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ITASCA
Consulting Group, Inc.

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 our trip report for the meeting on Review Outline for BWIP Site Technical Position on In-Situ Testing held in Silver Spring on 15 May 1986. Please call me if you have any questions.

Sincerely,

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 TRIP REPORT

DATES: 15 May 1986

LOCATION: Nuclear Regulatory Commission
Silver Spring, Maryland

PURPOSE: Review Outline for BWIP Site Technical Position on In-Situ Testing

ITASCA ATTENDEES: M. Board and R. Hart (Itasca Consulting Group)

PREPARED BY: M. Board and R. Hart

SUMMARY

The meeting was attended by NRC technical staff from the Basalt, Tuff and Salt Programs. The draft Itasca STP outline was presented by M. Board. J. Buckley and M. Nataraja presented the DOE SCP Chapter 8.3 outline. Chapter 8.3 includes a discussion of planned testing and analyses for design and performance assessment activities. To aid in NRC's SCP review, it was determined that the STP should be written in the same format. A copy of the revised outline for the BWIP STP is attached. The majority of the remainder of the day was spent in discussion of the re-writing of the draft outline to conform with the SCP. Comparisons were made between the BWIP STP and those for the Tuff and Salt Programs. It was determined that there is little overlap (except in the broad rationale) between the BWIP and Salt STPs; however, there is a good deal of similarity in the BWIP and Tuff STPs. Much of the rationale can be used for the Tuff STP.

Following the STP discussions, the FLAC and μDEC personal computer codes were demonstrated to David Tiktinsky and John Buckley. These codes will form the basis of two workshops to be held with NRC staff during July or August. The codes and user manuals were left with David Tiktinsky.

SPECIFIC COMMENTS

The basic ideas on the BWIP rationale and testing plan were reviewed by M. Board. The major points of our proposed approach are described below.

The BWIP ESTF test plan was based heavily on the use of point compression testing on the walls of the ESTF facility to determine the stress-strain behavior of the rock mass. Due to the variability of basalt intraflow structures and the high stiffness of the flows, it appears to be of little use to conduct these tests at a few locations and orientations in the ESTF. It is felt that this type of test (e.g., plate bearing) will only compress the skin of the excavation; its use in design and performance assessment is not obvious. Because it is difficult to characterize the jointing even short distances within the rock mass, the analysis of these test results may prove difficult and ambiguous. Instead, two major points must be proven in the ESTF:

(1) that stable openings can be constructed without excessive difficulty; and

(2) that the behavior of these excavations (i.e., the yield behavior of the rock mass, the displacement response, etc.) under ambient and elevated thermal conditions must be shown to be predictable, with the major physical phenomena understood. The tests conducted in the ESTF should lead to a means of bounding the mechanical response of the rock mass as well as increasing the confidence in the numerical modeling.

It was proposed that a different approach to in-situ testing than that taken by BWIP is prudent. Rather than a "point" approach to defining a mechanical model using a number of plate bearing and small single flatjack tests, measurement of gross rock mass response over a wide range of rock mass intra-flow structures is suggested. This "integrated" approach can be accomplished by driving additional drifts from the ES facility in an attempt to explore the Cohassett intraflow structures. These drifts are to be instrumented and results compared to empirical and numerical models. As the volume of excavation increases, so does the understanding of the mechanical behavior and the confidence in the modeling prediction.

It is also suggested that a drift and pillar or "mine-by" experiment be conducted with full-scale repository openings in much the same manner as suggested by BWIP. However, we feel that this test allows an opportunity to raise a large volume of rock to elevated temperature in a simple configuration. It is suggested that heaters be placed in the conceptual horizontal configuration within the pillar created by the mine-by drifts. These heaters are to be energized and left on for significant periods of time (i.e., a continuing effort during repository development). Data sufficient for the license application can be obtained within the ES timeframe, but additional long-term rock and support response can be examined thereafter through a low-grade maintenance of the experiment. The details of this approach will be given in the STP.

Respectfully submitted,

Roger D Hart

Roger D. Hart
Itasca Consulting Group, Inc.

attach
rdh/ks

OUTLINE FOR SITE TECHNICAL POSITION

FOR IN-SITU TESTING AT THE HANFORD SITE

8.3 Planned Tests, Analyses, and Studies

A. Introduction — The BWIP Site

1. Location

2. General Geology of the Site

   i. Pasco Basin/flow origin
   ii. Typical intraflow structure

3. Reference Repository Locations

   i. Grande Ronde Flow System
   ii. Cohassett Flow

      a. thickness, dip
      b. intraflow structure
      c. lateral, vertical variability
      d. stress state
      e. methane
      f. groundwater

8.3.2 Repository Program

8.3.2.1 Overview

8.3.2.1.1 Introduction

8.2.3.1.2 Geomechanics in the Repository Design Process

8.2.3.1.2.1 flow chart illustrating determination of structural repository design, allowable gross thermal load

8.2.3.1.2.2 definition of design objectives and criteria

8.2.3.1.2.3 the use of empirical and numerical design models—a modeling strategy

8.2.3.1.2.4 the role of geomechanics in design

8.3.2.1.3 Enumeration and Prioritization of Geomechanical Information Needs

8.3.2.1.3.1 Geotechnical Description of the Rock Mass

8.3.2.1.3.1.1 determination of in-situ state of stress

8.3.2.1.3.1.2 investigation of lateral variability of Cohassett Flow

8.3.2.1.3.1.3 investigation of vertical variability of Cohassett Flow

8.3.2.1.3.2 Determination of constructability of excavations and emplacement boreholes and documentation of the effects of construction on the rock mass

8.3.2.1.3.3 Documentation of the stability of excavated openings and emplacement boreholes under the conditions of the variable intraflow structures within the Cohassett Flow; evaluation of thermal loading on excavation and emplacement hole stability; determination of the extent of yield around openings; identification of rock mass failure mode

8.3.2.1.3.4 Determination of a thermomechanical constitutive model and constitutive properties for jointed basalt in the various ground conditions encountered in the repository development (the model must have the ability to represent the yield behavior of the rock mass); demonstration of an understanding of the thermal and mechanical behavior of the rock rather than merely a curve-fitting exercise

8.3.2.1.3.5 Demonstration that models of the thermomechanical behavior of the rock mass (numerical or otherwise) can adequately predict the range of behavior exhibited by the rock mass in the ES facility; determination of the bounds or conservatism in the modeling approach.

8.3.2.1.4 Strategy for Resolution of Information Needs through In-Situ Testing

8.3.2.1.4.1 "representativeness" of in-situ testing in basalt

8.3.2.1.4.1.1 variability of basalt

8.3.2.1.4.1.2 scale effects — concept of continuum vs discontinuum approach to constitutive model development

8.3.2.1.4.1.3 effects of anisotropy

8.3.2.1.4.1.4 determination of how many tests must be conducted and at what scale

8.3.2.1.4.1.5 duration of testing

8.3.2.1.4.2 measurement of the large scale or "integrated" response of the rock mass

8.3.2.1.4.2.1 Discuss the idea that the basalt flows are highly variable in nature, both laterally and vertically. It makes little sense to attempt to measure point rock properties using techniques which compress only the damaged skin of the opening because they will not likely represent the rock mass as a whole. A better approach is to measure the "integrated" response of the rock mass resulting from single and multiple excavations in the widest possible range of the ground conditions to be encountered. This is supplemented by a few "key" tests, if needed, to help better define constitutive properties and thermal and coupling effects on the rock mass.

8.3.2.1.4.2.2 Discuss the strategy for definition of a set of numerical models to be used in design and risk assessment. Discuss the instrumentation of excavation and field testing as a means of providing proper constitutive laws and properties as well as a method of providing for code verification. We wish to emphasize the importance of the <u>practical</u> demonstration of the ability to excavate stable openings in the basalt and that, as greater experience is gained in more types of ground, we will gain greater confidence in the ability to predict rock mass response with models.

8.3.2.1.5 Components of Test Plan

8.3.2.1.5.1 site characterization, exploration, qualification of flow variability

8.3.2.1.5.2 examination of excavation response and stability; determination of yield behavior and formation of disturbed zone

8.3.2.1.5.3 examination of the thermomechanical response of emplacement boreholes and excavations under simulated repository conditions

8.3.2.1.5.4 determination/verification of a thermomechanical constitutive model for in-situ basalt

8.3.2.1.5.5 verification of geotechnical models used in design; assessment of the conservatism in the modeling approach

8.3.2.2 Verification or Measurement of Host Rock Environment

8.3.2.2.1 outline of exploration drifting and drilling

8.3.2.2.2 construction monitoring

8.3.2.2.2.1 drilling, blasting

8.3.2.2.2.2 methane, water inflow

8.3.2.2.2.3 air temperature, humidity

8.3.2.2.2.4 diamond drilling

8.3.2.2.3 geotechnical mapping

8.3.2.2.3.1 geotechnical classification, development of an engineering basis for classifying rock mass response and support performance

8.3.2.2.3.2 data base management

8.3.2.2.3.3 in-situ stress measurement

8.3.2.2.3.4 geophysical logging

8.3.2.3 Coupled Interactive Tests

8.3.2.3.1 Discussion of near field coupled phenomena in basalt

8.3.2.3.2 Discussion of methodology for determining need for coupled testing

8.3.2.4 Design Optimization Activities and Tests

8.3.2.4.1 Shaft Response

8.3.2.4.1.1 rationale

8.3.2.4.1.2 pore pressure monitoring behind liner

8.3.2.4.1.3 liner stress change

8.3.2.4.1.4 liner closure measurement

8.3.2.4.1.5 liner sealer and disturbed zone

8.3.2.4.2 Excavation Stability

8.3.2.4.2.1 rationale

8.3.2.4.2.2 single headings driven to explore intraflow structure variability

8.3.2.4.2.2.1 mining plan description and operation

8.3.2.4.2.2.2 instrumentation/observational methods

8.3.2.4.2.2.3 analysis/model verification

8.3.2.4.2.3 multiple excavations

8.3.2.4.2.3.1 full-scale excavations (heading and bench)

8.3.2.4.2.3.2 mine-by experiment description and operation

8.3.2.4.2.3.3 instrumentation/observational methods

8.3.2.4.2.3.4 analysis/model verification

8.3.2.4.2.4 emplacement boreholes

8.3.2.4.2.4.1 drilling plan, description and operation

8.3.2.4.2.4.2 instrumentation/observational methods

8.3.2.4.2.4.3 analysis

8.3.2.4.2.5 drift and borehole stability at elevated temperature

8.3.2.4.2.5.1 rationale

8.3.2.4.2.5.2 test set-up — heaters to be placed in pillar in mine-by test; raise rock mass temperature

8.3.2.4.2.5.3 test operation/borehole performance/support performance

8.3.2.4.2.5.4 instrumentation/observational methods

8.3.2.4.2.5.5 analysis/verification of models/constitutive law verification

8.3.2.4.2.5.6 long-term test operation

8.3.2.4.2.6 constitutive model development

8.3.2.4.2.6.1 rationale

8.3.2.4.2.6.2 constitutive model development process

8.3.2.5 Repository Modeling

8.3.2.5.1 Repository Modeling Process

8.3.2.5.1.1 physical scale

8.3.2.5.1.2 time scale

8.3.2.5.1.3 coupling phenomena

8.3.2.5.2 Model Development and Verification

8.3.2.5.2.1 model types

8.3.2.5.2.2 required capabilities

8.3.2.5.2.3 model validation

8.3.2.5.2.4 defining model conservatism and confidence

8.3.3 Seal System Program

8.3.3.1 Overview

8.3.3.1.1 geomechanical performance of seals in repository environment

8.3.3.1.2 information needs

8.3.3.2 Seal Material Testing

8.3.3.2.1 rooms and drifts

8.3.3.2.1.1 materials (cementitious, earthen, basalt)

8.3.3.2.1.2 placement techniques, in-place properties, documentation of drift-backfill surface, damage zone treatment

8.3.3.2.1.3 durability

8.3.3.2.1.4 groundwater flow in backfill

COST BREAK-OUT

Labor

M. Board	16 hrs @ $22.02/hr	$ 352.32
R. Hart	16 hrs @ $22.12/hr	353.92
	TOTAL LABOR	$ 706.24

Actual Expenses

Travel

Airfare (to WDC)	
Board	$ 500.00
Hart	500.00
Miscellaneous Travel Expenses (taxis)	8.00

Motel

Board (1 night @ $44.00/night)	44.00
Hart (1 night @ $44.00/night)	44.00

Meals

Board	$ 11.67
Hart	8.00

Miscellaneous Expenses

Board (telephone)	$ 9.84

TOTAL EXPENSES: $ 1,125.51

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