing independent calculations in order to strengthen the validity of evaluating results from one configuration for performance of a different one.

The document indicates that exploratory shafts will become part of the repository.

<u>Summary of the Document</u>

The document consists of 16 sections presented by individuals from NNWSI contractors. Affiliations are not always clear. Section 1 is an introduction, Sections 2-11 relate to Facilities Design, and Sections 12-16 relate to Equipment Design.

1. Introduction (T. O. Hunter, SNL): Meeting Objectives

2. Facilities Design Presentation - Design Philosophy/Control (L. W. Scully, SNL)

   Meeting Objective: SCP-Conceptual Design Presentation, Types of Engineering Studies

3. Repository Setting (L. W. Scully, SNL)

   Location-geology

4. Design Basis - Surface Facilities - Facilities Design Presentation (C. V. Subramanian; SNL)

   Design Basis Common to Surface/Underground
   Design Basis Surface
   Design Basis Reference Waste Package
   Potential WHB (Waste Handling Building) Locations
   Design Basis Characteristics Affecting Surface Division
   Flood Map
   Design Basis Seismic Hazard Evaluations

5. Surface Facilities - Current Concepts (N. A. Norman, Bechtel National, Inc.)

    Project Organization
    Location and Access Plan
    Overall Site Plan (2 sheets)
    Seismicity Considerations: Data and Analysis; Design Guidelines
    Tuff Repository - Perspective Sketch
    Waste Handling Building No. 2
    Daily Waste Throughputs Based on 250 Workdays per Year
    Radiological Protection
    Dose Assessments for Repository Facilities
    Spent Fuel Handling - Mechanical Flow Diagram (4 sheets)
    Waste Treatment Building
    Waste Air Exhaust and Filter Building
    Performance Confirmation Building

6. Surface Facilities — Emphasis for ACD (Advanced Conceptual Design) (C. V. Subramanian, SNL)

7. Design Basis - Underground Facilities (R. E. Stinebaugh, SNL)

8. Underground Facilities - Current Concepts (R. F. Harig, Parsons Brinckerhoff)

    Project Organization
    Subsurface Repository Components
    Layout Area for Conceptual Design in Relation to Underground Facilities Boundary
    General Layout Underground Facility Access
    Layout - Spent Fuel - Vertical Emplacement Scheme (5 sheets)
    Spent Fuel - Horizontal Emplacement (3 sheets)
    Layout - Co-mingled Waste - Short Horizontal Emplacement (355 ft long Holes) (4 sheets)
    Layout - Drainage Configuration
    General Ventilation Requirements
        Environmental Criteria
        Airflow Requirements
        Air Velocity
        Vertical Emplacement Ventilation System

Comparison of Main Fan Maximum Airflows
and Pressures (Horizontal vs Vertical
Emplacement)
Isometric Diagram: Mining Methods and Sequence -
Vertical Emplacement
Waste Emplacement Operations - General Criteria
Conceptual Flow Diagrams - Spent Fuel - Vertical
Emplacement - Horizontal Emplacement
G-Tunnel Drill & Blast Objectives
G-Tunnel Layout Plan; Round #5 Blast Design;
Preliminary Results; Benefits to Underground
Design

9. Design Analysis (A. J. Mansure, SNL)

Overview
Position Study
Lateral Uncertainty Due to Uncertainty in Fault Dip
Determination of Additional Wells Required to Reduce
Uncertainty in High/Low Lithophysae Contact
Useable Area for Nuclear Waste Disposal in Yucca
Mountain Area Needed
Thermal Design of Underground Facility
Near-Field Thermal Design
Horizontal Emplacement Borehole Wall Temperature
Thermomechanical Analysis of Underground Facility; Work
to Date; Past Calculations Applicable to Current
Design
Vertical Emplacement Reference Thermomechanical Calculations (Parameters)
Vertical Emplacement Strength/Stress Ratios (3 sheets)
Vertical Emplacement Reference Thermomechanical Calculations (Results)
Parameter Uncertainty, Thermomechanical Sensitivity,
and Data Requirement
Thermomechanical Analysis of Underground Facility:
Future Work

10. Sealing (J. A. Fernandez, SNL)

Overview
Sealing Concepts Developed
Repository Sealing Program Shaft Sealing Concept
Discrete Fault Seal/Drain Concepts
Hydrologic Calculations
Matrix Flow Models - Drift and Shaft Analyses

Drift and Shaft Analyses Conclusions
Scenario for Surface Water Inflow (Debris Embankment – Shaft Flooding)
Scenario for Surface Water Inflow (Discrete Fault)
Fractional Release Rate (Case 1)
Summary Conclusions from ES Performance Analysis
Repository Sealing Activity - Key to Hydrologic Analyses

11. Underground Facilities – Emphasis for ACD (R. F. Stinebaugh, SNL)

Special Studies:

to resolve design alternatives
general studies/ analysis/ evaluations

Design Report:

reference configuration for LA Design
concentrate on elements important to safety and that affect containment and isolation
LAD subsystem design requirements

12. Equipment Design Presentation: Design Philosophy/Control (J. R. Tillerson, SNL)

Guiding Principles:

sufficient development to make defensible technical decisions

equipment proof–of–principle demonstrations prior to LA

Cost Impact of Hole Length and Standoff (Horizontal Emplacement)

Cost Comparison Between Horizontal and Vertical Emplacement

NNWSI Equipment Development – Program Sequence of Planned Activity

Equipment Program – Design Philosophy/Control

13. Emplacement Hole Drilling/Lining (K. D. Young, SNL)

Horizontal Drill Program

Isometric views of: vertical drilling equipment; horizontal emplacement; horizontal boring machine; overcore drill; horizontal boring machine (phases I and II); development boring machine; derrick and control panel-vacuum chip removal system

Development Prototype Boring Machine Fabrication and Testing Schedule

Horizontal Drilling Program Reports: SAND83-7085; 84-0184 (in review); 84-7100 (in review); 84-7103; 84-7209; 85-7111

14. Waste Emplacement/Retrieval Equipment (R. E. Stinebaugh, SNL)

Isometric views of equipment (5)

vertical emplacement (mechanical plug or tuff backfill cross-sections)

retrieval/emplacement equipment (3 views)

horizontal emplacement hole (2 views)

15. Equipment Design Presentation – Future Emphasis for Equipment (R. E. Stinebaugh, SNL)

Cable Retrieval System
Emplacement & Retrieval Transporter System
Emplacement & Retrieval System
Radioactive Waste Package and Dolly

16. Future Efforts (L. W. Scully, SNL)

ACD Studies

No MRS; No Spent Fuel Consolidation
Single–State Facilities

ACD Study Results

Reference Configuration functions
LAD subsystem design requirements
Emphasize safety-related systems
De-emphasize support facilities

Problems, Limitations, and Deficiencies

Considerable overlap exists between this document review and the trip report for Itasca's attendance at the NRC Update Meeting on 26-27 February 1986. One of the main purposes of the February meeting was to describe and discuss the status of NNWSI Conceptual Design (as presented at the DOE meeting in Albuquerque on 11 February 1986). Consequently, some items discussed in the trip report are repeated here for completeness.

This is a review of viewgraphs, without the benefit of having attended the presentation thereof, hence the complete context of the material is not known. Therefore it must be recognized that all comments made here are based on partial information only.

This review follows the order of the DOE handouts as summarized above, with corresponding section numbers.

2. Facilities Design Presentation – Design Philosophy/Control.

Types of Engineering Studies

The list suggests (and this inference might not be correct) that very little thermomechanical analysis is in progress. Given the severe reservations expressed earlier about previous analyses (e.g., Itasca Document Reviews 001-01-1, 001-02-9, 001-02-10, 001-02-11), this reinforces the impression that heavy reliance on earlier documents will continue to create assessment problems, and reinforces the desirability for independent NRC analyses.

Subsystem Design Requirements

Subsystem Design Requirements are listed in the second viewgraph. Who is responsible for establishing the appropriate requirements—WBS-DAS? Later, it is suggested that the Subsystem Design Requirements obtain data from Reference Information Base. Does the RIB contain ranges and distributions (i.e., uncertainty), or are only average values included? How does the RIB relate to other data bases?

3. Repository Setting

Ghost Dance Fault and multiple other exposed or inferred faults run through the central repository block.

4. Surface Facilities – Design Basis

The statement that flood control will pose only modest requirements needs justification. Flooding could have a significant impact on repository operations and performance for several reasons, in particular:

(1) surface facilities are partially located in low-lying areas (washes?);

(2) shafts are within, or close to, low-lying areas (washes?); and

(3) floods can cause preferential infiltration (e.g., along faults).

5. Surface Facilities – Current Concepts

Overall Site Plan

500 year flood estimate needs to be confirmed

elevation, distance and topography around tuff ramp portal in particular need to be checked – same for emplacement exhaust shaft, waste ramp portal

consequences of flooding near WHB2 and of part of the restricted area need to be evaluated potential of flooding of surface fault exposures and potential of infiltration along faults need to be evaluated

ramps cross multiple faults—inflow potential, stability considerations need to be addressed

A reasonable estimate is needed of the risk of flash flooding, associated discharge rates, and debris caused by floods. Consideration also should be given to design of surface facilities with respect to the 500-year flood, including the type of fence to be used around the secured facility.

Performance Confirmation Building

What is the performance measure(s) and what is done to remedy substandard performance?

6. Emphasis for ACD

Does the pre-closure safety analysis consider only radiation? What are the scenarios considered? How is the underground radiation safety integrated with the surface pre-closure activities?

7. Underground Facilities - Design Basis

Emplacement options remain open: vertical vs horizontal

Seismic hazard analysis of underground facilities appears to be missing. Detailed considerations of seismic effects have been included in the surface facility design. The underground facility design needs to consider seismic effects (earthquakes, NTS tests) and fault displacements. Fault displacements might be particularly important for the horizontal hole emplacement design option if it is possible that such holes might be intersected by faults. Fault displacements crossing emplacement holes would have immediate containment and isolation consequences, as well as retrieval implications. Equally important would be an assessment of the possibility that faults might be preferential flow paths.

Ramp access will be used for waste delivery. This will require assured control of the transporter vehicles especially when carrying canisters. Control methods will need to be detailed. Risk assessments and failure scenario studies would be desirable.

Ramps will cross faults. Static and dynamic stability, as well as potential for water inflow need to be analyzed.

Why is there a fundamental difference between the temperature limits imposed for vertical emplacement as compared to horizontal emplacement: 50°C in the access drifts for vertical emplacement, 50°C in the emplacement drifts for horizontal emplacement? This ambiguity in the design basis, which has major implications when comparing horizontal with vertical emplacement, is discussed in more detail in Itasca Document Review No. 001-02-11. It implies that the design basis allows considerably higher temperatures in access drifts for horizontal emplacement, and considerably higher temperatures in the emplacement drifts for vertical emplacement. While this thermal distribution is to be expected logically from the respective emplacement configurations, it is not at all clear what the rationale is for allowing such totally different design bases for retrievability.

It is to be noted that the exploratory shafts will be part of the repository, hence their impact on isolation will need to be addressed.

8. Underground Facilities - Current Concepts

Subsurface Repository Components - Repository Layout

The fact that the overall perimeter area as well as the panel size are independent of the emplacement configuration confirm that near-field effects have virtually no impact on design (i.e. design appears to be driven almost entirely by average thermal inputs and by far-field effects). It is far from clear that this is obvious or acceptable.

The figure of the layout area for conceptual design does not show any of the faults within the repository block shown in the earlier Repository Setting figure, even though the Legend lists Faults, and general faulted areas around the repository block are shown. It appears that the emplacement exhaust shaft will be in a faulted and lithophysae zone.

The waste ramp will run through a lithophysae zone. Faults intersecting ramps are not shown on this figure.

Shafts are sufficiently close to waste emplacement areas to warrant explicit attention to thermal effects on long term isolation impact.

<u>Underground Facility Layout - Spent Fuel - Vertical Emplacement</u>

Spacing between access drifts has been reduced somewhat from SAND83-1884 (Gram et al, 1985) (1400 vs. 1525'), standoff (78') from access drifts has been introduced, emplacement drift spacing has been increased somewhat (112' vs 100'), emplacement drift width has been reduced (16' vs. 20', still somewhat larger than used in the fundamental thermomechanical reference, SAND 83-0372 (Johnstone et al, 1984). Probably the most significant change is the decrease in hole spacing from 30' to 15'. Particularly the latter change suggests the desirability of re-assessing and comparing all presently available thermal analyses. Average thermal loading has been increased to 57 kW/acre (50 kW/acre in Gram et al, 1985; 57 kW/acre in Johnstone et al, 1984).

<u>Underground Facility Layout - Spent Fuel - Horizontal Emplacement</u>

Access drift spacing is given as 1400' [Gram et al (1985) gives 1360' on p. 11, 1632' on p. 12]. Gram et al indicates the use of twin access drifts, present design gives direct access from triple parallel main drifts to emplacement panels. Emplacement hole orientation has been rotated by 90°. Hole spacing has been reduced from 157' to 102', hole length increased from 656' to 682', standoff increased from 80' to 102'. Emplacement alcoves are detailed and are considerably wider (31'x31' vs. 20'x20') than given in Gram et al, 1985.

<u>General Requirements</u>

The statement that main fans will not be reversible is in violation of 30CFR57 requirements.

Ventilation air leakage is assumed to be from the development system to the waste emplacement system. Given the tendency of airflow induced by the thermal gradients through the rock to be away from the waste, this deserves checking.

It is possible that the decision to install non-reversible main fans will be justified on radiological exposure considerations. If this decision is questioned, NRC might have to develop a position with regard to its concern about such exposures during presumably very short term emergency reversals (e.g., because of fire underground).

Environmental criteria should also consider wet-bulb temperature and humidity.

All air velocities are high, extremely so in conveyor entries, ramps, and even development areas.

<u>G-Tunnel Drill & Blast Objectives - Preliminary Results - Benefits to Underground Design</u>

Objectives identify need to minimize perimeter rock damage as required by 10CFR60.133. Validity of extrapolation from G-Tunnel to repository will need to be addressed.

It is unclear which computer models are being validated.

9. Underground Facilities - Design Analysis

<u>Useable area for Nuclear Waste Disposal in Yucca Mountain</u>

It would be desirable to check the vitrophyre and high lithophysae intersections shown on the map with best available site geology Concern about the NNWSI determination of the available area has been expressed earlier (e.g., EI Document Review File No. 1085-010).

Need for area:

- lateral flexibility is severely limited, and might create problems in meeting 10CFR60, § 60.133.b
- an 80 kW/acre thermal load is being considered. Given that analysis results using 57 kw/acre loading (Johnstone et al, 1984) might have been interpreted optimistically, this has to raise serious concerns. These thermal loads may be rather high for un-reprocessed spent fuel, especially because the thermal conductivity of tuff is relatively low.

- The viewgraph of useable area assumes an overburden constraint of 200 m. Section 60.122(b)(5) considers a minimum emplacement depth of 300 m as a favorable condition (10CFR60).

Thermal Design of Underground Facility

The 1983 Unit Evaluation Study (Johnstone et al, 1984) is cited as major reference. Consideration is being given to increase the thermal loading above 57 kW/acre, based on preliminary far-field and near-field studies. It would be extremely desirable to obtain details on these studies. In earlier reviews of thermal mechanical analyses (Itasca Document Review 001-02-1; 001-02-9; 001-02-10) we have expressed strong reservations about the analyses performed to date, and recommended independent analyses. The possibility for NNWSI to increase thermal loading amplifies those concerns and recommendations.

Near-Field Thermal Design

It is to be noted that the initial output from some containers could exceed that of the reference design container by over 50%. This could have major implications for near-field performance—i.e., emplacement hole, liner, emplacement and access drifts, retrieval ventilation requirements, etc. This issue is urgently in need of clarification.

Variable emplacement hole spacing is being considered. This introduces a new uncertainty in the design.

The near-field thermal design constraint of 275°C borehole wall temperature is bothersome. It implies canister <u>surface</u> temperatures in excess of 300°C; the waste <u>centerline</u> temperature could then be unacceptably high. The thermal stress due to a 240°C temperature change in the rock can be estimated using the upper-bound expression "$E \alpha \Delta\theta/(1-\nu)$". Using nominal values ($E = 15$ GPA, $\nu = 0.25$, $\alpha = 7.5 \times 10^{-6}$ $°C^{-1}$), a thermal stress of roughly 36 MPa is predicted. This, combined with excavation stresses, could well exceed the rock strength or cause shear failure along joints.

The factor of 40 variation in the initial thermal output is cause for concern—unless, of course, an upper-bound calculation using 5.4 kW/canister results in an acceptable thermal response.

Horizontal Emplacement Borehole Wall Temperature

The maximum hole wall temperature is substantially less than the maximum given in Gram et al, 1985. (210°C vs. 280°C). Details are not available, and it is recommended to acquire and review relevant documents as soon as possible.

A potentially beneficial effect of boiling near the waste canisters is alluded to—namely, better isolation because moisture is driven away from the waste package. A potentially adverse effect should also be recognized—accelerated corrosion in a steam environment. This would tend to reduce the package life and thus result in poorer containment.

Thermomechanical Analysis of Underground Facility

The presentation of the scope of work to date may give the false impression that numerous items have been considered in great detail. However, analyses we have seen so far do not include, for example, lined horizontal holes, intersections, and ramp-fault intersections. Analyses to date for shafts, boreholes, joint displacement, and intact rock failure have been extremely superficial.

Vertical Emplacement Reference Thermomechanical Calculations

As pointed out in earlier document reviews (Itasca File No. 001-02-9; 001-02-10), and discussed there in more detail, the rock strengths listed here (compressive 75.4 MPa; Tensile 9 MPa) appear very high. All conclusions stated here must be considered as based on exceedingly optimistic strength assumptions.

The conclusion that joint activation is restricted to side walls is probably valid for certain joint orientations and not others. Unless the orientation is known with certainty, different orientations should be considered in the analysis. The assumed compressive strength of 75 MPa is respresentative of very good quality rock but may be too high for the rock mass.

A sidewall strength/stress ratio of less than unity is evident in some of the plots shown. What does this mean with respect to artificial support requirements?

The negative vertical closure of the unventilated drift case is questionable.

Vertical Emplacement Strength/Stress Ratios

It is to be noted that the analyses show that joint strengths are exceeded along the entire sidewall. Although time does not permit a detailed comparison, a quick glance suggests substantial differences with results in Johnstone et al (1984). This deserves more detailed comparison.

Parameter Uncertainty

It would be instructive to include strengths in this analysis.

10. Underground Facilities - Sealing

It is encouraging to see performance assessment analyses in determining sealing needs. However, the assertion that, for horizontal emplacement, drift backfill does not alter flow past horizontally-emplaced waste packages is questionable. A number of factors, such as altered gradients, could result in perturbation of an initially downward flow such that, in the near field, a two- or three-dimensional flow field would exist after closure. The scenarios considered do not include perched water.

Shaft Sealing Concept

Presumably what is presented is only schematic. Settlement plug geometry is structurally questionable.

Discrete Fault Seal/Drain Concepts

Relies on long-term performance of fracture grouting in an unsaturated, possibly temporarily dry, jointed rock, on engineered barriers (dams), and on assured floor drainage.

Drift and Shaft Analyses

No details given - discussed at length in comments on NRC/ DOE ES Meeting (8-28-85) and associated document reviews.

14. Equipment Design - Waste Emplacement/Retrieval

Vertical Emplacement

Components include thimble, liner, mechanical plug, and tuff backfill. Characteristics and performance of all these components need to predicted throughout retrievability period.

Horizontal Emplacement

Performance of all components needs to be predicted throughout retrievability period.

Recommended Action

1. Integrated Thermomechanical Stability Analysis.

This primary recommendation, for NRC to conduct an integrated thermomechanical stability analysis for a NNWSI repository, is based on the following NRC information needs:

10CFR60.133

(a) (1). The orientation, geometry, layout, and depth of the underground facility, ... shall contribute to the containment and isolation of radionuclides.

(b) flexibility of design

(c) underground openings

(1) ... retrievability option maintained.

(2) ... reduce the potential for deleterious rock movement...

(i) thermal loads

> ... taking into account the predicted thermal and thermomechanical response of the host rock...

NRC staff will need to make a determination as to whether these rule requirements have been satisfied. At present the picture is confused due to the repeated changes in input variables that have been used in various DOE(SNL) analyses. Serious reservations have been expressed in this and in earlier document reviews about input data assumptions and hence results of various thermomechanical analysis. For all these reasons it is proposed that NRC perform an independent integrated assessment of the thermomechanical rock mass response at the proposed Yucca Mountain repository site. It is proposed that such an assessment include the following phases:

A. Data Collection and Integration.

Collection of all appropriate thermomechanical data, including ranges, uncertainties, etc.

As a minimum, this would include rock strength, moduli, joint strength, stiffness, stress measurement results, thermal properties (conductivity, expansion, heat capacity)—all of these correlated to mineralogy, porosity, location, etc.

The data is to be summarized in an annotated form which will allow a ready assessment of the acceptability of input data used by NNWSI in thermomechanical analyses.

This is believed to be an essential and minimum step, needed in preparation of future major document reviews.

We realize that some of the data has been collected in NUREG CR-4110 (Repository Site Report for Unsaturated Tuff, Yucca Mountain, 1985). The action recommended here would supplement the NUREG report.

B. Thermal Input Definition

The design review document confirms the likelihood of encountering significant deviations from the standard reference canister 3.4 kW/acre input thermal load. The design/rock mechanics group needs, both for future document reviews and for its own analyses, a better understanding of the most likely thermal input that will be in place, as well as of its likely variability. This is critical for near-field performance assessments (emplacement hole, liner, backfill, emplacement and access drifts, ventilation).

C. Structural Geology/Tectonics

The rock mechanics/design group needs to assemble an integrated picture, from an engineering viewpoint, of structural features and tectonic activities that might impact on isolation, containment, and retrievability.

Of particular concern in this regard, given the intensity of faulting in the general area, is whether the risk exists of potentially active faults intersecting emplacement holes and remaining undetected. Shear displacements along such faults raise containment, isolation, and retrievability concerns. Potential inflow raises similar concerns. Faults, in general, raise concerns about opening stability, in this case particularly ramps and drifts.

It is recommended, as part of this study of the potential influence of faults, that NRC explore the possibility of investigating the influence of faulting on the stability of underground openings in the same general structural domain of the Yucca Mountain area—e.g., through site inspections of mines in the area.

D. Thermomechanical Analyses

It is recommended that NRC perform a series of scoping analyses of the thermomechanical response of the repository rock mass. These calculations should cover a reasonable fraction of the presently very wide uncertainty band on the input variables. Topics of particular concern for the rock mechanics/design group include:

- emplacement hole stability

  Consider range of thermal inputs (B, above) of mechanical and thermal properties (A), potential influence of faults (C). Consider steel liner performance (e.g., literature review on steel at 200-300°C in steam environment).

- Emplacement and access drift temperatures and stability

  Of particular concern are very wide emplacement alcoves, hole/drift intersections, drift/drift intersections, support or reinforcement temperatures, creep, softening, etc.

  Analyses for these critical features need to consider same variable ranges as for emplacement holes.

- Analysis of ESTF plans

  ESTF experiment results will provide critical input to LA. Although judgmental assessment based on detailed review of test plans is helpful, it would be preferable to perform systematic numerical investigations of the proposed experiments. This would allow an early indication as to whether or not the proposed tests and instrumentation are likely to satisfy the essential NRC information needs.

- Effect of structural discontinuities

  Characterization of discontinuities is important in assessing what effect, if any, presence of discontinuities have on stability and preferential water flow paths around excavations. Characterization should include orientation, persistence, roughness, strength properties, and stiffness.

2. Document Acquisition, Distribution, and Review.

   This DOE design review again lists several documents to which at present we do not have access. It would be highly desirable to provide these to Itasca, and if possible to have them reviewed, preferably before the review of major DOE document (e.g., EA, SCP) in which they are likely to be used as references.

   Of particular interest are SAND 85-7104, SAND 83-1805, SAND 83-7443, SAND 84-7125, SAND-83-0757. (All but the first one are referenced in SAND 83-1884, Gram et al, 1984, and have been identified as documents needed in Itasca Document Review File 001-02-10, where several other critical thermomechanical references have been identified). Desirable but with a less urgent priority are emplacement and retrieval (Robbins) reports SAND 83-7085; SAND 84-0184; SAND 84-7100; SAND 84-7103; SAND 84-7209; SAND 85-7111.

3. Determination of the Representativeness of ESTF and of Adequacy of Site Characterization.

   Numerous indications already have been given that the mechanical and thermal properties of the Topopah Spring welded tuff are highly variable. Variability in mechanical response similarly is suggested by the likely influence of faults. The difficult problem of ascertaining the representativeness of the site characterization and ESTF information deserves in depth study.

4. Flood Predictions and Impact Assessments.

Floods could have a direct impact on surface facilities and on underground facilities, the latter particularly because of the risk of preferential inflow along faults, and because of the close proximity of ramp portals and shaft collars to potential flood areas. 10CFR60.122(C)(1) explicitly identifies this potentially adverse condition. The Draft EA (DOE, 1984, pp. 6-256/7) disclaims the presence of this adverse condition. NRC will need a well-justified position in this regard.

5. Development of an Independent NRC SCP/ESTP

Based on presently available site information, what should be included in an NRC-developed SCP and ESTP. This could form the basis for an evaluation of DOE plans—i.e., how much of NRC information needs will be satisfied by DOE proposals?

6. Observational (Field) Study of Potential Impact of Faults

Visit mines in the same structural domains as Yucca Mountain and inspect impacts of faults for, as examples,

- evidence of deterioration since opening mines(s)
- evidence of intensified support requirements

With all recognized limitations (e.g., shallow, small excavations, different rock types), this still would provide a qualitative indication about the potential impact of faults.

7. Engineering Review of Available Geological/Hydrological/ Geochemical/Seismic Information

Review by design/rock mechanics group of NRC, DOE, and other literature. It is not clear whether past time limitations have allowed such an integration effort for NRC staff, but it certainly has not been possible for the consultants.

8. Rock Bolt/Reinforcement Studies

Rock bolts (as well as grout, mesh, shotcrete) will be exposed to a hostile environment for an extended period of time.

Uncertainty about performance could be reduced by an experimental (comprehensive and full-scale, or even preliminary, scoping, with limited tests) investigation of systems likely to be used.

Generic studies would be of considerable benefit to the NRC HLW repository performance assessments as a whole, but need to be complemented by site specific interactions (e.g., with tuff, groundwater/steam, unsaturated conditions).

These studies also would contribute directly to an improved understanding of emplacement hole/liner performance.

9. Determination of Rock Properties as a Function of Time, Temperature and Saturation (e.g., water/steam)

This logically preceeds or complements the reinforcement/support studies recommended in (8).

REFERENCES

Johnstone, J. Keith, Ralph R. Peters, and Paul F. Gnirk. Unit Evaluation at Yucca Mountain, Nevada Test Site: Summary Report and Evaluation. SAND83-0372. June 1984.

10 CFR 60 (Code of Federal Regulations), Title 10. "Energy", Part 60, "Disposal of High-Level Radioactive Wastes in Geologic Repositories." U.S. Gov't. Printing Office, Washington, D.C.

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