DEC 14 1984

~~102.5~~/DCG/84/12/7/0

- 1 -

DISTRIBUTION:
WM r/f
WMEG r/f
NMSS r/f
LBarrett
NTanious
DGupta
DTiktinsky
JGreeves
HMiller
LHigginbotham
MKnapp
JOBunting
RBrowning
MBell
PDR

MEMORANDUM FOR: King Stablein
Repository Projects Branch
Division of Waste Management

FROM: Naiem S. Tanious
Engineering Branch
Division of Waste Management

Dinesh C. Gupta
Engineering Branch
Division of Waste Management

David H. Tiktinsky
Engineering Branch
Division of Waste Management

SUBJECT: COMMENTS ON NNWSI SANDIA AND USGS DESIGN/ROCK MECHANICS DATA REVIEWS

During July 18-20, 1984, NRC staff visited the Sandia National Laboratories, Albuquerque, New Mexico, and reviewed NNWSI Design/Rock Mechanics data. Later, during September 24-25, 1984, the staff reviewed additional NNWSI Design/Rock Mechanics data at the USGS Office, Menlo Park, California. During the two data reviews, we identified data and requested copies of relevant reports from DOE. Most of the requested information was received in November 1984, and we have now completed the data review.

Based on our review of the data and the additional information requested from DOE, we have prepared the enclosed report. The report summarizes our review findings and documents our observations/comments on data, tests, and procedures. Recommendations to DOE have also been suggested, where deemed appropriate.

WM Record File 102
WM Project 11
Docket No.
PDR ✓
LPDR ✓
Distribution:
(Return to WM, 623-SS) 2

OFC	WMEG	WMEG	WMEG	WMEG	WMEG	
NAME	DCGupta	NTanious	DTiktinsky	MSNataraja	JGreeves	
DATE	12/14/84	12/14/84	12/14/84	12/14/84	12/14/84	

NV8447 69

DEC 14 1984

102.5/DCG/84/12/7/0

We have coordinated the information contained in the attached report with the Repository Projects Branch, and believe it is appropriate to transmit our comments to DOE.

Naiem S. Tanious
Engineering Branch
Division of Waste Management

for Dinesh C. Gupta
Engineering Branch
Division of Waste Management

David H. Tiktinsky
Engineering Branch
Division of Waste Management

Enclosure:
As stated

cc: Lake Barrett
Seth Coplan
Mysore Nataraja
John Greeves
Philip Justus

OFC	WMEG	WMEG	WMEG	WMEG	WMEG			
NAME	DCGupta:cj	NTanious	DTiktinsky	MSNataraja	JGreeves			
DATE	/ /84	/ /84	/ /84	/ /84	/ /84			

INTRODUCTION:

During July 18-20, 1984, the NRC staff visited the Sandia National Laboratories, Albuquerque, New Mexico, to review NNWSI Design/Rock Mechanics data. Later, during September 24-25, 1984 the staff reviewed additional design/rock mechanics data at the United States Geological Survey (USGS) office at Menlo Park, California. The Sandia data contained results from G-Tunnel heated block test, small diameter heater test, rock mechanics laboratory and field tests, and thermal and bulk properties tests. The USGS data consisted of results from hydraulic fracturing insitu stress tests, tuff strength tests, and tuff permeability tests.

During the Sandia and USGS review visits, hard copies of some data and reports were requested from DOE. These copies were received in November 1984.

This report is a summary of the review at Sandia/USGS and the recently received data and pertinent reports. It documents our observations/comments and recommendations to DOE.

G-Tunnel Heated Block Experiment

Purpose:

The objectives of the heated block experiment are to: determine the thermo-mechanical properties of the jointed tuff in the G-tunnel, and gain experience with the measurement technique for later use during the site characterization at the Yucca Mountain site. Specifically, the heated block experiment is to provide estimates of thermal conductivity, insitu modulus of deformation, joint deformation and strength and Poisson's ratio of the insitu rock mass.

Observations/Comments

- At the time of data review in July 1984, the NRC staff requested the DOE to provide sufficient data to perform an independent analysis on one loading cycle of the test. The DOE has not provided the requested data.
- It is noted that some instruments did not function during testing and additional work may be needed to make further improvements in some of the measuring instruments.

Small Diameter Heater Test in Tuff

Purpose:

The small diameter heater experiments were conducted in welded and non-welded tuff to: (1) measure the rock temperature distribution in the immediate vicinity of the heater hole; (2) monitor the possible migration of water around the heater; and (3) evaluate instruments for measuring rock surface temperature. The test is a prototype for underground site characterization work in the insitu test facility.

Observations/Comments

° Detailed data for these tests have not yet been received from the DOE.

° Based on our review of the available information, we have no comments on these tests.

Rock Mass Classification

Purpose:

The purpose of rock mass classification is to arrive at rock competency rating and to assign relative qualitative assessment of the Grouse Canyon Member (welded tuff in G-tunnel). Specifically, the RQD, fracture orientation and fracture planarity are to be documented.

Observations/Comments

° Based on our review, we find that most of the steps of data reduction and analyses are not clearly documented. Therefore, the flow of information between the raw data to the final summary is not very clear. The procedures and analysis steps need further documentation.

° The final rock classification ratings have not been provided to the NRC.

° At the time of the review, we were informed that the rock mass classification procedures are documented in the report SAND-2034. The NRC staff has requested the DOE to provide a copy of the SAND-2034 report. However, the report has not been released to the NRC staff.

Field Testing

Purpose:

The objectives of field testing at G-tunnel are to: develop a data base for a welded tuff that may be similar to the Topopah Spring member, and to develop data gathering techniques and procedures that will be used in the insitu test facility. The field tests reviewed were the Goodman Jack test, and the Insitu Permeability test.

Observations/Comments

The following observations on field testing data and procedures are made:

A. Goodman Jack Test

- The procedures used were documented adequately, however it is not possible from the data package to determine if all procedures were followed (i.e., no statements were noted and no indication of independent checks were identified).

- Calibration data were not available in the data file. These should be included in data files on Goodman Jack Testing.

- Acceptance/rejection criteria for the test data were not documented. Future tests should document these criteria.

B. Insitu Permeability Measurement Using Zone Packer Injection Method

- This test as performed appeared to be intended primarily for development of testing procedures. Based on our review of the test results, we suggest that for future tests the data files should be complete (i.e., include documentation for calibration tests, pretesting, borehole logs, and test preparation).

Rock Mechanics Laboratory Tests

Purpose:

The purpose of these rock mechanics laboratory tests is to determine the mechanical properties of the Topopah Spring and Calico Hills tuff members and the effect of temperature and pore pressure on their strength and Young's modulus. Specifically these tests were uniaxial and triaxial compressive

strength to determine parameters such as compressive strength and its change with confinement, coefficient of internal friction, Poisson's ratio, and Young's modulus. Specimens for these tests were taken out of G-tunnel or cut from cores obtained from the USGS boreholes in Yucca Mountain.

Observations/Comments

° Triaxial compression tests were designed following prioritization of test parameters such as effects of water saturation, strain rate, confining pressure and temperature. However, due to unavailability of samples of similar mineralogy and bulk properties (i.e., samples of intact rock of adequate size) not all the test parameters were investigated in detail. Because of lack of samples, the results of such tests may not be representative of the rock properties and therefore important design and rock mechanics parameters may not have been investigated thoroughly.

° The data reduction steps for the triaxial compression tests were not always clearly documented (e.g. the data values quoted in the summary tables in SAND 82-1315 cannot be read directly from the plots). Also the following items were not included in the raw data sheets: a) lithologic description of rock; b) data and sampling environment; c) type of failure; and d) a sketch of original sample showing inhomogeneities and post failure conditions. This information should be documented.

Thermal and Bulk Properties Tests

Purpose:

The objectives of these laboratory tests are to determine the following properties: 1) coefficient of thermal expansion under confined conditions (stress is applied to the test specimens) and unconfined condition (stress free conditions), 2) porosity, grain density, dry bulk density, moisture content, and degree of saturation, and 3) thermal conductivity. Some of the properties were determined as a function of temperature, confining pressure and saturation. The tests were run on tuff rock specimens taken from cores supplied by USGS.

Observations/Comments

° In all the laboratory tests, one observation stands out: the tests were run under a well written procedure. This procedure included an operating procedure (procedure for running the test), instrument calibration with corrective action, non-conformance, revisions, and documentation. The procedure was used internally at Sandia and a similar one was used

externally with contractors to Sandia (for example Terratek, Incorporated, of Salt Lake City).

Sealing Tests

Purpose

The objective of these tests is to develop sealants and test their performance in tuff for use in a geologic repository. Specifically, the tests included the design of tuff-concrete mixes and running tests of its properties, such as strength permeability, chemical composition, geochemical interaction with the rock, etc.

Observations/Comments

° From our brief survey of the Sandia sealing program, it appears that the program and the data generated from various tests are technically sound. However, at the time of our visit, the test data were not assembled in easily retrievable files, and it was difficult to conduct a thorough review. It is suggested that the data be compiled, processed, and properly filed, so that it can be readily retrieved for independent review.

° It is recognized that the repository sealing test program is still in the conceptual stage. However, no particular grout or concrete mix has been identified in the Sandia report "SAND-83-1778, Repository Sealing concepts for the NNWSI Project - August 1984."

° The Sandia report SAND-83-1778 discusses grout injection as a part of sealing concepts proposed for isolating water-producing faults or fracture zones. However, pressure grouting the rock can sometimes create hydraulic fractures (depending on the rock, insitu stresses, etc.). The possibility of hydraulic fracturing and its effect on effectiveness of sealing has not been adequately discussed in the report.

In Situ Stress Hydraulic Fracturing Tests

Purpose:

The objective of the hydraulic fracturing test is to determine the insitu stress field in geologic horizons or strata intersected by the borehole. Specifically three principal stresses are determined, two are horizontal (or near horizontal) and the third is the vertical stress. The tests run at Yucca Mountain were at four boreholes: USW G-1, USW G-2, USW G-3, UE-25P#1.

Comments

° In the hydrofracture tests, it is important that the straddle packers be set at the correct pressure in a way that they would not move during pressurization of the hole before formation breakdown. In the data files, it is indicated that during some of the tests, the packers moved, thus nullifying these test runs. For these runs, the method of detecting the packer movements in the holes needs further documentation.

° Another usual problem with the packers is the leakage around their edges during pressurization resulting in discarding some of the test results. For cases where test results were discarded due to leakage around packers, the method of detecting such leakage needs further documentation.

° For determination of the orientation of the hydraulic fractures, imprints of the direction and inclination of fractures before and after the tests are needed. In all four tests, the USGS used televiewer logs (imprints were omitted) to show the rock fractures prior to the hydrofracture test. For determining the orientation of fractures after the test, the USGS used televiewer log in USW G-1 and impression packers in the other three holes. Thus, the methods of determining orientation of fractures before and after the tests were not consistent, except for core hole USW G-1. Because of the unavailability of consistent data for all tests, it is difficult to distinguish drilling-induced hydrofractures from other natural fractures.

° For determination of the magnitude of the maximum horizontal stress, it is necessary to find the tensile strength of the rock by conducting laboratory tests on cores. These tests were not run for most of the rock cores obtained from the four hydrofracture holes. Consequently, the maximum horizontal stress value was not determined. Although it is recognized that the tuff has fractures, it is not clear why in the majority of horizons hydraulically fractured, no tests were run for tensile strength.

° During drilling of USW G-1, several fault zones were identified from the core samples (USGS open file report 84-85, Page 2). This information should be considered by DOE in developing the NNWSI repository design.

2. Stress-Strain and Sliding Friction Tests

Purpose

The objective of the USGS laboratory stress-strain tests is to determine the strength and sliding friction coefficient of fractured tuff rock

specimens under confining stresses resembling insitu horizontal stresses. The tests were conducted on cores taken from outcropping members of two tuff rock formations: the Topopah Spring and the Bullfrog.

Observations/Comments

° The stress-strain tests were conducted on cores cut from rock samples taken from surface outcrops of the two formations. Because the samples from outcropping formations may not be fully representative of conditions of insitu rocks within and around the host rock formation, additional investigations and testing may be necessary to effectively support the results of these tests and allow their utilization in evaluating underground frictional sliding potential on fault surfaces either by insitu stresses or due to mining induced stresses.

3. Permeability Tests

Purpose

The objective of the USGS laboratory permeability tests was to study the change in permeability and fluid chemistry of Topopah Spring and Bullfrog Tuff members under conditions simulating a nuclear waste repository environment.

Observations/Comments

° The results from these tests showed a reduction in permeability of 25-50 percent when the tuff specimens were heated to 250°C. These results are based on laboratory tests on cores cut from outcrop blocks of tuff. Therefore, the results may not be fully representative of insitu conditions at the repository horizons where the permeability will be affected by different fracture systems. Since the permeability of rock is an important engineering parameter affecting many aspects of the repository design and performance, we recommend additional tests on rock samples taken from the horizons of interest. In addition, tests should be conducted on the rock mass in the underground insitu test facility.

Final Remarks

It should be noted that we did not review the data from a quality assurance audit point of view; however, we did find that in some cases the procedures, calibration, data acceptance/rejection criteria were not documented prior to starting the tests. We recommend that for future tests the DOE should document

the needed procedures in advance of starting the tests. Furthermore, any changes during the test should be documented.

We feel that our review of the available rock mechanics data at the Sandia/USGS office was very helpful to us. We were able to become familiar with the available data, the procedures used for collecting them, and with some of the laboratory testing apparatus. During our review, the Sandia/USGS staff were very cooperative and helpful in providing the needed assistance.