

WP No. 124213-86  
Rev. C  
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MODIFIED WORK PLAN TO SUPPORT  
QUALITY ASSURANCE LEVEL ASSIGNMENTS

for

Sandia National Laboratories  
NNWSI WBS ELEMENT 1.2.4.2.1.3.S  
LABORATORY PROPERTIES

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List of Activities and Tasks

A. Laboratory Property Measurement

- III A.1. Preparation of report on thermal conductivity and thermal expansion of lithophysae-rich Topopah Spring Member.
- III A.2. Preparation of report on sample size effects on mechanical properties of welded, devitrified Topopah Spring Member.
- III A.3. Preparation of report on mechanical properties of Topopah Spring Member from USW G-2.
- III A.4. Compression testing to determine temperature sensitivity of mechanical properties of welded, devitrified Topopah Spring Member.
- I A.5. Heat capacity measurements for tuff units expected to be within the region of elevated temperatures surrounding the repository.
- I A.6. Mechanical properties of welded, devitrified Topopah Spring Member at high temperature and/or low strain rates.
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- I A.9. Mechanical properties of fractures in welded, devitrified Topopah Spring Member.
- I A.10. Spatial variability of bulk, thermal, and mechanical properties.
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  - II B.1. Development of empirical relationships between porosity and mechanical properties.
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  - I B.3. Analysis of spatial variation of properties using data from QA Level I core samples.

WBS 1.2.4.2.1.3.S LABORATORY PROPERTIES

1. Objectives and Issues Addressed

A. Objectives

The objective is to develop, through laboratory measurements, a data base for the bulk, thermal, and mechanical properties of tuff. The data base will include the spatial variation of these properties and the variations of the properties that result from variations in environmental parameters (e.g., temperature, pressure, and moisture content). The data provided by these investigations will be used in thermal and mechanical analyses of the responses of tuff to excavation of the disposal area and in the evaluation of the effects of the heat released by the waste.

B. Issues Addressed

The Issues and Information Needs addressed are based on the Issues Hierarchy dated 4/15/86.

1. This WBS element will address the following Issues and Information Needs:

Issue 1.16

- 1.16.2 Spatial distribution of thermal and mechanical properties.

Issue 4.8

- 4.8.2 Spatial distribution of thermal and mechanical properties.

2. The information obtained in this WBS element will contribute to the resolution of the following Issues and Information Needs:

Issue 1.1

- 1.1.1 Site information needed to calculate the releases of radionuclides to the accessible environment.

Issue 1.4

- 1.4.1 Site information and design concepts needed to assess the performance of the containment barrier.

Issue 1.6

- 1.6.1 Site information and design concepts needed to identify the fastest path of likely radionuclide travel and to calculate the ground-water travel time along that path.

Issue 1.7

- 1.7.1 Site information and design concepts needed to assess the effects of the repository on site characteristics.
- 1.7.2 Effects on the geohydrologic, geochemical, and rock characteristics.

- Issue 1.11  
1.11.1 Definition of the near field environment of the waste packages following emplacement.
- Issue 1.12  
1.12.1 Site characterization information needed for design.  
1.12.6 Predicted thermal and thermomechanical response of the host rock, surrounding strata, and groundwater system.
- Issue 1.13  
1.13.1 Site, waste package, and underground facility information needed for design of seals and their placement methods.
- Issue 1.14  
1.14.2 Description of the unsaturated zone hydrologic system at the site.  
1.14.3 Description of the saturated zone hydrologic system at the site.
- Issue 1.17  
1.17.4 Potential effects of future climatic conditions on rock characteristics.
- Issue 1.18  
1.18.6 Potential effects of erosion on rock characteristics.
- Issue 1.20  
1.20.5 Potential effects of igneous and tectonic activity on rock characteristics.
- Issue 1.21  
1.21.4 Potential effects of exploiting natural resources on rock characteristics.
- Issue 2.6  
2.6.1 Site information needed for design.
- Issue 4.1  
4.1.1 Site and design information needed to assess the ability to retrieve emplaced waste.
- Issue 4.3  
4.3.1 Site and performance assessment information needed for design.
- Issue 4.5  
4.5.1 Site and performance assessment information needed for design.  
4.5.4 Potential impacts of rock characteristics on design.
- Issue 4.5  
4.5.10 Determination that the underground facilities can be constructed, operated, closed, and decommissioned with reasonably available technology.

C. Regulations and Requirements Addressed

Regulations and requirements addressed by the issues referenced in this WBS are cited in the NNWSI Systems Requirements Document.

#### D. Related Project Plans

The relationship between this WBS element and other work in the project is addressed in the NNWSI Site Characterization Plan (SCP), Chapter 2, Chapter 6 (Section 6.1.2), and Chapter 8 (Sections 8.3.1.4.2 and 8.3.1.11.2). Related testing is discussed in the NNWSI Exploratory Shaft Test Plan (ESTP) and is presented in the Work Plan for WBS 1.2.6.9.2.3.S (Exploratory Shaft Geomechanical Test). The data and reference values obtained under this WBS will be controlled as specified in the NNWSI Systems Engineering Management Plan (SEMP) and the NNWSI Configuration Management Plan.

#### 2. Principal Investigator

F. B. Nimick, Sandia National Laboratories (SNL), Albuquerque, NM

#### 3. Statement of Work

##### A. Laboratory Property Measurement

Bulk, thermal, and mechanical property data for the tuffaceous rocks from Yucca Mountain will be determined experimentally. These data will be used in thermal and mechanical analyses of temperature fields and thermal and mechanical stresses induced by the presence of underground openings and heat-producing waste in the rock. The data will be combined with theoretical considerations to estimate rock mass properties. Bulk properties also will be used in hydrologic analyses and in calculating radionuclide retardation. In addition, large rock laboratory experiments will be conducted to provide data for evaluating rock mass models as presented in the Work Plan for WBS 1.2.4.6.1.S (Repository Performance Code Development/Certification). The following tasks will be performed in support of this activity.

##### A.1. Preparation of report on thermal conductivity and thermal expansion of lithophysae-rich Topopah Spring Member.

- a. Purpose: To document the results of tests to determine the thermal conductivity and thermal expansion of lithophysae-rich Topopah Spring Member. Testing has been completed under Quality Assurance Level III controls. The results of these tests will be integrated with previous data and will provide part of the basis for calculations for areal power density, near-field drift temperatures after waste emplacement, and container centerline temperatures to support ACD studies.
- b. Information Needs: 1.11.1, 1.12.1, 1.12.6, 1.16.2, 2.6.1, 4.1.1, 4.3.1, 4.5.1, 4.5.4, 4.5.10, 4.8.2.
- c. Methods, Techniques, and Equipment: N/A
- d. Technical Procedures:
  - Available Procedures - N/A
  - Needed Procedures - N/A

- e. Computer Codes:
  - Available Computer Codes - N/A
  - Needed Computer Codes - N/A
- f. Documentation of Results: SAND85-2437, Thermal Conductivity and Thermal Expansion of a Lithophysal Zone within the Topopah Spring Member of the Paintbrush Tuff. Data to be entered into Tuff Data Base.
- g. Quality Assurance Level: III
- h. Remarks: QA Level III is assigned to the preparation of this SAND report because the supporting data was collected under QA Level III controls.

**A.2. Preparation of report on sample size effects on mechanical properties of welded, devitrified Topopah Spring Member.**

- a. Purpose: To document data to quantify effects of sample size on mechanical properties. Data will be used to estimate differences in strength and elastic properties of rock mass and rock matrix materials to support ACD studies
- b. Information Needs: 1.12.1, 1.12.6, 1.16.2, 2.6.1, 4.1.1, 4.3.1, 4.5.1, 4.5.4, 4.5.10, 4.8.2.
- c. Methods, Techniques, and Equipment: N/A
- d. Technical Procedures:
  - Available Procedures - N/A
  - Needed Procedures - N/A
- e. Computer Codes:
  - Available Computer Codes - N/A
  - Needed Computer Codes - N/A
- f. Documentation of Results: SAND85-0709, Effects of Sample Size on the Mechanical Properties of Topopah Spring Tuff. Data to be entered into Tuff Data Base.
- g. Quality Assurance Level: III
- h. Remarks: QA Level III is assigned to the preparation of this SAND report because the supporting data was collected under QA Level III controls.

**A.3. Preparation of report on mechanical properties of Topopah Spring Member from USW G-2.**

- a. Purpose: To document the results of tests on compressive strength and elastic properties and add these data to previously existing (QA Level III) data for use in ACD analyses.
- b. Information Needs: 1.12.1, 1.12.6, 1.13.1, 1.16.2, 1.17.4, 1.18.6, 1.20.5, 1.21.4, 2.6.1, 4.1.1, 4.3.1, 4.5.1, 4.5.4, 4.5.10, 4.8.2.
- c. Methods, Techniques, and Equipment: N/A
- d. Technical Procedures:
  - Available procedures - N/A
  - Needed procedures - N/A

- e. Computer Codes:
    - Available Computer Codes - N/A
    - Needed Computer Codes - N/A
  - f. Documentation of Results: SAND85-0703, Uniaxial and Triaxial Compression Test Series on the Topopah Spring Member from USW G-2, Yucca Mountain, Nevada. Data to be entered into Tuff Data Base.
  - g. Quality Assurance Level: III
  - h. Remarks: QA Level III is assigned to the preparation of this SAND report because the supporting data was collected under QA Level III controls.
- A.4. Compression testing to determine temperature sensitivity of mechanical properties of welded, devitrified Topopah Spring Member.
- a. Purpose: To obtain data for defining parameter variation of properties. Temperature effects of mechanical properties will be measured in a preliminary series of elevated temperature tests to evaluate related ACD analysis assumptions.
  - b. Information Needs: 1.7.1, 1.7.2, 1.12.1, 1.12.6, 1.13.1, 1.16.2, 2.6.1, 4.1.1, 4.3.1, 4.5.1, 4.5.4, 4.5.10, 4.8.2.
  - c. Methods, Techniques, and Equipment: Conventional triaxial compression testing with and without elevated temperature. Standard testing methods: ASTM C170-50 (Reapp. 1981) and ASTM D2938-79.
  - d. Technical Procedures:
    - Available Procedures - TP-4e, Constant Strain Rate Triaxial Compression Tests.
    - Needed Procedures - None
  - e. Computer Codes:
    - Available Computer Codes - N/A
    - Needed Computer Codes - N/A
  - f. Documentation of Results: SAND report will be written as required by milestone N429. Data to be entered into Tuff Data Base.
  - g. Quality Assurance Level: III
  - h. Remarks: QA Level III is assigned because data is for comparison with sensitivity effects data previously obtained under QA Level III controls.
- A.5. Heat capacity measurements for tuff units expected to be within the region of elevated temperatures surrounding the repository.
- a. Purpose: Measured heat capacity values are needed to confirm the predicted (calculated) values currently being used as input for calculations of heat transfer phenomena. These calculations include evaluations of waste orientation, container spacing, container

centerline temperatures, and drift temperatures used to support ACD studies of drift and borehole opening stability.

- b. Information Needs: 1.7.1, 1.11.1, 1.12.1, 1.12.6, 1.13.1, 1.16.2, 2.6.1, 4.1.1, 4.3.1, 4.5.1, 4.5.4, 4.5.10, 4.8.2.
- c. Methods, Techniques, and Equipment: Combined Differential Scanning Calorimetry (DSC) and Thermogravimetric Analysis (TGA) testing. Standard testing methods: ASTM C351-82.
- d. Technical Procedures:
  - Available Procedures - None
  - Needed Procedures - Determination of Specific Heat by DSC; Determination of Volatile Content by TGA.
  - Standard testing methods will be modified and expanded as necessary.
- e. Computer Codes:
  - Available Computer Codes - N/A
  - Needed Computer Codes - N/A
- f. Documentation or Results: SAND report will be written. Data to be entered into Tuff Data Base.
- g. Quality Assurance Level: I
- h. Remarks: These tests will be conducted on samples which have already been collected and exist in the SNL Core Library. Uncertainties exist with regard to the quality of existing sample materials and data obtained from these tests cannot be considered QA Level I without QA Level I qualification of the sample materials. The QA Level assigned to this task applies only to the testing and not the resulting data. The quality of the data will be determined by the quality of the sample materials. QA Level I is assigned to this task so that the resulting data can be used in a license application should the sample materials be qualified as QA Level I.

A.6. Mechanical properties of welded, devitrified Topopah Spring Member at high temperature and/or low strain rates.

- a. Purpose: Busted Butte samples will be tested to quantify temperature and strain rate effects on mechanical properties. Data will be used to evaluate ACD analysis assumption that small reductions in strength result from strain rate interest in repository conditions.
- b. Information Needs: 1.7.1, 1.7.2, 1.12.1, 1.12.6, 1.13.1, 1.16.2, 2.6.1, 4.1.1, 4.3.1, 4.5.1, 4.5.4, 4.5.10, 4.8.2.
- c. Methods, Techniques, and Equipment: Conventional triaxial compression and creep testing with and without elevated temperature. Standard testing methods: ASTM C170-50 (Reapp. 1981), ASTM C832-84, ASTM D2938-79 and ASTM D4341-84.

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- d. Technical Procedures:  
     Available Procedures - None  
     Needed Procedures - Constant Strain Rate Triaxial  
     Compression Tests; Triaxial Compression Creep Tests.  
     Standard testing methods will be modified and expanded  
     as necessary.
- e. Computer Codes:  
     Available Computer Codes - N/A  
     Needed Computer Codes - N/A
- f. Documentation of Results: Report will be written. Data to  
     be entered into Tuff Data Base.
- g. Quality Assurance Level: I
- h. Remarks: These tests will be conducted on samples which  
     have already been collected and exist in the SNL Core  
     Library. Uncertainties exist with regard to the  
     quality of existing sample materials and data obtained  
     from these tests cannot be considered QA Level I without  
     QA Level I qualification of the sample materials. The QA  
     Level assigned to this task applies only to the testing  
     and not the resulting data. The quality of the data will  
     be determined by the quality of the sample materials. QA  
     Level I is assigned to this task so that the resulting  
     data can be used in a license application should the  
     sample materials be qualified as QA Level I.

A.7. Anisotropy of mechanical properties of welded, devitrified  
 Topopah Spring Member.

- a. Purpose: Busted Butte samples will be tested to provide  
     information on the effects of sample orientation on  
     mechanical properties. Data will be used to evaluate  
     ACD analysis assumption that negligible changes in  
     properties result from sample orientation effects, i.e.  
     the rock is assumed to be isotropic.
- b. Information Needs: 1.12.1, 1.12.6, 1.16.2, 2.6.1, 4.1.1,  
     4.3.1, 4.5.1, 4.5.4, 4.5.10, 4.8.2.
- c. Methods, Techniques, and Equipment: Conventional uniaxial  
     compression testing. Standard testing methods: ASTM  
     C170-50 (Reapp. 1981) and ASTM D2938-79.
- d. Technical Procedures:  
     Available Procedures: Rock Mechanics Laboratory Tests  
     (Letter of Criteria to Org. 1542). Procedure will be  
     modified and expanded as necessary.  
     Needed Procedures: Sample preparation. Standard testing  
     methods will be modified and expanded as necessary.
- e. Computer Codes:  
     Available Computer Codes - N/A  
     Needed Computer Codes - N/A
- f. Documentation of Results: Report will be written. Data to  
     be entered into Tuff Data Base.
- g. Quality Assurance Level: I

- h. Remarks: These tests will be conducted on samples which have already been collected and exist in the SNL Core Library. Uncertainties exist with regard to the quality of existing sample materials and data obtained from these tests cannot be considered QA Level I without QA Level I qualification of the sample materials. The QA Level assigned to this task applies only to the testing and not the resulting data. The quality of the data will be determined by the quality of the sample materials. QA Level I is assigned to this task so that the resulting data can be used in a license application should the sample materials be qualified as QA Level I.

A.8. Tensile strength of welded, devitrified Topopah Spring Member.

- a. Purpose: Very limited data are currently available on tensile strength of Topopah Spring core. Tensile strength measurements will be made to provide data for use in interpreting ACD analyses of drift and borehole stability.
- b. Information Needs: 1.12.1, 1.12.6, 1.16.2, 2.6.1, 4.1.1, 4.1.1, 4.3.1, 4.5.1, 4.5.4, 4.5.10, 4.8.2.
- c. Methods, Techniques, and Equipment: Brazilian indirect tests and direct tensile tests. Standard testing methods: ASTM D2936-84 and ASTM D3967-81.
- d. Technical Procedures:  
Available Procedures: None  
Needed Procedures: Sample Preparation; Direct Tension Tests; Indirect (Brazilian) Tension Tests. Standard testing methods will be modified and expanded as necessary.
- e. Computer Codes:  
Available Computer Codes - N/A  
Needed Computer Codes - N/A
- f. Documentation of Results: Report will be written. Data to be entered into Tuff Data Base.
- g. Quality Assurance Level: I
- h. Remarks: These tests will be conducted on samples which have already been collected and exist in the SNL Core Library. Uncertainties exist with regard to the quality of existing sample materials and data obtained from these tests cannot be considered QA Level I without QA Level I qualification of the sample materials. The QA Level assigned to this task applies only to the testing and not the resulting data. The quality of the data will be determined by the quality of the sample materials. QA Level I is assigned to this task so that the resulting data can be used in a license application should the sample materials be qualified as QA Level I.

**A.9. Mechanical properties of fractures in welded, devitrified Topopah Spring Member.**

- a. Purpose: Busted Butte samples will be tested to obtain data on mechanical properties of fractures. Fracture mechanical properties are an integral part of determining the response of underground openings to induced stresses and will be used as input to compliant-joint models in support of ACD analyses of opening stability.
- b. Information Needs: 1.7.1, 1.7.2, 1.12.1, 1.12.6, 1.16.2, 2.6.1, 4.1.1, 4.3.1, 4.5.1, 4.5.4, 4.5.10, 4.8.2.
- c. Methods, Techniques, and Equipment: Rotary friction tests as described in SAND86-0177.
- d. Technical Procedures:  
 Available Procedures: None  
 Needed Procedures: Determination of Friction and Stiffness Properties of Fractures. Previously documented methods will be modified and expanded.
- e. Computer Codes:  
 Available Computer Codes - N/A  
 Needed Computer Codes - N/A
- f. Documentation of Results: SAND report to be written as required by milestone N496. DRMS file L02B.A-06/06/84. Data to be entered into Tuff Data Base.
- g. Quality Assurance Level: I
- h. Remarks: These tests will be conducted on samples which have already been collected and exist in the SNL Core Library. Uncertainties exist with regard to the quality of existing sample materials and data obtained from these tests cannot be considered QA Level I without QA Level I qualification of the sample materials. The QA Level assigned to this task applies only to the testing and not the resulting data. The quality of the data will be determined by the quality of the sample materials. QA Level I is assigned to this task so that the resulting data can be used in a license application should the sample materials be qualified as QA Level I.

**A.10. Spatial variability of bulk, thermal, and mechanical properties.**

- a. Purpose: Cores from new boreholes will be tested to evaluate spatial variability of properties. Data may also be used as part of basis for qualification of previously obtained data for use in licensing.
- b. Information Needs: 1.1.1, 1.4.1, 1.6.1, 1.12.1, 1.12.6, 1.13.1, 1.14.2, 1.14.3, 1.16.2, 1.17.4, 1.18.6, 1.20.5, 1.21.4, 2.6.1, 4.1.1, 4.3.1, 4.5.1, 4.5.4, 4.5.10, 4.8.2.
- c. Methods, Techniques, and Equipment: Conventional techniques for measuring density, porosity, thermal conductivity, thermal expansion, heat capacity and mechanical properties. Standard testing methods: ASTM STP 869,

ASTM C97-83, ANSI/ASTM C128-84, ANSI/ASTM C135-66 (Reapp. 1976), ASTM C170-50 (Reapp. 1981), ASTM C351-82, ASTM C693-84, ASTM C832-84, ANSI/ASTM D1188-83, ASTM D2216-80, ASTM D2936-84, ASTM D2938-79, ASTM D3967-81, ASTM D4341-84, and ISRM Vol. 16, pp. 141-156.

d. Technical Procedures:

Available procedures - None

Needed procedures - Sample Preparation; Determination of Density and Porosity; Determination of Thermal Conductivity; Determination of Thermal Expansion; Determination of Specific Heat by DSC; Constant Strain Rate Triaxial Compression Tests; Determination of Tensile Strength. Standard testing methods and previously documented procedures will be modified and expanded as necessary.

e. Computer Codes:

Available Computer Codes - N/A

Needed Computer Codes - N/A

f. Documentation of Results: Reports will be written. Data to be entered into Tuff Data Base.

g. Quality Assurance Level: I

h. Remarks: QA Level I is assigned because it is the intended purpose of this task to provide data for license application. The QA Level assignment applies to both the testing and the resulting data.

A.11. Laboratory large block test.

a. Purpose: This task will provide laboratory-controlled input data for code validation of a compliant-joint material model used in finite-element computer programs. These tests will provide data for input to components of the model as well as a composite response. The computer programs will be used for evaluating the stability of underground openings in the repository in licensing related calculations.

b. Information Needs: 1.7.1, 1.7.2, 1.11.1, 1.12.1, 1.12.6, 2.6.1, 4.1.1, 4.3.1, 4.5.1, 4.5.4, 4.5.10.

c. Methods, Techniques, and Equipment: Conventional uniaxial compression testing. Rotary friction tests as described in SAND86-0177. Uniaxial and biaxial loading of a large block of rock in a reaction frame (internal dimensions on the order of a square meter). Standard testing methods: ASTM C170-50 (Reapp. 1981) and ASTM D2938-79.

d. Technical Procedures:

Available Procedures: TTRD-LP-4b, Unconfined Compression Tests. Procedure will be modified and expanded as necessary.

Needed Procedures: Sample Collection and Preparation; Determination of Friction and Stiffness Properties of Fractures; Determination of Uniaxial and Biaxial

Response of a Large Block of Fractured Rock. Standard testing methods and previously documented procedures will be modified and expanded as necessary.

- e. Computer Codes:
  - Available Computer Codes - N/A
  - Needed Computer Codes - N/A
- f. Documentation of Results: Report will be written.
- g. Quality Assurance Level: I
- h. Remarks: QA Level I is assigned to this task because it will provide data used to support validation of computer programs intended for use in license application analyses. The QA Level assignment applies to both the testing and the resulting data. Code validation analyses will be conducted under WBS 1.2.4.6.1.S (Repository Performance Code Development/Certification).

## B. Laboratory Property Analysis

Statistical analysis of the data to evaluate the variability of properties will be performed as follows:

- B.1. Development of empirical relationships between porosity and mechanical properties.
  - a. Purpose: Development and confirmation of empirical relationships between porosity and mechanical properties is necessary to allow estimation of mechanical properties in regions which cannot be adequately sampled for mechanical testing. Preliminary relationships have been developed from previously obtained mechanical properties, porosity, and mineralogic characterization data (QA Level III). This task will determine porosity and mineralogic characteristics on core samples from which mechanical properties data have been obtained. The data will then be used to refine the equations which describe the relationship between porosity and mechanical properties. Estimates resulting from this analysis may be used as input to ACD sensitivity analyses of drift and borehole opening stability.
  - b. Information Needs: 1.12.1, 1.12.6, 1.16.2, 2.6.1, 4.1.1, 4.3.1, 4.5.1, 4.5.4, 4.5.10, 4.8.2.
  - c. Methods, Techniques, and Equipment: Conventional techniques for measuring density and porosity. Conventional methods for mineralogic characterization of samples. Conventional least-squares analysis to estimate quality of relationships which are determined by data evaluation. Standard testing methods: ASTM C97-83, ANSI/ASTM C128-84, ANSI/ASTM C135-66 (Reapp. 1976), ASTM C693-84, ANSI/ASTM D1188-83, ASTM D2216-80, and ISRM Vol. 16, pp. 141-156.

d. Technical Procedures:

Available Procedures - UNM-IM-PAP, Analysis of Rocks and/or Mineral Samples; UNM-IM-PAP, Preparation of Polished Thin Sections of Rocks and/or Mineral Samples. Previously documented procedures will be modified and expanded as necessary.

Needed Procedures - Determination of Density and Porosity; X-Ray Analysis of Rocks and/or Mineral Samples. Standard testing methods will be modified and expanded as necessary.

e. Computer Codes:

Available Computer Codes - N/A

Needed Computer Codes - N/A

f. Documentation of Results: Report will be written.

g. Quality Assurance Level: II

h. Remarks: QA Level II has been assigned because the resulting estimates will be used to support ACD analyses. The QA Level assignment applies to the development of the equations and not to the quality of the data used to develop the equations.

B.2. Analysis of spatial variation of properties and of the effects of parameter variation of properties.

a. Purpose: This task will analyze and integrate bulk, thermal, and mechanical properties (from laboratory tests), including spatial variation, parameter effects, and statistical evaluations to provide recommended values for the Reference Information Base.

b. Information Needs: 1.1.1, 1.4.1, 1.6.1, 1.12.1, 1.12.6, 1.14.2, 1.14.3, 1.16.2, 2.6.1, 4.1.1, 4.3.1, 4.5.1, 4.5.4, 4.5.10, 4.8.2.

c. Methods, Techniques, and Equipment: Statistical analysis by analysis-of-variance.

d. Technical Procedures:

Available Procedures - SAS User's Guide.

Needed Procedures - N/A

e. Computer Codes:

Available Computer Codes - SAS computer software system for statistical analysis. Verification of this system will be conducted as part of this task.

Needed Computer Codes - None

f. Documentation of Results: SAND84-2658, Matrix Properties of Thermal/Mechanical Units at Yucca Mountain: Recommended Values and Spatial Variation. SAND85-0762, Bulk, Thermal and Mechanical Properties of the Topopah Spring Member of the Paintbrush Tuff, Yucca Mountain, Nevada as required by milestone N403.

g. Quality Assurance Level: II

h. Remarks: QA Level II is assigned because principal use of information is to provide values to the Reference Information Base in support of ACD analyses. These

values will be supplemented or replaced with values determined under WBS 1.2.6.9.2.3.S.

**B.3. Analysis of spatial variation of properties using data from QA Level I core samples.**

- a. Purpose: To establish spatial variability and to support qualification of previously obtained data for use in licensing analyses.
- b. Information Needs: 1.1.1, 1.4.1, 1.6.1, 1.12.1, 1.12.6, 1.13.1, 1.14.2, 1.14.3, 1.16.2, 1.17.4, 1.18.6, 1.20.5, 1.21.4, 2.6.1, 4.1.1, 4.3.1, 4.5.1, 4.5.4, 4.5.10, 4.8.2.
- c. Methods, Techniques, and Equipment: Statistical analysis by analysis-of-variance.
- d. Technical Procedures:
  - Available Procedures - SAS User's Guide.
  - Needed Procedures - N/A
- e. Computer Codes:
  - Available Computer Codes - SAS computer software system for statistical analysis. Verification of this system will be conducted as part of this task.
  - Needed Computer Codes - None
- f. Documentation of Results: Report will be written.
- g. Quality Assurance Level: I
- h. Remarks: This task will analyze spatial variability of bulk, thermal, and mechanical properties using data obtained under Task A.10 from QA Level I core samples. QA Level I is assigned because it is the intended of this activity to provide data for use in license application.

**4. Data and Materials Needed**

**Task A.1. Preparation of report on thermal conductivity and thermal expansion of lithophysae-rich Topopah Spring Member.**

Data Needed - N/A  
Source of Data - N/A  
Quality of Data - N/A

Materials Needed - N/A  
Source of Materials - N/A  
Quality of Materials - N/A

**Task A.2. Preparation of report on sample size effects on mechanical properties of welded, devitrified Topopah Spring Member.**

Data Needed - N/A  
Source of Data - N/A  
Quality of Data - N/A

Materials Needed - N/A  
Source of Materials - N/A  
Quality of Materials - N/A

Task A.3. Preparation of report on mechanical properties of Topopah Spring Member from USW G-2.

Data Needed - N/A  
Source of Data - N/A  
Quality of Data - N/A

Materials Needed - N/A  
Source of Materials - N/A  
Quality of Materials - N/A

Task A.4. Compression testing to determine temperature sensitivity of mechanical properties of welded, devitrified Topopah Spring Member.

Data Needed - N/A  
Source of Data - N/A  
Quality of Data - N/A

Materials Needed - Outcrop samples have been collected and are located in the SNL Core Library and at subcontractor.  
Source of Materials - Busted Butte. Materials collected by SNL.  
Quality of Materials - Documentation of material collection activities exists but has not been evaluated to determine extent of QA controls utilized.

Task A.5. Heat capacity measurements for tuff units expected to be within the region of elevated temperatures surrounding the repository.

Data Needed - Mineralogy and bulk chemistry data of heat capacity samples.  
Source of Data - Data obtained by SNL under this task.  
Quality of Data - Documentation of the data collection activities exists but has not been evaluated to determine extent of QA controls utilized.

Materials Needed - Core samples have been collected and are located in SNL Core Library.  
Source of Materials - UE-25a#1, USW G-1, USW G-2, and USW G-4. Materials collected by the USGS.  
Quality of Materials - QA Level of core materials has not been determined.

Task A.6. Mechanical properties of welded, devitrified Topopah Spring Member at high temperature and/or low strain rates.



Data Needed - N/A  
Source of Data - N/A  
Quality of Data - N/A

Materials Needed - Outcrop samples have been collected and are located in the SNL Core Library.  
Source of Materials - Busted Butte. Materials collected by SNL.  
Quality of Materials - Documentation of material collection activities exists but has not been evaluated to determine extent of QA controls utilized.

**Task A.7. Anisotropy of mechanical properties of welded, devitrified Topopah Spring Member.**

Data Needed - N/A  
Source of Data - N/A  
Quality of Data - N/A

Materials Needed - Outcrop samples and are located in SNL Core Library.  
Source of Materials - Busted Butte. Materials collected by SNL.  
Quality of Materials - Documentation of material collection activities exists but has not been evaluated to determine extent of QA controls utilized.

**Task A.8. Tensile strength of welded, devitrified Topopah Spring Member.**

Data Needed - N/A  
Source of Data - N/A  
Quality of Data - N/A

Materials Needed - Outcrop and core samples have been collected and are located in SNL Core Library.  
Source of Materials - Outcrop from Busted Butte. Outcrop materials collected by SNL. Core materials from USW G-1 and USW GU-3. Core materials collected by the USGS.  
Quality of Materials - Documentation of outcrop material collection activities exists but has not been evaluated to determine extent of QA controls utilized. QA Level of core materials has not been determined.

**Task A.9. Mechanical properties of fractures in welded, devitrified Topopah Spring Member.**

Data Needed - N/A  
Source of Data - N/A  
Quality of Data - N/A

Materials Needed - Outcrop samples have been collected and are located in SNL Core Library.  
Source of Materials - Busted Butte. Materials collected by SNL.

Quality of Materials - Documentation of material collection activities exists but has not been evaluated to determine extent of QA controls utilized.

**Task A.10. Spatial variability of bulk, thermal, and mechanical properties.**

Data Needed - N/A  
Source of Data - N/A  
Quality of Data - N/A

Materials Needed - Core samples.  
Source of Materials - Core holes at Yucca Mountain, specific locations to be determined. Core materials to be collected by the USGS.  
Quality of Materials - Material to be collected in accordance with QA Level I requirements.

**Task A.11. Laboratory large block tests.**

Data Needed - N/A  
Source of Data - N/A  
Quality of Data - N/A

Materials Needed - A block of rock on the order of 1 meter x 1 meter x 0.5 meter. The mechanical anisotropy of the block must be less than 10 percent. A smaller block (0.5 meters x 0.5 meters x 0.5 meters) is also required, taken from a position adjacent to the larger block. The suggested rock type is either fine grained granite or massive sandstone.  
Source of Materials - Any source which has rock as described above.  
Quality of Materials - Material to be collected in accordance with QA Level I requirements.

**Task B.1. Development of empirical relationships between porosity and mechanical properties.**

Data Needed - Data collected under Task A.8 and all bulk and mechanical data previously collected under this WBS.  
Source of Data - Records for all data collected under this WBS exist or will exist in the SNL Data Records Management System (DRMS).  
Quality of Data - The quality of the data collected under Task A.8 will be determined by the QA Level of the samples used in testing. Data previously collected under this WBS have not been evaluated to determine the extent of QA controls utilized.

Materials Needed - Core samples have been collected and are located in the SNL Core Library.

Source of Materials - UE-25a#1, USW G-1, USW GU-3, and USW G-4.  
Materials collected by the USGS.  
Quality of Materials - QA Level of core materials has not been determined.

**Task B.2. Analysis of spatial variation of properties and of the effects of parameter variation of properties.**

Data Needed - Data collected under Tasks A.4 and A.6, and all bulk and mechanical data previously collected under this WBS.  
Source of Data - Records for all data collected under this WBS exist or will exist in the SNL Data Records Management System (DRMS).

Quality of Data - The quality of the data collected under Tasks A.4 and A.6 will be determined by the QA Level of the materials used for testing. Data previously collected under this WBS have not been evaluated to determine the extent of QA controls utilized.

Materials Needed - N/A  
Source of Materials - N/A  
Quality of Materials - N/A

**Task B.3. Analysis of spatial variation of properties using data from QA Level I core samples.**

Data Needed - Data collected under Task A.10.  
Source of Data - Records for all data collected under this WBS will exist in the SNL Data Records Management System (DRMS).  
Quality of Data - Data collected under Task A.10 will meet the requirements of QA Level I.

Materials Needed - N/A  
Source of Materials - N/A  
Quality Assurance - N/A

**5. Non-Standard Methods or Techniques**

**Task A.9. Mechanical properties of fractures in welded, devitrified Topopah Spring Member.**

Method for determining mechanical properties of fractures using rotary friction tests is developed and described in SAND086-0177.

**Task A.11. Laboratory large block tests.**

Method for determining mechanical properties of fractures using rotary friction tests is developed and described in SAND086-0177.

Uniaxial and biaxial loading of a large block of rock in a reaction frame to be developed and documented in procedures prior to testing.

6. Location of Work Performance

Sandia National Laboratories, Albuquerque, NM

Contractors: RE/SPEC, Rapid City, SD (Task A.4)  
TBD (Tasks A.5, A.6, A.9, A.10, and A.11)  
University of New Mexico, Albuquerque, NM (Mineralogy data in support of Task B.1)

7. Quality Assurance Requirements

The following Quality Assurance Levels have been assigned to the tasks described in this WBS.

Quality Assurance Level I: Tasks A.5, A.6, A.7, A.8 ~~and A.9~~, A.10 and A.11  
Quality Assurance Level II: Tasks B.1 and B.2  
Quality Assurance Level III: Tasks A.1, A.2, A.3 and A.4

8. Application of Results

The bulk, thermal, and mechanical data and resulting reference values obtained under this WBS will be used by SNL's Geoscience Analysis Division to support the Tuff Data Base (WBS 1.2.1.3.1.S) and recommend values for the Reference Information Base (WBS 1.2.1.3.3.S); by SNL's Geotechnical Design Division to support shaft/ramp design (WBS 1.2.4.3.3.S), subsurface excavation design (WBS 1.2.4.3.4.S), development and verification of computer codes to be used in analysis of repository performance (WBS 1.2.4.6.1.S), design analysis (WBS 2.4.6.2.S), and rock-mass analysis (WBS 1.2.4.2.1.1.S), and; by SNL's Geotechnical Projects Division to support in-situ testing in G-Tunnel (WBS 1.2.7.2.S), performance confirmation (WBS 1.2.4.6.4.S), and in-situ testing in the Exploratory Shaft (WBS 1.2.6.9.2.3.S).

9. Schedule

Starting date: 1978; anticipated ending date: 1989

10. Past and Expected Achievements

A. Past Achievements

A data set of bulk, thermal, and mechanical property data has been experimentally determined and documented for use in modeling

analyses and rock mass property estimation. The results include information from all stratigraphic units at Yucca Mountain, starting with the lowest unit originally considered as a potential host unit for the underground portion of a repository. The results are required for repository design and performance assessments calculations.

B. Expected Achievements

FY86

Continue study of the spatial variability of properties, using additional data from exploratory drill holes.

Continue to measure frictional properties of fractures in the Topopah Spring Member.

Measure the heat capacity of tuff units in which elevated temperatures will occur as the result of waste emplacement in the Topopah Spring Member.

Initiate tests to determine the effects of low strain rates and high temperatures on mechanical properties of welded tuff.

FY87

Design and initiate a large block laboratory tests that will provide data for evaluating rock mass models.

Complete study of the spatial variability of properties determined from samples from all exploratory drill holes.

Complete measurement of the fracture properties in the Topopah Spring Member.

Complete the study of the effects of low strain rates and high temperature on mechanical properties.

FY88 and FY99

Perform tests on core obtained in accordance with Quality Assurance Level I requirements from new drill holes as core becomes available. Perform statistical analyses to compare results to those from previous tests and, if necessary, revise values in the Reference Information Base.

11. Milestones and Deliverables

<u>Milestone Number</u>	<u>Description and Criteria</u>	<u>Completion Date</u>
Level 2		
N403	Recommended Matrix Properties of Topopah Spring Member  This study will provide recommended values for bulk, mechanical, and thermal properties for intact rock in the Topopah Spring Member at Yucca Mountain. The properties will serve as input to thermal, mechanical, and thermal/mechanical calculations of the effects of a repository on the surrounding rock. The milestone will be met by submitting a SAND report to WMPO/NVO for policy review.	06/30/86
N429	Parameter Effects on Mechanical Properties of the Topopah Spring Member  The effects of changes in pressure, temperature, strain rate, and degree of saturation on mechanical properties must be understood in order to transfer the results of laboratory tests to in-situ conditions. The deliverable will be a report, submitted to WMPO/NVO, which summarizes the results of a test matrix designed to study the effect of these parameters.	06/30/86
N496	Report on Properties of Fractures in the Topopah Spring Member  The properties of fractures in the Topopah Spring Member are required for analysis of the response of the Member to the presence of underground openings and/or heat-producing waste. The deliverable will be a report submitted to WMPO/NVO.	09/30/86

## 12. Costs

Costs are in thousands of expenditure-year dollars.

### FY86

SNL Labor Costs: \$357      Other Costs: \$350

### FY87

SNL Labor Costs: \$409      Other Costs: \$481

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FY88

SNL Labor Costs: \$205    Other Costs: \$264

FY89

SNL Labor Costs: \$ 66    Other Costs: \$267

13. Performance Measurement

Percent complete

# NNWSI QUALITY ASSURANCE LEVEL ASSIGNMENT

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**APPROVALS (Signature and Date)**

PI Francis Minick 8/5/86  
Supervisor Thomas P. Bepko 8/5/86  
WMPO (PQM) James B. Bepko 8/5/86

PQA Connie Chas 8/5/86  
TPO Thomas P. Bepko 8/5/86  
WMPO (Tech) J.P. Bepko 8-8-86

Activity: A. Laboratory Property Measurement

Task Description	QA Level	QA Criteria	Level Justification
A.1. Preparation of report on thermal conductivity and thermal expansion of lithophysae-rich Topopah Spring Member.	III	* 1, 2, 6, 15-18	This QA Level assignment applies only to preparing the report on tests that were done using QA Level III controls. This task is, therefore, assigned QA Level III (Steps 1 thru 11 do not apply).
A.2. Preparation of report on sample size effects on mechanical properties of welded, devitrified Topopah Spring Member.	III	* 1, 2, 6, 15-18	This QA Level assignment applies only to preparing the report on tests that were done using QA Level III controls. This task is, therefore, assigned QA Level III (Steps 1 thru 11 do not apply).
A.3. Preparation of report on mechanical properties of welded, devitrified Topopah Spring Member.	III	* 1, 2, 6, 15-18	This QA Level assignment applies only to preparing the report on tests that were done using QA Level III controls. This task is, therefore, assigned QA Level III (Steps 1 thru 11 do not apply).
A.4. Compression testing to determine temperature sensitivity of mechanical properties of welded, devitrified Topopah Spring Member.	III	* 1-8, 10-18	Data will be used for comparison with sensitivity effects data previously obtained under QA Level III controls. This task is, therefore assigned QA Level III (Steps 1 thru 11 do not apply.)

\* QA LEVEL III CRITERIA FOR SNL USE ONLY



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**Activity: A. Laboratory Property Measurement**

<b>Task Description</b>	<b>QA Level</b>	<b>QA Criteria</b>	<b>Level Justification</b>
A.5. Heat capacity measurements for tuff units.	I	1-8, 10-18	QA Level I is assigned so that the data may be used for license application if the sample materials are qualified for QA Level I use (Step 4). QA Level applies to the testing and not the data.
A.6. Mechanical properties of Topopah Spring at high temperatures and/or low strain rates.	I	1-8, 10-18	QA Level I is assigned so that the data may be used in license application if the sample materials are qualified for QA Level I use (Step 4). QA Level applies to the testing and not the data.
A.7. Anisotropy of mechanical properties of welded devitrified Topopah Spring Member.	I	1, 2, 3, 5, 6, 8, 10-18	QA Level II is assigned so that the data may be used in license application if the sample materials are qualified for QA Level I use (Step 4). QA Level applies to the testing and not the data.
A.8. Tensile strength of welded, devitrified Topopah Spring Member.	I	1, 2, 3, 5, 6, 8, 10-18	QA Level I is assigned so that the data may be used for license application if the sample materials are qualified for QA Level I use (Step 4). QA Level applies to the testing and not the data.
A.9. Mechanical properties of fractures in welded, devitrified Topopah Spring Member.	I	1-8, 10-18	QA Level I is assigned so that the data may be used for license application if the sample materials are qualified for QA Level I use (Step 4). QA Level applies to the testing and not to the data.

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Activity: A. Laboratory Property Measurement

Task: A.1. Preparation of report on thermal  
conductivie and thermal expansion of  
of lithophysae-rich Topopah Spring.

PI F. B. Nimick

QA Criterion	Applies	Does Not Apply	Comments
1. OA Organization	X		
2. OA Program	X		
3. Design & Scientific Investigation Control		X	Task is for prepara- tion of report only.
4. Procurement Document Control		X	No procurement.
5. Instructions Procedures & Drawings		X	Task is for prepara- tion of report only.
6. Document Control	X		
7. Control of Purchased Material, Equipment, and Services		X	No procurement.
8. ID and Control of Materials, Parts, Components and Samples		X	No manufacturing or samples involved.
9. Control of Processes		X	No special processes.
10. Inspection		X	No inspection or surveillance involved.
11. Test and Experiment/ Research Control		X	No tests/experiments.
12. Control of Measuring and Test Equipment		X	
13. Handling, Shipping, and Storage		X	No manufacturing or tests involved.
14. Inspection, Test, and Operating Status		X	No instruments, hard- ware or samples involved.
15. Control of Nonconformances	X		
16. Corrective Action	X		
17. OA Records	X		
18. OA Audits	X		

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Activity: A. Laboratory Property Measurement

Task: A.2. Preparation of report on sample size effects on mechanical properties of welded, devitrified Topopah Spring Member. PI F. B. Nimick

QA Criterion	Applies	Does Not Apply	Comments
1. QA Organization	X		
2. QA Program	X		
3. Design & Scientific Investigation Control		X	Task is for preparation of report only.
4. Procurement Document Control		X	No procurement.
5. Instructions Procedures & Drawings		X	Task is for preparation of report only.
6. Document Control	X		
7. Control of Purchased Material, Equipment, and Services		X	No procurement.
8. ID and Control of Materials, Parts, Components and Samples		X	No manufacturing or samples involved.
9. Control of Processes		X	No special processes.
10. Inspection		X	No inspection or surveillance involved.
11. Test and Experiment/Research Control		X	No tests/experiments.
12. Control of Measuring and Test Equipment		X	
13. Handling, Shipping, and Storage		X	No manufacturing or tests involved.
14. Inspection, Test, and Operating Status		X	No instruments, hardware or samples involved.
15. Control of Nonconformances	X		
16. Corrective Action	X		
17. QA Records	X		
18. QA Audits	X		

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Activity: A. Laboratory Property Measurement

Task: A.3. Preparation of report on mechanical properties of welded, devitrified Topopah Spring Member.

PI F. B. Nimick

QA Criterion	Applies	Does Not Apply	Comments
1. OA Organization	X		
2. OA Program	X		
3. Design & Scientific Investigation Control		X	Task is for preparation of report only.
4. Procurement Document Control		X	No procurement.
5. Instructions Procedures & Drawings		X	Task is for preparation of report only.
6. Document Control	X		
7. Control of Purchased Material, Equipment, and Services		X	No procurement.
8. ID and Control of Materials, Parts, Components and Samples		X	No manufacturing or samples involved.
9. Control of Processes		X	No special processes.
10. Inspection		X	No inspection or surveillance involved.
11. Test and Experiment/Research Control		X	No tests/experiments.
12. Control of Measuring and Test Equipment		X	
13. Handling, Shipping, and Storage		X	No manufacturing or tests involved.
14. Inspection, Test, and Operating Status		X	No instruments, hardware or samples involved.
15. Control of Nonconformances	X		
16. Corrective Action	X		
17. OA Records	X		
18. OA Audits	X		

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Activity: A. Laboratory Property Measurement

Task: A.4. Compression testing to determine  
temperature sensitivity of mechanical  
properties of Topopah Spring.

PI F. B. Nimick

QA Criterion	Applies	Does Not Apply	Comments
1. QA Organization	X		
2. QA Program	X		
3. Design & Scientific Investigation Control	X		Scientific investigation requirements apply
4. Procurement Document Control	X		
5. Instructions, Procedures & Drawings	X		
6. Document Control	X		
7. Control of Purchased Material, Equipment, and Services	X		
8. ID and Control of Materials, Parts, Components and Samples	X		Applies only to samples.
9. Control of Processes		X	No special processes. Applies only to surveillance.
10. Inspection	X		
11. Test and Experiment/ Research Control	X		
12. Control of Measuring and Test Equipment	X		
13. Handling, Shipping, and Storage	X		Applies only to samples.
14. Inspection, Test, and Operating Status	X		
15. Control of Nonconformances	X		
16. Corrective Action	X		
17. QA Records	X		
18. QA Audits	X		

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Activity: A. Laboratory Property Measurement

Task: A.5. Heat capacity measurements for  
tuff units.

PI F. B. Nimick

QA Criterion	Applies	Does Not Apply	Comments
1. OA Organization	X		
2. OA Program	X		
3. Design & Scientific Investigation Control	X		Scientific investigation requirements apply
4. Procurement Document Control	X		
5. Instructions, Procedures & Drawings	X		
6. Document Control	X		
7. Control of Purchased Material, Equipment, and Services	X		
8. ID and Control of Materials, Parts, Components and Samples	X		Applies only to samples.
9. Control of Processes		X	No special processes. Applies only to surveillance.
10. Inspection	X		
11. Test and Experiment/ Research Control	X		
12. Control of Measuring and Test Equipment	X		
13. Handling, Shipping, and Storage	X		Applies only to samples.
14. Inspection, Test, and Operating Status	X		
15. Control of Nonconformances	X		
16. Corrective Action	X		
17. OA Records	X		
18. OA Audits	X		

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Activity: A. Laboratory Property Measurement

Task: A.6. Mechanical properties of Topopah  
Spring at high temperatures and/or low  
strain rates.

PI F. B. Nimick

QA Criterion	Applies	Does Not Apply	Comments
1. OA Organization	X		
2. OA Program	X		
3. Design & Scientific Investigation Control	X		Scientific investigation requirements apply
4. Procurement Document Control	X		
5. Instructions, Procedures & Drawings	X		
6. Document Control	X		
7. Control of Purchased Material, Equipment, and Services	X		
8. ID and Control of Materials, Parts, Components and Samples	X		Applies only to samples.
9. Control of Processes		X	No special processes.
10. Inspection	X		Applies only to surveillance.
11. Test and Experiment/ Research Control	X		
12. Control of Measuring and Test Equipment	X		
13. Handling, Shipping, and Storage	X		Applies only to samples.
14. Inspection, Test, and Operating Status	X		
15. Control of Nonconformances	X		
16. Corrective Action	X		
17. OA Records	X		
18. OA Audits	X		



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Activity: A. Laboratory Property Measurement

Task: A.7. Anisotropy of mechanical properties  
of welded, devitrified Topopah Spring  
Member.

PI F. B. Nimick

QA Criterion	Applies	Does Not Apply	Comments
1. OA Organization	X		
2. OA Program	X		
3. Design & Scientific Investigation Control	X		Scientific investigation requirements apply
4. Procurement Document Control		X	No PROCUREMENT
5. Instructions, Procedures & Drawings	X		
6. Document Control	X		
7. Control of Purchased Material, Equipment, and Services		X	No PROCUREMENT
8. ID and Control of Materials, Parts, Components and Samples	X		Applies only to samples.
9. Control of Processes		X	No special processes. Applies only to surveillance.
10. Inspection	X		
11. Test and Experiment/ Research Control	X		
12. Control of Measuring and Test Equipment	X		
13. Handling, Shipping, and Storage	X		Applies only to samples.
14. Inspection, Test, and Operating Status	X		
15. Control of Nonconformances	X		
16. Corrective Action	X		
17. OA Records	X		
18. OA Audits	X		

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Activity: A. Laboratory Property Measurement

Task: A.8. Tensile strength of welded,  
devitrified Topopah Spring Member.

PI F. B. Nimick

QA Criterion	Applies	Does Not Apply	Comments
1. OA Organization	X		
2. OA Program	X		
3. Design & Scientific Investigation Control	X		Scientific investigation requirements apply
4. Procurement Document Control		X	No Procurement
5. Instructions, Procedures & Drawings	X		
6. Document Control	X		
7. Control of Purchased Material, Equipment, and Services		X	No Procurement
8. ID and Control of Materials, Parts, Components and Samples	X		Applies only to samples.
9. Control of Processes		X	No special processes. Applies only to surveillance.
10. Inspection	X		
11. Test and Experiment/ Research Control	X		
12. Control of Measuring and Test Equipment	X		
13. Handling, Shipping, and Storage	X		Applies only to samples.
14. Inspection, Test, and Operating Status	X		
15. Control of Nonconformances	X		
16. Corrective Action	X		
17. OA Records	X		
18. OA Audits	X		

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Activity: A. Laboratory Property Measurement

Task: A.9. Mechanical properties of  
fractures in welded, devitrified  
Topopah Spring Member.

PI F. B. Nimick

QA Criterion	Applies	Does Not Apply	Comments
1. QA Organization	X		
2. QA Program	X		
3. Design & Scientific Investigation Control	X		Scientific investigation requirements apply
4. Procurement Document Control	X		
5. Instructions, Procedures & Drawings	X		
6. Document Control	X		
7. Control of Purchased Material, Equipment, and Services	X		
8. ID and Control of Materials, Parts, Components and Samples	X		Applies only to samples.
9. Control of Processes		X	No special processes. Applies only to surveillance.
10. Inspection	X		
11. Test and Experiment/ Research Control	X		
12. Control of Measuring and Test Equipment	X		
13. Handling, Shipping, and Storage	X		Applies only to samples.
14. Inspection, Test, and Operating Status	X		
15. Control of Nonconformances	X		
16. Corrective Action	X		
17. QA Records	X		
18. QA Audits	X		

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Activity: A. Laboratory Property Measurement

Task: A.10. Spatial variability of bulk, thermal, and mechanical properties.

PI F. B. Nimick

QA Criterion	Applies	Does Not Apply	Comments
1. OA Organization	X		
2. OA Program	X		
3. Design & Scientific Investigation Control	X		Scientific investigation requirements apply
4. Procurement Document Control	X		
5. Instructions, Procedures & Drawings	X		
6. Document Control	X		
7. Control of Purchased Material, Equipment, and Services	X		
8. ID and Control of Materials, Parts, Components and Samples	X		Applies only to samples.
9. Control of Processes		X	No special processes. Applies only to surveillance.
10. Inspection	X		
11. Test and Experiment/ Research Control	X		
12. Control of Measuring and Test Equipment	X		
13. Handling, Shipping, and Storage	X		Applies only to samples.
14. Inspection, Test, and Operating Status	X		
15. Control of Nonconformances	X		
16. Corrective Action	X		
17. OA Records	X		
18. OA Audits	X		