CONSULTATIVE DRAFT

DESCRIPTION OF, AND SCHEDULE FOR, NNWSI TOPICAL REPORTS

Itasca Consulting Group

May 1988

NNWSI TOPICAL REPORTS

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I. INTRODUCTION

NRC directed Itasca to prepare eleven (11) topical reports (letter from D. Tiktinksy to R. Hart, 29 March 1988, see appendix). Additionally, NRC had previously requested Itasca to redirect three on-going studies from BWIP to NNWSI. This draft attempts to describe, in a very general manner, the work to be done for each report and to provide a preliminary work schedule. The topical reports are listed in Table I-1. The topical reports have been divided into three groups:

(1) thermomechanical;

(2) seal system; and

(3) ESF.

Individual topical reports are described in Sections II, III and IV. Detailed outlines for each topical report will be developed at a later date and discussed with NRC, as directed in the letter from D. Tiktinsky. Section V provides a preliminary schedule based on the assumption that all draft topical reports be completed by the end of 1988. (NOTE: The statutory SCP is presently scheduled for release in January 1989.)

Table I-1

LIST OF TOPICAL REPORTS

Topical Report	Title
A	Sensitivity Analyses for Key Joint Parameters
B	Thermal-Mechanical Analysis for NNWSI
C	The Effect of Dynamic Events on Drifts at NNWSI
D	Analyses of Alternative Waste Emplacement Concepts on Performance of Drifts and Boreholes
E	Sensitivity Study of Variations of Heat Loading for a Repository at Yucca Mountain
F	Stability of Openings During Retrieval
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L	Performance Confirmation Test Needs for Seals
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N	Exploratory Shaft Facility Design

II. THERMOMECHANICAL TOPICAL REPORTS

The topical reports which primarily concern mechanical and thermomechanical analyses are listed in Table II-1. The first three (3) topical reports were initiated under Task Order No. 005 to study issues related to the proposed repository at Hanford. Subsequently, these studies have been redirected to incorporate NNWSI site-specific parameters.

It is clear that there is considerable overlap among the nine (9) reports. The overall objective of the reports is to provide a comprehensive suite of calculations which provide guidance to persons reviewing design/rock mechanics issues in the statutory SCP and supporting documents.

Table II-2 gives a matrix of problem parameters, problem scale and the topical report which will address variation in the specific parameter. The list of problem parameters is taken from Tables 6-10 through 6-16 of the CDSCP.

Table II-1

TOPICAL REPORTS INVOLVING THERMOMECHANICAL ANALYSIS FOR NNWSI

STUDY	TASK	DESCRIPTION	TIME (weeks) Remaining	Suggested
A	005-01	SENSITIVITY OF JOINT PARAMETERS	3	6
B	005-01	THERMAL-MECHANICAL ANALYSIS	3	3
C	005-01	SEISMIC ANALYSIS	6	6
D	006-01-T1	ALTERNATIVE WASTE EMPLACEMENT CONCEPTS	6	6
E	006-01-T2	SENSITIVITY INVOLVING HEAT LOADING	6	6
F	006-01-T3	RETRIEVAL STABILITY	6	6
G	006-01-T4	BOREHOLE LINER STABILITY	6	4
H	006-01-T5	DISTURBED ZONE	6	6
I	006-01-T11	CONTINUUM VS DISCONTINUUM	4	6
		TOTAL	46	49

Table II-2

MATRIX OF PROBLEM PARAMETERS, PROBLEM SCALE AND TOPICAL REPORTS

PARAMETER	EMPLACEMENT Vertical	EMPLACEMENT Horizontal	DRIFT Vertical	DRIFT Horizontal	Access	FAR-FIELD
I. IN-SITU CONDITIONS						
vertical (σ_v)	assumed to be 7 MPa for all analyses					
horizontal (σ_h)	D	DG	ADHC	ACD		G
temperature	assumed to be 26°C for all analyses					
II. PHYSICAL PROPERTIES						
grain density	not used explicitly in any analysis					
porosity	not used explicitly in any analysis					
saturation	not used explicitly in any analysis					
bulk density, in-situ (ρ)	assumed to be 2.34 (g/cc) in all analyses					
bulk density, dry (ρ_{dry})	not used explicitly in any analysis					
III. INTACT ROCK-MECHANICAL PROPERTIES						
bulk modulus (k)			I	I		
shear modulus (G)			I	I		
unconfined strength (σ_c)	not used explicitly in any analysis					
cohesion			FI	FI		
friction (ϕ)			FI	FI		
tensile strength (σ_t)	$\sigma_t = (2c \cos\phi)/(1 + \sin\phi)$ for all analyses					

Table II-2 (continued)

PARAMETER	EMPLACEMENT Vertical	EMPLACEMENT Horizontal	DRIFT Vertical	DRIFT Horizontal	Access	FAR-FIELD
IV. JOINT MECHANICAL PROPERTIES						
unstressed aperture			H			
half-closure stress			H			
shear stiffness			AH	A		
normal stiffness			AH	A		
cohesion			AH	A		
residual friction (ϕ_r)		G	AFH	AF		G
JCS_o			H			
JRC_o			H			
V. ROCK MASS MECHANICAL PROPERTIES						
bulk modulus (K)	D	D	D	D		
shear modulus (G)	D	D	D	D		
unconfined strength (σ_u)		not used explicitly in any analysis				
cohesion	D	D	D	D		
friction (ϕ)	D	D	D	D		
VI. JOINT GEOMETRY						
spacing			ACF	ACF		
orientation		G	ACF	ACF		G
persistence			ACF	ACF		

Table II-2 (concluded)

PARAMETER	EMPLACEMENT Vertical	EMPLACEMENT Horizontal	DRIFT Vertical	DRIFT Horizontal	Access	FAR-FIELD
VII. THERMAL PROPERTIES						
conductivity (k)	BE	BE	BE	BE	BE	
coefficient of thermal expansion (α)	D	D	D	D		
thermal capacitance (Cp)	BE	BE	BE	BE	BE	

TOPICAL REPORT A: Sensitivity Analyses for Key Joint Parameters at NNWSI

Tuff is a highly-fractured rock, and its response to mining and heating will likely be controlled, to a large extent, by the mechanical response of the joints. An important question at the Nevada site is the extent to which the jointing controls rock mass response and which joint properties have the greatest influence on this response.

To address these questions, a parametric analysis will be conducted on the room-scale response of the rock mass for the proposed NNWSI conceptual design (vertical emplacement mode). The following joint properties will be examined with respect to their effect on rock mass response:

(1) friction angle;
(2) cohesion;
(3) stiffness parameters;
(4) roughness; and
(5) spacing, attitude, and continuity.

Approximately five (5) weeks of the original eight (8) weeks specified for this task has been spent doing BWIP analyses. A minimum of six (6) weeks is suggested to perform the analyses for NNWSI. Therefore, an additional three (3) weeks are required beyond the three (3) weeks remaining. Mark Christianson is the principal investigator for this report.

TOPICAL REPORT B: Thermomechanical Analysis for NNWSI

A detailed analysis of the emplacement hole and thermal and mechanical response of the rock mass at NNWSI is being performed using FLAC/STRES3D. The following problems are to be examined:

(1) the thermal regime around the emplacement borehole for horizontal and vertical emplacement schemes; and

(2) the temperatures at various times at points of interest (i.e., emplacement and access drifts).

Approximately three (3) weeks remain in this task. Due to the reduced scope of this task (compared to the original task outlined for BWIP), this time is considered sufficient. Mark Board is the principal investigator for this report.

TOPICAL REPORT C: The Effect of Dynamic Events on Drifts at NNWSI

Evaluation of the effects of dynamic events at NNWSI must address two types of events:

(1) natural seismicity (earthquakes); and

(2) underground nuclear explosions (UNEs).

Both event types will be studied as part of this task. Each event type has distinctly different time histories and it will first be necessary to develop "typical" time histories for each event type. The development of time histories will be based on literature review and will take roughly one week for each event type. The analyses will be performed using UDEC, and the results will be compared to empirical observations. Only the period during pre-closure will be studied, as drifts will be backfilled during the post-closure period.

Of particular interest to these studies is whether the stress waves will cause spalling of rock on the excavation periphery or slip along existing discontinuities. The effects of shotcrete and rockbolts in mitigating the dynamic effects will also be considered.

Two drift excavation geometries (horizontal and vertical emplacement) will be examined for each event. Several different event magnitudes will be studied in an attempt to define the onset of significant damage. Only one set of joint friction or cohesion will be studied (primary failure modes are assumed to involve mainly tensile failure). Analyses will be made for the period immediately following excavation and at the end of the pre-closure period.

A minimum of six weeks is suggested for this work. Loren Lorig is proposed as the principal investigator.

TOPICAL REPORT D: Analyses of Alternative Waste Emplacement Concepts on Performance of Drifts and Boreholes

The following alternative waste emplacement concepts have been proposed:

(1) single canister in short vertical hole (reference design);

(2) multiple (up to 18) canisters in long horizontal holes; and

(3) one to three canisters in short horizontal holes (see CDSCP, p. 6-4).

The first week of this study period will be used to review the latest concepts concerning various waste emplacement options. Numerical analyses using STRES3D will be used to evaluate temperatures and stresses in the rock mass surrounding boreholes. Numerical analyses using HEFF will be used to evaluate temperatures and stresses in a rock mass surrounding drifts. Analyses will use equivalent rock mass elastic properties.

The six (6) person-weeks allotted for this topical report appears adequate at this time. Barry Brady is proposed as the principal investigator.

TOPICAL REPORT E: Sensitivity Study of Variations of Heat Loading For a Repository at Yucca Mountain

Current layouts for both vertical and horizontal emplacement methods reflect the use of an areal power density of 57 kW/acre (and an initial heat load of 3.03 kW per waste package) [CDSCP, p. 6-148]. This areal power density was recommended by Johnstone et al. (1984) to limit floor temperatures in unventilated vertical emplacement drifts to 100°C or less during the first 110 years (p. 10). This gross thermal loading (or areal power density) has been used for all subsequent conceptual designs, even though the 100°C criteria apparently can no longer be met. Changes in ventilation system concepts have resulted in replacing the constraint with a tentative design goal of 50°C at 50 years (see p. 8.3.5.2-1). This tentative design goal requires that the temperatures be less than 50°C at 50 years for horizontal emplacement drifts or vertical emplacement access drifts.

The CDSCP indicates (p. 6-231) that, with the change to this constant, the allowable thermal loading could increase above the current design basis of 57 kw/acre. The objective of this topical report is to investigate the combinations of rock mass thermal properties and areal power densities that would meet present tentative design goals.

The first week of this work will involve review of all design goals which apply to determination of the allowable areal power density. For example, the borehole wall temperature should be less than 235°C at all times (see p. 6-195). The remaining five (5) weeks will be used to determine conditions of areal power density and rock mass thermal properties which satisfy existing design criteria. Both HEFF and STRES3D will be used for numerical analyses. Possible combinations of thermal loading and thermal properties will be examined with respect to impacts of opening stability during the pre-closure period.

A minimum of six (6) person-weeks is proposed for this work, with Barry Brady as principal investigator.

Reference

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

TOPICAL REPORT F: Stability of Opening During Retrieval

Analyses will be performed using UDEC and FLAC to study the stability of drifts during retrieval. Cooling is anticipated for retrieval in both horizontal and vertical emplacement methods. The CDSCP indicates that ambient air can be used to cool the horizontal emplacement drifts, but cooled air will be required prior to entry of vertical emplacement drifts (p. 6-337). The calculations will start with the conditions expected at 50 years following waste emplacement. The calculations will also consider the effects of temperature changes on emplaced support components.

A minimum of six (6) weeks is recommended for this work, with Mark Mack as principal investigator.

TOPICAL REPORT G: Emplacement Borehole Liner Stability Analyses

Only the horizontal waste emplacement involves the use of liners. The SCP CDR assumes a 1/2-inch liner thickness (p. B-2). Appendix B presents preliminary liner stress analyses based on assumed rock loads and simple ring analysis. These analyses show very low stress levels (less than 1.5 ksi) for all cases in which 0.5-inch liners were assumed. Corrosion was considered by repeating analyses with thicknesses as small as 0.15 inches. Even with this thickness, stresses in the liner remained below the yield stress of at least 30 ksi. Although the calculations involved numerous simplifying assumptions, they do produce the expected results. It is difficult to conceive of repository conditions under which the liner modeled as a ring would behave inelastically. Consequently, only a few two-dimensional confirmatory analyses are assumed.

A potentially more significant scenario involves a liner transversed by a fault. Fault movement could result from thermally-induced stresses or a dynamic event. Three-dimensional analyses using 3DEC and STRES3D are planned to evaluate displacement magnitude. In such analyses, the boreholes will not necessarily be explicitly modeled.

It is suggested that one (1) week of confirmatory two-dimensional analyses be followed by three weeks of preliminary three-dimensional analyses. Roger Hart is proposed as the principal investigator.

TOPICAL REPORT H: Disturbed Zone

The NRC GTP on the disturbed zone states that

> NRC considers that . . . a disturbed zone of . . . five opening heights for non-circular openings, or fifty meters, whichever is largest, from any underground opening, excluding surface shafts and boreholes, may be the minimum appropriate distance for use in calculations of compliance with the pre-waste emplacement groundwater travel time criterion (10CFR60.113(a)(2)) [Draft GTP: Interpretation and Identification of the Disturbed Zone in the High Level Waste Rule (10CFR60), June 20, 1986, p. 17).

The GTP goes on to state that DOE should calculate the extent of the disturbed zone and discusses some effects that should be accounted for in the analyses. It should be noted that DOE "will justify a definition for the disturbed zone as a boundary 10m or less below any underground opening . . ." (CDSCP, p. 8.4-66).

Analyses to be performed for this topical report will be limited to the consideration of stress redistribution and thermomechanical effects around vertical emplacement drifts. Numerical analyses will be performed using UDEC, together with joint constitutive models employing non-linear normal stiffnesses. The non-linear joint normal stiffnesses are required to determine permeability changes. The result of these analyses will be plots of relative permeability change versus distance from the excavation. Similar plots are contained in Case and Kelsall (1987) and Christianson and Lorig (1988).

A minimum of six (6) weeks is recommended for this work, with Mark Christianson as principal investigator.

References

Case, John B. and Peter C. Kelsall. "Modification of Rock Mass Permeability in the Zone Surrounding a Shaft in Fractured Welded Tuff," Sandia Report SAND86-7001, March 1987.

Christianson, M. and L. Lorig. "Appendix A: Preliminary Numerical Sensitivity Study of Factors Influencing the Change in Permeability in Rock Mass Surrounding a Shaft in Tuff," Appendix to Itasca Consulting Group, Document Review 006-01-59 for the U.S. NRC, April 1988.

TOPICAL REPORT I: Continuum versus Discontinuum Modeling for NNWSI

NNWSI is currently not planning to extensively use discontinuum modeling in performance calculations of the mechanical response of the rock mass to heating and mining-induced disturbance. [An exception to this is that the distinct element method is identified for possible use in wedge analysis for emplacement holes (see CDSCP Section 8.3.2.2.6).] Its present approach is to develop a continuum constitutive law for tuff which includes nonlinear effects of joint behavior. This continuum material model will then be examined in light of field data from testing at the ES facility.

This task is aimed at determination of the adequacy of a continuum versus discontinuum modeling approach for problems at NNWSI. To address this objective, the following questions will be investigated.

1. At what scale of analysis (i.e., emplacement hole, drift, or repository) is it feasible to use the distinct element method?

2. At each scale, what effect does detail in modeling of joint structure have on the results of thermomechanical analysis? The tuff has approximately 13 fractures/meter at dips of 80 to 90 degrees, with much less frequent fracture at the inclinations (see CDSCP Table 6-15, p. 6-61). All of these fractures do not equally control the overall behavior. The question to be addressed is how many of these fractures need to be modeled and at what point is a continuum model sufficient for bounding the rock mass response?

3. What general procedures are necessary for development of a continuum constitutive law?

An effort of six (6) person-weeks (rather than the previously suggested four (4) person-weeks) is suggested for this topical report. The reason for this is that the issue of continuum versus discontinuum modeling will continue to be important in the NNWSI project. Mark Board is proposed as principal investigator.

III. SEAL SYSTEM TOPICAL REPORTS

Topical reports J through M concern various aspects of the seal system. It is clear that there is considerable overlap among the four reports. This may prove sufficient time in which to set up a team that could tackle all four—i.e., we could probably justify the following:

(1) geochemist, 1/2 week on each report;

(2) hydrologist, 1/2 week on each report; and

(3) radionuclide release expert, ???

One very desirable starting point for all four would be a fairly comprehensive computer literature search, to be done through the University of Arizona library.

Jaak Daemen will be the principal investigator for all seal system topical reports.

TOPICAL REPORT J: Borehole and Shaft Seals in the Unsaturated Zone

Unique needs for borehole and shaft seals in the unsaturated zone are :

(1) airflow control;

(2) volume change (shrinkage) control; and

(3) dessication effects.

GTP format should be followed—i.e., essentially review GTP in light of unique needs imposed by emplacement in unsaturated zone.

We need to review NNWSI sealing documents, identify GTP needs/requirements that have been addressed and those that are not addressed.

Analyses in support could (should?) include:

- thermally-driven airflow analysis
- thermally-driven water (steam?) flow
- water inflow from surface

] could rapidly start exceeding allowed level of effort

- implications of water level changes? (Szymanski's report concepts?)

We should identify, review, summarize literature on free drainage:

(1) a week is the absolute minimum;

(2) 2 weeks may allow preliminary inclusion of discussion of geomechanical/thermal/mechanical effects.

For seals, we should identify (locate), review, summarize, critically evaluate relevant literature on seal performance in unsaturated environment:

- environmental definition: summarize from available NNWSI reports (1 week?)

- earthen seals: bentonite/clay/crushed tuff performance in airflow/intermittent water flow environment (1-2 weeks?)

- cement/grout/concrete seals: evaluate performance in airflow/intermittent water flow environment (1-2 weeks?)

- rock/water/seal interactions: chemistry (1-2 weeks?)

Manpower Recommendations:

- 1-2 weeks, hydrologist: free drainage (unsaturated zone, thermal effects, chemical effects)

- 1-2 weeks, geochemist: (cement/bentonite/tuff)

TOPICAL REPORT K: Material Selection for Sealing Materials

Summarize/review various reports that have presented methodology, basis and testing needs for repository sealing in general (generic).

Identify aspects that distinguish sealing in an unsaturated environment from sealing in a saturated environment.

Discuss implications of unsaturated environment for seal performance.

Material selection is likely to lead to generally proposed sealants: cementitious (cement, concrete); earthen (bentonite/crushed rock).

Selection methodology should include:

- performance (design) requirements
- material performance parameters
- environmental factors affecting performance
  - temperature
  - humidity, water/air flow
  - chemistry, rock, water

Presumably, in-situ environment will be obtained from review of published NNWSI documents.

Basis: performance requirements

meet EPA/NRC requirements

independent performance analysis? (probably beyond scope of task)

make some numerical variations/sensitivity analyses on Fernandez et al. (1987)?

bring in performance analysis specialist for one week (critical review of Fernandez et al., 1987; expert judgment modifications of numerical conclusions)?

bring in radionuclide release specialist?

To what extent should basis include major future changes? Szymanski scenarios?

Testing Needs: demonstrate compliance with performance/design objectives

Performance Criteria: flow -> permeability

Manpower Recommendations:

1 week each, hydrologist and geochemist

TOPICAL REPORT L: Performance Confirmation Test Needs for Seals

Identify regulatory performance confirmation requirements:

- in general
- specifically for seals
- specific aspects for unsaturated zone
- testing needs
- testing schedule

Consideration needs to be given to in-situ testing vs laboratory testing (respective advantages and disadvantages).

Main aspect for testing requirements will be testing in tuff, which tends to be chemically quite active.

Laboratory testing can start earlier and, most importantly, allows closer control of test environment (might miss some unexpected interaction effects: initiate some in-situ tests ASAP, and design experiments so that they can be continued until permanent closure).

Manpower Recommendations:

1 week each, hydrologist and geochemist

TOPICAL REPORT M: EXTRAPOLATION OF SHORT-TERM TEST DATA FOR LONG-TERM SEAL PERFORMANCE

Summarize generic strategies that have been proposed and/or developed for:

- extrapolation of long-term repository performance
- specifically, extrapolation of long-term seal performance
  - natural/manmade analogs
  - geochemical stability predictions
  - thermodynamic stability
- accelerated (aging) testing
- testing of artificially-aged/deteriorated seals under ranges of (extremes of) expected future conditions

Identify parameters that are likely to change with time and would (might) affect seal performance:

- rock deformation -> seal loading (tectonically-induced/thermally-induced rock alteration/deterioration)
- seal deformation (expansion/shrinkage as a function of expected environment)
- loads on seals (e.g., backfill, thermal)
- wetting/drying cycles

Manpower Recommendation:

2 weeks, geochemist (cement/bentonite/tuff)

IV. ESF TOPICAL REPORT (Topical Report N — Exploratory Shaft Facility Design)

This topical report will discuss the likely impacts of ESF construction on design and operation of the final repository. Because much of the ESF will eventually be incorporated into the repository, construction of the ESF facility is subject to requirements of 10CFR60 (in particular, Section 60.133, Additional Design Criteria for the Underground Facility).

The topical report will include discussion in the following areas:

(1) review of latest ESF design (such as described in Section 8.4 of the CDSCP);

(2) construction monitoring (blast monitoring, displacement monitoring, etc.) which should occur during ESF construction [see, for example, Cording et al. (1975)];

(3) construction specifications, including review of subsurface QA requirements (see, for example, Morrison-Knudson and Fluor, 1987); and

(4) evaluation of potential adverse impacts of construction on ability to characterize the site and construct repository.

A minimum of six weeks is proposed for this work, with Krishan Wahi as principal investigator.

References

Cording, E. J., A. J. Hendron, Jr., W. H. Hansmire, J. W. Mahar, H. H. MacPherson, R. A. Jones and T. D. O'Rourke. "Methods for Geotechnical Observations and Instrumentation in Tunneling," Department of Civil Engineering Department, University of Illinois at Urbana-Champaign, Report to NSF, UILU-ENG 75 2022, December 1975.

Morrison-Knudson Engineers, Inc. and Fluor Technology Inc. "Subsurface Quality Assurance Practices," Report Under Contract AC02-83WM46656, AC02-87CH10290, AC02-83CH10140, DOE/CH/46656-07, 1987.

V. SCHEDULE

Figure V-1 shows the schedule for completing topical reports. The line segments indicate the time period during which work on the topical report is expected to be on-going. Initials of the Principal Investigator are shown above the line segment and the suggested person-weeks are shown in parentheses below the line segment.

Figure V-1

SCHEDULE FOR TOPICAL REPORTS

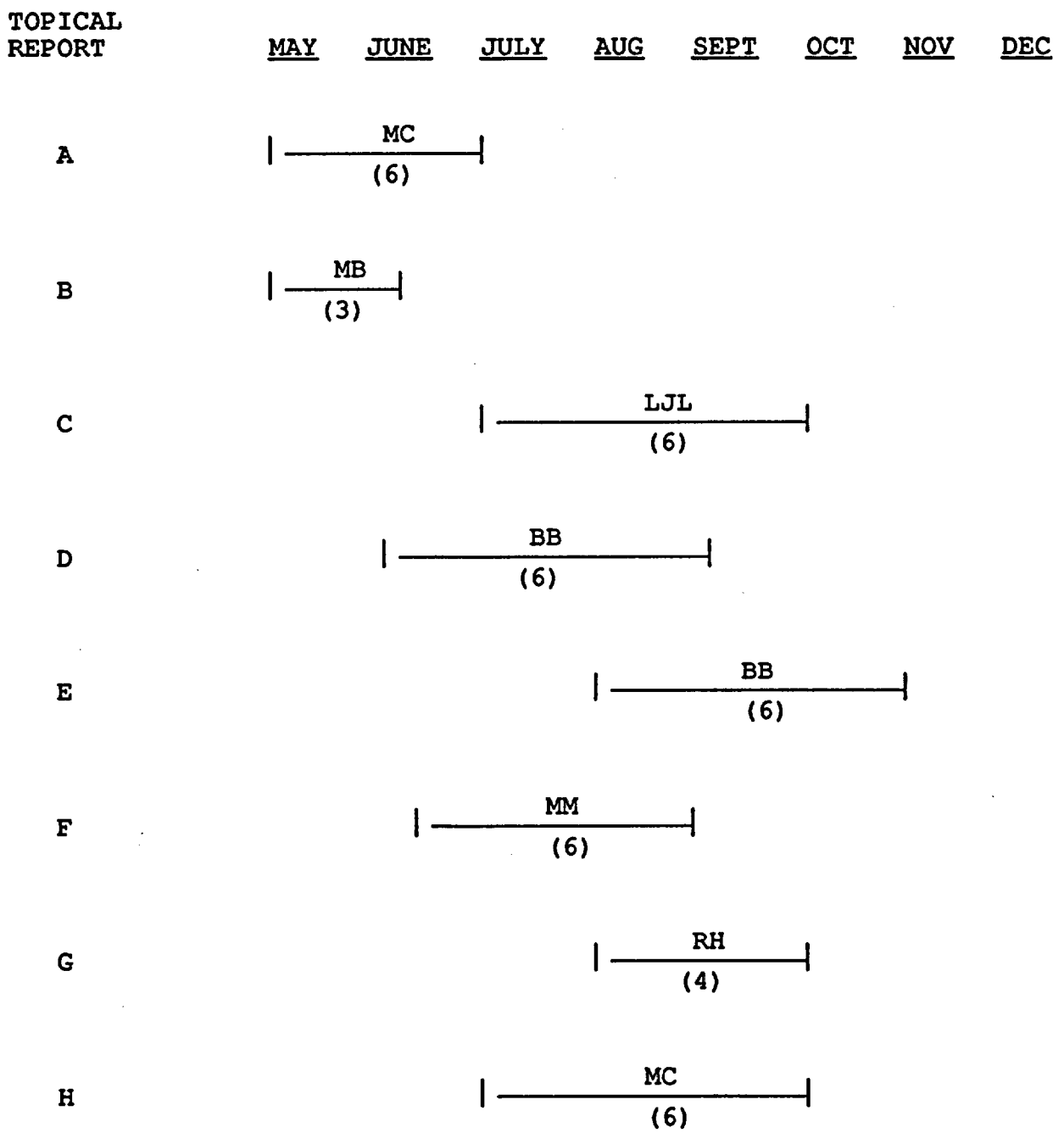
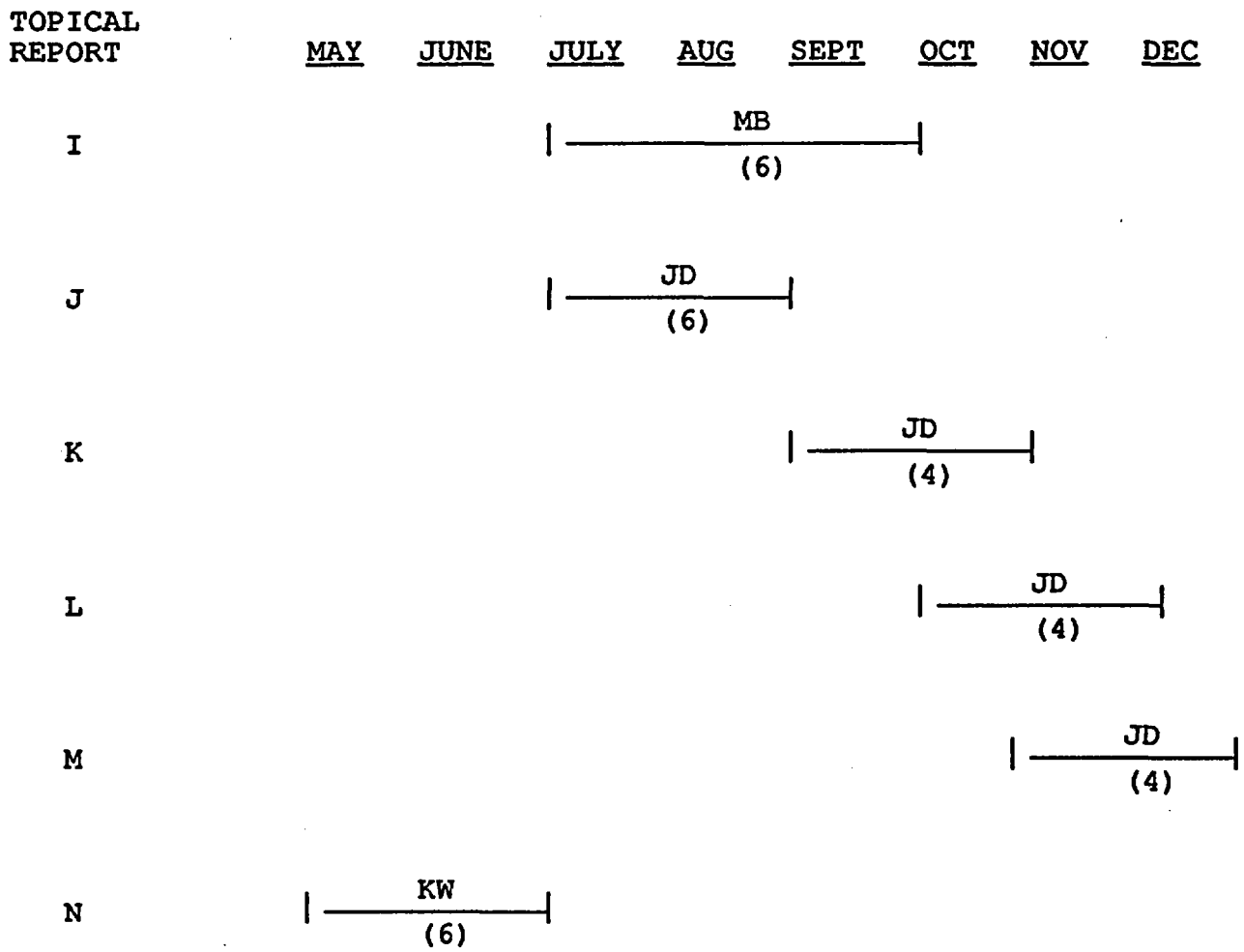


Fig. V-1 (continued)



APPENDIX

LETTER FROM DAVID TIKTINKSY TO ROGER HART

March 28, 1988

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

MAR 28 1988

RECEI

Mr. Roger Hart
Itasca Consulting Group
P.O. Box 14806
Minneapolis, Minnesota 55414

Dear Mr. Hart:

ITASCA should perform the following work under task order 001 and 006 of the contract NRC-02-85-002 in support of the Geotechnical Engineering / Design section's ongoing work by the staff. These activities involve the preparation of topical reports. ITASCA should be prepared to discuss the topical reports during meetings to be held in Rockville, Md. at NRC headquarters after outlines and preliminary work are completed. ITASCA should prepare a draft topical report for the following topics.

1) Analyses of alternative waste emplacement concepts on performance of drifts and boreholes. This topical report should consider the alternative of horizontal versus vertical emplacement for waste canisters for a repository at Yucca Mountain. Analyses should be performed as the basis for conclusions in the topical report. This effort should take no more than 6 person weeks.

2) Sensitivity study of variations of heat loading for a repository at Yucca Mountain. This topical report should discuss the impacts on stability of the openings during operation/retrieval and the effects of varying the areal heat loading on stability. This effort should take no more than 6 person weeks and should be backed up by analyses.

3) Stability of openings during retrieval. This topical report should discuss the stability of openings for retrieval for both horizontal and vertical emplacement. Analyses should also be performed to investigate the effects of heating / cooling a repository and the effect on retrieval. This effort should take no more than 6 person weeks.

4) Emplacement Borehole Liner Stability analyses. This topical report should analyse the effects of rock movement and heat on the stability of the borehole liner and the subsequent effect on maintaining the retrieval option. In addition the work performed on this topical report should provide the basis for review of DOE's similar analyses. This effort should take no more than 6 person weeks.

5) Disturbed zone. This topical report should provide the basis for review of the disturbed zone proposed by DOE for a potential repository at Yucca Mountain from the thermomechanical point of view. The NRC GTP on the Disturbed zone should be used as a basis for the topical report. Analyses should be performed to back up any conclusions made in the topical report. This effort should take no more than 6 person weeks.

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6) Borehole and Shaft Seals in the Unsaturated Zone. This topical report should discuss the unique needs for borehole and shaft seals in the unsaturated zone. The NRC GTP on borehole and shaft seals should be used as a guide for this topical report. In addition, current concepts of free drainage proposed in the CDSCP by DOE should also be covered in the topical report. This effort should take no more than 6 person weeks.

7) Material selection for sealing materials for a repository at Yucca Mountain. This topical report should discuss the methodology, basis and testing needs for material selection for seals for a repository in the unsaturated zone. This effort should take no more than 4 person weeks.

8) Performance confirmation test needs for seals. This topical report should discuss what tests are needed during the performance confirmation period for seals in the unsaturated zone. This effort should take no more than 4 person weeks.

9) Extrapolation of short term test data for long term seal performance. This topical report should discuss how data which will be obtained during a relatively short period of time may be extrapolated for the post closure period of performance. This effort should take no more than 4 person weeks.

10) Exploratory shaft facility design. This topical report should discuss construction monitoring that should take place during ESF construction, construction specifications, and evaluation of adverse impacts of construction on repository construction. This effort should take no more than 6 person weeks.

11) Discontinuum vs. Continuum analyses for NNWSI. This topical report should investigate the use of continuum and discontinuum analyses for NNWSI. The document that was prepared for BWIP should be used as a basis for this topical report. This effort should take no more than 4 person weeks.

Other work to be performed by ITASCA is as follows:

1) Document review of the MUDEC code and the applicability of using an implicit thermal calculation scheme. This review should take no more than 10 person days.

2) Review of the draft of the NRC GTP on Anticipated and Unanticipated Events and processes. This review should take no more than 5 person days.

3) Prior approval was given for a senior consultant to attend a QA review meeting for the CDSCP draft comments in Rockville, Md. held in late February, 1988.

4) Two senior engineers should attend a one day workshop on the CDSCP draft comments which will be held in Washington, D.C. in late March, 1988.

The action taken by this letter is considered to be within the scope of the current contract NRC-02-85-002. No changes to costs or delivery of contracted products are authorized. Please notify me immediately if you believe this letter would result in changes to costs or delivery of contracted products. I can be reached on (301) 492-0534.

Sincerely,

David Tiktinsky

David H. Tiktinsky
Technical Review Branch
Division of High-Level Waste Management
Office of Nuclear Material Safety
and Safeguards

cc: E. Knox, NRC