Department of Energy
Washington, DC 20585

SEP 7 1993

Mr. Joseph J. Holonich, Director
Repository Licensing & Quality Assurance
Project Directorate
Division of High-Level Waste Management
Office of Nuclear Material Safety
and Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr. Holonich:

Enclosed with this letter is a controlled copy of Study Plan 8.3.1.15.1.2, Revision 1, "Laboratory Thermal Expansion Testing," prepared by the U.S. Department of Energy (DOE) for the Yucca Mountain site. The Study Plan numbers correspond to the same numbers used in the Site Characterization Plan (SCP) for the Yucca Mountain site.

Study plans are prepared, reviewed, and approved under Yucca Mountain Site Characterization Project Office (YMPO) quality assurance procedures.

This study plan revision, which updates the study plan with respect to the current configuration of the Exploratory Studies Facility, was submitted to YMPO for review before the 1993 Department of Energy (DOE)/U.S. Nuclear Regulatory Commission (NRC) study plan agreement became effective. Therefore, DOE has reviewed the study plan for consistency with the content requirements for study plans, as given in Attachment B to the Summary of the DOE/NRC meeting on the Level-of-Detail for the SCP (May 7-8, 1986). Enclosure 2 is a list of technical procedures to be used in conjunction with this study plan.

It should be noted that there may be some inconsistencies in the milestone report titles and schedules given in this study plan and those in the SCP. Study plans, in general, represent a further evolution of the study in the areas related to schedules and milestones relative to the SCP, and as such, represent DOE's current plans.

Enclosure 3 provides a discussion of how Site Characterization Analysis Open Comment 55, which was directed to SCP Section 8.3.1.15.1.2, is addressed in this study plan.

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The Document Transmittal/Acknowledgement Record for your controlled copy of the study plan should be signed and dated and returned to the Document Control Center in Las Vegas, Nevada.

If you have any questions, please contact Ms. Sheila Long at 202-586-1447.

Sincerely,

Dwight E. Shelor
Associate Director for
Systems and Compliance
Office of Civilian Radioactive
Waste Management

Enclosures:
1. Study Plan 8.3.1.15.1.2, Revision 1
2. Technical Procedures for Study Plan 8.3.1.15.1.2
3. SCA Open Item Related to Study Plan 8.3.1.15.1.2

cc: w\enclosure
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ΓUDY 8.3.1.15.1.2 - LABORATORY THERMAL EXPANSION TESTING

¡4 "Procedure for Vacuum Saturation of Geologic Core Samples"

¡5 "Drying Geologic Samples to Constant Weight"

ı0 "Inspection of Samples Used in Thermal Properties Measurements"

1 "Inspection of Mechanical and Electrical Measuring Equipment Used for Thermal Properties Testing"

"Measurement of Thermal Expansion of Geologic Samples Using a Push R Dilatometer"

7 "Calibration of Temperature Sensors Used for Thermal Properties Testing'

5 "Calibration of Lawson Board Systems"

Encl 2

The specific concerns stated in the U.S. Nuclear Regulatory Commission's (NRC) Site Characterization Analysis (SCA) Open Comment 55 regarding the statistical approach outlined in Study Plan 8.3.1.15.1.2, "Laboratory Thermal Expansion Testing," are addressed below.

Mean, Standard Deviation, and Confidence Levels

Because the thermal/mechanical units have been defined based on differences in thermal properties, mechanical properties, or both, each of the units will be examined as an independent population. Thus, the mean and standard deviations for the thermal properties values obtained from laboratory measurements will be computed for each thermal/mechanical unit.

As stated in Section 2.2.1, the identification of data requirements and associated qualitative confidence levels was based on the expert judgement of repository design personnel with little or no support in the form of sensitivity analysis. If additional analyses indicate a change in sensitivity to thermal expansion behavior than assumed in the SCP, the numbers of samples required for experiments will be adjusted appropriately.

Number of Tests Required

The methodology for establishing the number of tests required is described in Section 2.2.1. Table 2.2-2 summarizes the initial estimates of numbers of samples required for site characterization of thermal expansion behavior for each thermal/mechanical unit.

The minimum number of tests necessary to satisfy the SCP data requirements is based on qualitative confidence levels and statistical tolerance limits (assuming a normal distribution) for each thermal/mechanical unit. Some of the data requirements have tighter constraints than others. The initial sampling estimates are based on the tightest constraints (i.e., the greatest number of samples). After the initial data are obtained, the validity of the assumptions (i.e., normality of the statistical distribution) will be examined, and the data will be evaluated to determine whether the data requirements are satisfied. If not, the data requirements will be reevaluated, and additional testing will be conducted as necessary.

Assumptions

1. Properties are evenly distributed throughout the mass

   The purpose of this study is to address the issue of horizontal, vertical, and small-scale spatial variability of thermal expansion behavior. Thus, it is not assumed that thermal expansion behavior is evenly distributed throughout the rock mass. Instead, it is assumed that the thermal expansion for each thermal/mechanical unit is significantly different. Consequently, the samples from each thermal/mechanical unit will be examined as an independent population.

   This approach implies that the current definition of the thermal/mechanical units is valid. As discussed in Section 3.2.5, "Analysis of Measurements," this assumption will be examined. At several times during the data-gathering process, data from adjacent

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units will be examined and compared to evaluate whether the division into thermal/mechanical units is appropriate.

2. <u>The measured values are not a function of testing sample size or direction</u>

   Section 2.2.3, "Effects of Test Parameters on Thermal Expansion," discusses the scoping studies that will be performed to assess the effects of confining pressure, sample size, saturation level, and irradiation of samples on thermal expansion behavior.

   The thermal expansion behavior of tuff also is potentially a function of orientation (i.e., may be anisotropic). As outlined in Section 2.2.2.1, "Sampling in New Core Holes," the presence or absence of anisotropy will be examined by taking samples of different orientations from Unit TSw2.

   If any of these parameters is found to have a significant effect on the thermal expansion behavior of tuff, the sampling and test program will be modified to include characterization of these parameter effects.

3. <u>The populations are normally distributed</u>

   As discussed in Section 2.2.1, the method used to design the initial sampling program assumes a normal distribution. Existing data on thermal expansion do not suggest that the data are <u>not</u> from normally distributed populations. Once the site characterization testing begins, the resulting data will be examined periodically to assess whether the assumption of normality is justified (see Item 2 of Section 3.2.5). If the data do not represent a sample from a normal distribution, the actual distribution will be evaluated, and additional samples will be tested, if necessary, to meet the data requirements.

4. <u>Sampling is not biased due to jointing hole direction, etc.</u>

   Efforts to avoid any bias in sampling are discussed in Section 2.2.2.1. In each core hole, the thermal/mechanical units each will be divided into n potential sampling intervals, where n is the number of samples specified in Table 2.2-2. In each of these intervals, a sample will be selected from a location as close to the center of the interval as possible. The only criterion applied to the selection of a sample will be that a sample must be of sufficient size to meet any size requirements imposed by the type of experiment. Adjustments to the sampling program may be necessary so that the statistical basis of the program will be maintained while still acquiring as close to n samples as possible. The nature of these adjustments will depend on the situation. The same approach will apply to core obtained from the MPBX holes (see Sections 2.2.2.2 and 2.2.2.3).

5. <u>The determination of the necessary number of samples is based on a Gaussian tolerance level</u>

As explained in Section 2.2.1, statistical tolerance limits based on a normal distribution are used as to determine the number of samples required for site characterization of thermal properties. Two-sided statistical tolerance limits are used in these estimates.

Determination of Alpha and Gamma Levels

The rationale for determining alpha and gamma levels is provided in Section 2.2.1. The assigned levels of α, as shown in Table 2.2-1, are associated with data requirements that request a qualitative level of confidence--high, medium, or low. These qualitative levels of confidence were assigned by different individuals with different problems to address. The values of α have been selected in an attempt to be commensurate with all of the qualitative requirements. The estimate of the required number of samples assumes that the proportion of the population (1-A) required to lie within the tolerance limits (defined as Bx) is the same as $(1-\alpha) = C$, where $(1-\alpha)$ is the confidence level. For the three levels of confidence, the values for α and γ are: $\alpha = 0.05$; $\gamma = 1-\alpha = .95$ (high confidence); $\alpha = 0.10$; $\gamma = 1-\alpha = .90$ (medium confidence), and $\alpha = 0.25$; $\gamma = 1-\alpha = .75$ (low confidence).