MODIFIED WORK PLAN TO SUPPORT

QUALITY ASSURANCE LEVEL ASSIGNMENTS

for

Sandia National Laboratories

NNWSI WBS ELEMENT 1.2.4.6.2.S

DESIGN ANALYSIS

Approvals (signature and date):

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List of Activities and Tasks

A. Design Parameter Evaluations

II A.1. Preliminary Borehole and Drift Temperature Calculations.
I A.2. LAD Borehole and Drift Temperature Calculations.
II A.3. Preliminary Waste Distribution Strategy Analysis.
I A.4. LAD Waste Distribution Strategy Analysis.

B. Far-Field Thermomechanical Evaluation

II B.1. Preliminary Documentation of Thermomechanical Stratigraphy of Yucca Mountain.
I B.2. LAD Documentation of Thermomechanical Stratigraphy of Yucca Mountain.
II B.3. Preliminary Determination of Allowable Far-Field Areal Power Density.
I B.4. LAD Determination of Allowable Far-Field Areal Power Density.

C. Excavation Stability Analysis

II C.1. Preliminary Excavation Stability Analysis.
I C.2. LAD Excavation Stability Analysis.

D. Layout Analysis

II D.1. Preliminary Determination of Area Needed for the Underground Facility.

III D.2. Preliminary Comparison of Layout to the 3-D Model of Yucca Mountain.

V D.3. LAD Comparison of Layout to the 3-D Model of Yucca Mountain.

E. Horizontal and Vertical Emplacement Comparison and Performance Assessment in support of ACD.

IV

WBS 1.2.4.6.2.S DESIGN ANALYSIS

1. Objectives and Issues Addressed

A. The objective is to establish the analytic basis for the underground facility design, including (1) the relationship of the underground facility layout to the three-dimensional model of Yucca Mountain, (2) the relationship of the heat generated by the waste to the layout of the underground facility and the design of the underground openings, and (3) the establishment of design parameters that are criteria for design of the layout and underground openings. The stability of these openings will also be analyzed.

B. Issues Addressed

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

Issues 1.12
1.12.1 Site characterization information needed for design.
1.12.3 Design concepts for orientation, geometry, layout, and depth of the underground facility, including flexibility to accommodate site-specific conditions.
1.12.4 Design concepts for design of engineered barriers that are part of the underground facility.
1.12.5 Impacts of excavation methods on containment and isolation.
1.12.6 Predicted thermal and thermomechanical response of the host rock, surrounding strata, and groundwater system.
1.12.7 Reference postclosure underground facility designs.

Issue 4.5
4.5.4 Potential impacts of rock characteristics on design.
4.5.10 Determination that the underground facilities can be constructed, operated, closed, and decommissioned using reasonably available technology.

C. Regulations and Requirements Addressed

Regulations and requirements addressed by the issues referenced in this WBS are cited in the NNWSI System 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 6, Sections 6.4.2 and 6.4.8 and Chapter 8, Sections 8.3.2.6 (parts 1 through 7) and 8.3.2.9 (parts 4 and 10).

Work related to the position of the underground facility, the thermal loading and borehole stability is in support of WBS 1.2.4.3.4.S (Underground Excavations). Computer codes used in this WBS element will be verified and validated in WBS 1.2.4.6.1.S. The data and reference values used 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

A. J. Mansure, Division 6314, Sandia National Laboratories (SNL), Albuquerque, NM.

3. Statement of Work

A. Design Parameter Evaluations

Allowable ranges of parameters that are used to establish design criteria for design of the repository layout and underground openings will be established. In addition, methods will be established to provide guidance for design changes due to differences in local geological structure encountered during construction.

A.1. Preliminary Borehole and Drift Temperature Calculations

a. Purpose: Perform thermal analyses of the near-field surrounding the waste canisters in support of the Advanced Conceptual Design (ACD). The calculation of temperature distributions are required to establish thermomechanical design criteria and to insure that temperatures remain within the limits established in the SCP (Sections 8.3.2.6 and 8.3.2.9). In addition, sensitivity studies and reference calculations for use in WBS 1.2.4.3.4.S, 1.2.1.2.S, 1.2.4.2.1.4.S, and 1.2.4.2.3.2.S will be performed.
b. Information Needs: 1.12.1, 1.12.6, 1.12.7, 4.5.4, 4.5.10.
c. Methods, Techniques, and Equipment: Analytic solutions and finite element methods will be used for calculations.
d. Technical Procedures:
   Available Procedures - None.
   Needed Procedures - None.
e. Computer Codes:
   Available Computer codes - COYOTE, SPECTROM, ARRAY F, and SIM for thermal analyses.
   Needed Computer Codes - None.

f. Documentation of Results: SAND reports will be written to document significant reference calculations.
g. Quality Assurance Level: II
h. Remarks: Thermal analysis of near-field surrounding waste canister, sensitivity studies and reference calculations in support of ACD will be done. A SAND report (SAND84-7208) has been published reviewing approaches to thermal modeling for design of borehole spacing and environment. A report covering the sensitivity analyses of drift temperatures and stresses to variation in rock-mass properties is in preparation (SAND86-1250).

A.2. LAD Borehole and Drift Temperature Calculations.

a. Purpose: Perform thermal analyses of the near-field surrounding the waste canisters in support of the License Application Design (LAD). The calculation of temperature distributions are required to establish thermomechanical design criteria and to insure that temperatures remain within the limits established in the SCP (Sections 8.3.2.6 and 8.3.2.9). In addition, sensitivity studies and reference calculations for use in WBS 1.2.4.3.4.S, 1.2.1.4.S, 1.2.4.2.1.4.S, and 1.2.4.2.3.2.S will be performed
b. Information Needs: 1.12.1, 1.12.6, 1.12.7, 4.5.4, 4.5.10.
c. Methods, Techniques, and Equipment: Analytic solutions and finite element methods will be used for calculations.
d. Technical Procedures:
Available Procedures - None.
Needed Procedures - None.
e. Computer Codes:
Available Computer Codes - COYOTE, SPECTROM, and SIM for thermal analyses.
Needed Computer Codes - None.

f. Documentation of Results: SAND reports will be written to document significant reference calculations.
g. Quality Assurance Level: I
h. Remarks: Thermal analysis of near-field surrounding waste canister, sensitivity studies and reference calculations in support of LAD will be done. A SAND report (SAND84-7208) has been published reviewing approaches to thermal modeling for design of borehole spacing and environment. A report covering sensitivity analyses of drift temperatures and stresses to variation in rock-mass properties is in preparation (SAND86-1250).

A.3. Preliminary Waste Distribution Strategy Analysis

a. Purpose: Because of differences in waste age and the amount of time the spent fuel was in the reactor (burnup) there is a large variability in the thermal output of the waste. The purpose of this task is to perform parametric studies on the effects of age and burnup on waste emplacement and spacing, insuring that the near-field temperature requirements documented in the SCP (Sections 8.3.2.6 and 8.3.2.9) will be satisfied. In addition, containment enhancement schemes, such as moisture control through boiling, will be systematically studied. The results of these studies will be applied to the formulation of design criteria for the ACD and WBS 1.2.4.3.4.S, 1.2.3.4.5.S, and 1.2.4.5.S.
b. Information Needs: 1.12.1, 1.12.6, 1.12.7, 4.5.4, 4.5.10.
c. Methods, Techniques, and Equipment: Analytic solutions and finite element methods will be used for calculations.
d. Technical Procedures:
Available Procedures - None.
Needed Procedures - None.

e. Computer Codes:
Available Computer Codes - COYOTE, SPECTROM, ARRAY F, and SIM for thermal analyses.
Needed Computer Codes - None.

f. Documentation of Results: SAND reports will be written to document significant reference calculations.

g. Quality Assurance Level: II

h. Remarks: Parametric studies of the effect of waste age and burnup on emplacement spacing in support of ACD will be accomplished. Scoping calculations on waste distribution designs have been completed and documented in SAND84-7214.

A.4. LAD Waste Distribution Strategy Analysis.

a. Purpose: Because of differences in waste age and the amount of time the spent fuel was in the reactor (burnup) there is a large variability in the thermal output of the waste. The purpose of this task is to perform parametric studies on the effects of age and burnup on waste emplacement and spacing, insuring that the near-field temperature requirements documented in the SCP (Sections 8.3.2.6 and 8.3.2.9) will be satisfied. In addition, containment enhancement schemes, such as moisture control through boiling, will be systematically studied. The results of these studies will be applied to the formulation of design criteria for LAD and WBS 1.2.4.3.4.S, 1.2.3.4.5.S, and 1.2.4.5.S.

b. Information Needs: 1.12.1, 1.12.6, 1.12.7, 4.5.4, 4.5.10.

c. Methods, Techniques, and Equipment: Analytical solutions and finite element methods will be used for calculations.

d. Technical Procedures:
Available Procedures - None.
Needed Procedures - None.

e. Computer Codes:
Available Computer Codes - COYOTE, SPECTROM, and SIM for thermal analyses.
Needed Computer Codes - None.

f. Documentation of Results: SAND reports will be written to document significant reference calculations.

g. Quality Assurance Level: I

h. Remarks: Studies of the effect of waste age and burnup on near-field environment in support of LAD will be accomplished. Scoping calculation on waste distribution designs have been completed and documented in SAND84-721.

B. Far-Field Thermomechanical Evaluation

Traditional mine design techniques and practices do not usually consider the effects of temperature on intact rock or rock-mass properties. The effect of the thermal load generated by the emplaced waste must therefore be carefully evaluated. In this task, a three-dimensional, thermomechanical stratigraphic model of Yucca Mountain is derived from geological and laboratory data. This model is then used in the determination of the allowable areal power density (APD) for the waste generated heat. The APD must meet the constraints of the design criteria. Sensitivity studies involving the effects of waste age and burnup on the predicted thermal distributions will also be conducted.

B.1. Preliminary Documentation of Thermomechanical Stratigraphy of Yucca Mountain.

a. Purpose: Geologic data from drill hole core, the exploratory shaft and surface mapping of faults along with laboratory data on the thermomechanical behavior of the different stratigraphic units are synthesized into a three-dimensional model of the thermomechanical stratigraphy of Yucca Mountain. The model is a necessary step in determining the APD. An important consideration in determining the APD is to insure that

the thermal loading does not degrade the mechanical strength or structural stability of any component of the facility to the point where the established design criteria cannot be satisfied. This can only be done by detailed analyses of the spatial distribution of temperature and material properties. In this task, a preliminary model will be developed for use in developing the ACD.

b. Information Needs: 1.12.1, 1.12.5, 1.12.6, 1.12.7, 4.5.4, 4.5.10.

c. Methods, Techniques, and Equipment: Geologic and thermo-mechanical data will be correlated with the geographic layout using an engineering work station with standard CAD software capable of three-dimensional display mapping.

d. Technical Procedures:
Available Procedures - None.
Needed Procedures - None.

e. Computer Codes:
Available Computer Codes - None.
Needed Computer Codes - None.

f. Documentation of Results: Details of the derived model will be documented in SAND reports.

g. Quality Assurance Level: II.

h. Remarks: A preliminary 3-D model of Yucca Mountain for APD calculations in support of ACD will be assembled from available geologic data. Preliminary results have been documented in a SAND report "A Thermomechanical Far-Field Model of Yucca Mountain."

B.2. LAD Documentation of Thermomechanical Stratigraphy of Yucca Mountain.

a. Purpose: Geologic data from drill hole core, the exploratory shaft and surface mapping of faults, along with laboratory data on the thermomechanical behavior of the different stratigraphic units, are synthesized to form a three-dimensional model of the thermomechanical stratigraphy of Yucca Mountain. The model is a necessary step in determining the APD. An

important consideration in determining the APD is to insure that the thermal loading does not degrade the mechanical strength or structural stability of any component of the facility to the point where the established design criteria cannot be satisfied. This can only be done by detailed analyses of the spatial distribution of temperature and material properties. In this task the model will be refined for use in developing the LAD.

b. Information Needs: 1.12.1, 1.12.6, 1.12.7, 4.5.4, 4.5.10.

c. Methods, Techniques, and Equipment: Geologic and thermo-mechanical data will be correlated with the geographic layout using an engineering work station and standard CAD software capable of three-dimensional display mapping.

d. Technical Procedures:
Available Procedures - None.
Needed Procedures - None.

e. Computer Codes:
Available Computer Codes - None.
Needed Computer Codes - None.

f. Documentation of Results: Details of the derived model will be documented in SAND reports.

g. Quality Assurance Level: I

h. Remarks: A refined 3-D model of Yucca Mountain for APD calculations in support of LAD will be generated. Preliminary results have been documented in a SAND report "A Thermomechanical Far-Field Model of Yucca Mountain."

B.3. Preliminary Determination of Allowable Far-Field Areal Power Density.

a. Purpose: Using thermal analysis techniques, along with the three-dimensional thermomechanical model of Yucca Mountain, the allowable Areal Power Density (APD) will be determined which satisfies the constraints of the established design criteria. Sensitivity analysis will also be performed to determine the effects of waste age and burnup on the APD calculations for use in WBS 1.2.4.3.4.S.

b. Information Needs: 1.12.1, 1.12.3, 1.12.6.
c. Methods, Techniques, and Equipment: Finite element methods will be used for calculations.
d. Technical Procedures:
Available Procedures - None.
Needed Procedures - None.
e. Computer Codes:
Available Computer Codes - COYOTE, SPECTROM, and JAC for thermomechanical analyses.
Needed Computer Codes - None.
f. Documentation of Results: SAND reports will be written to document significant reference calculations.
g. Quality Assurance Level: II
h. Remarks: APD determined in this task will be used as input for the ACD. To date, design analysis has assumed an areal power density of 57 kW/acre for spent fuel. An updated finite element model of Yucca Mountain has been constructed under Task B.1. for reevaluation of the APD.

B.4. LAD Determination of Allowable Far-Field Areal Power Density.

a. Purpose: Using thermal analysis techniques, along with the three-dimensional thermomechanical model of Yucca Mountain, the allowable Areal Power Density (APD) will be determined which satisfies the constraints of the established design criteria. Sensitivity analysis will also be performed to determine the effects of waste age and burnup on the APD calculations for use in WBS 1.2.4.3.4.S.
b. Information Needs: 1.12.1, 1.12.3, 1.12.6, 1.12.7, 4.5.4, 4.5.10.
c. Methods, Techniques, and Equipment: Finite element methods will be used for calculations.

d. Technical Procedures:
Available Procedures - None.
Needed Procedures - None.

e. Computer Codes:
Available Computer Codes - COYOTE, SPECTROM, and JAC for thermomechanical analyses.
Needed Procedures - None.

f. Documentation of Results: SAND reports will be written to document significant reference calculations.

g. Quality Assurance Level: I

h. Remarks: APD determined in this task will be used as input for the LAD.

C. Excavation Stability Analysis

A key factor in retrievability is that the drifts and boreholes must remain stable through the retrieval period. Stability analyses in the presence of thermal stresses induced by the heat given off by the waste and the fractured nature of the host rock at Yucca Mountain require analysis methods that are not standard to the mining industry. Therefore, analysis methods will be developed for extrapolating stability conditions to the long times required for retrievability.

C.1. Preliminary Excavation Stability Analysis.

a. Purpose: Methods will be developed for analysis of the long-term stability of mine drifts and waste emplacement boreholes in the presence of elevated temperatures due to waste heat. Analyses will be performed to insure that proposed designs satisfy the design criteria documented in the SCP (Section 8.3.2.9). The results of these analyses will form a design basis to be used in the ACD and WBS 1.2.4.3.4.S.

b. Information Needs: 1.12.1, 1.12.5, 1.12.8., 1.12.7, 4.5.4, 4.5.10.
c. Methods, Techniques, and Equipment: Finite element methods and boundary element methods will be used for analysis calculations.
d. Technical Procedures:
Available Procedures - None.
Needed Procedures - None.
e. Computer Codes:
Available Computer Codes - DINAT, ADINA, HEFF, STRES3D, BMINES, LINED, BEPL, VISCOT, DOT, COYOTE, SPECTROM, and JAC for thermomechanical analyses.
Needed Computer Codes - None.
f. Documentation of Results: SAND reports will be written to document significant reference calculations.
g. Quality Assurance Level: II
h. Remarks: Development of analysis methods for assessing long-term stability of boreholes and drifts is in support of ACD.

C.2. LAD Excavation Stability Analysis.

a. Purpose: Methods developed for analysis of the long-term stability of mine drifts and waste emplacement boreholes will be used to formulate a design basis to be used in developing the LAD and to ensure the proposed designs satisfy the criteria documented in the SCP (Section 8.3.2.9).
b. Information Needs: 1.12.1, 1.12.5, 1.12.6, 1.12.7, 4.5.4, 4.5.10.
c. Methods, Techniques, and Equipment: Finite element methods and boundary element methods will used for analysis calculations.

d. Technical Procedures:
Available Procedures - None.
Needed Procedures - None.

e. Computer Codes:
Available Computer Codes - ADINAT, ADINA, HEFF, STRES3D, BMINES, LINED, BEPTL, VISCOT, DOT, COYOTE, SPECTROM, and JAC for thermomechanical analyses.
Needed Computer Codes - None.

f. Documentation of Results: SAND reports will be written to document significant reference calculations.

g. Quality Assurance Level: I

h. Remarks: Stability analysis methods will be applied to LAD to insure retrievability conditions are satisfied.

D. Layout Analysis

The positioning and layout of the repository in the context of the actual site geology is required to assess the effect of conditions such as water table level and overburden on expected performance. In addition, the layout must be configured such that it fits within the constraints of the site geology, taking into account factors which will effect performance. Layout analysis will be performed to explore alternative configurations and positioning of the repository and to insure that the layout will conform to design criteria stated in the SCP Section 8.3.2.6.

D.1. Preliminary Determination of Area Needed for the Underground Facility

a. Purpose: Repository area needed will be determined based on the APD determined in Task B.3 and the area required for other facilities such as the ESTF and various shops. Area requirements must be shown to be in compliance with the site selection criteria in 10 CFR part 960.

b. Information Needs: 1.12.1, 1.12.3, 1.12.7.
c. Methods, Techniques, and Equipment: An engineering work station with standard CAD software capable of three-dimensional display will be used to compare repository designs with the three-dimensional geologic model of Yucca Mountain (WBS 1.2.1.3.2.S).
d. Technical Procedures:
Available Procedures - None.
Needed Procedures - None.
e. Computer Codes:
Available Computer Codes - None.
Needed Computer Codes - None.
f. Documentation of Results: Results of this analysis will be documented in SAND reports.
g. Quality Assurance Level: II
h. Remarks: Repository area determined in this task is in support of ACD.

D.2. Preliminary Comparison of Layout to the 3-D Model of Yucca Mountain.

a. Purpose: Layout designs of the repository will be compared with the three-dimensional geologic model of Yucca Mountain developed in Task B.1 to insure that the designs are compatible with the site geology and to develop criteria for altering construction methods based on local geological anomalies.
b. Information Needs: 1.12.1, 1.12.3, 1.12.4, 1.12.5, 1.12.7, 4.5.10.
c. Methods, Techniques, and Equipment: An engineering work station with standard CAD software capable of three-dimensional display will be used to compare repository designs with the three-dimensional geologic model of Yucca Mountain (WBS 1.2.1.3.2.S).
d. Technical Procedures:
Available Procedures - None.
Needed Procedures - None.
e. Computer Codes:
Available Computer Codes - None.
Needed Computer Codes - None.

f. Documentation of Results: Results of this analysis will be documented in SAND reports.
g. Quality Assurance Level: II
h. Remarks: Design studies to insure compatibility of layout with local geology are in support of ACD.

D.3. LAD Comparison of Layout to the 3-D Model of Yucca Mountain.

a. Purpose: Layout designs of the repository will be compared with the three-dimensional geologic model of Yucca Mountain developed in Task B.2 to insure that the designs are compatible with the site geology and to develop criteria for altering construction methods based on local geological anomalies. Results of this task will provide input to the LAD.
b. Information Needs: 1.12.1, 1.12.3, 1.12.4, 1.12.5, 1.12.7 4.5.10.
c. Methods, Techniques, and Equipment: An engineering work station with standard CAD software capable of three-dimensional display will be used to compare repository designs with the three-dimensional geologic model of Yucca Mountain (WBS 1.2.1.3.2.S).
d. Technical Procedures:
Available Procedures - None.
Needed Procedures - None.
e. Computer Codes:
Available Computer Codes: - None.
Needed Computer Codes - None.
f. Documentation of Results: Results of this analysis will be documented in SAND reports.
g. Quality Assurance Level: I

h. Remarks: Layout design will be compared with 3-D model to insure compatiblity with local geology and provide design guidance for LAD.

E. Horizontal and Vertical Emplacement Comparison and Performance Assessment in Support of ACD.

a. Purpose: A performance tradeoff study will be performed comparing the characteristics of the horizontal and vertical emplacement options. The study will include such factors as borehole and drift stability and amount of moisture in contact with the waste containers. The study will be accomplished by compiling results of analyses done under this and other WBS elements.
b. Information Needs: 1.12.1, 1.12.3, 1.12.4, 1.12.5, 1.12.6 1.12.7, 4.5.4, 4.5.10.
c. Methods, Techniques, and Equipment: N/A
d. Technical Procedures:
Available Procedures - None.
Needed Procedures - None.
e. Computer Codes:
Available Computer Codes - None.
Needed Computer Codes - None.
f. Documentation of Results: Results of this analysis will be documented in SAND reports.
g. Quality Assurance Level: II
h. Remarks: This task involves a performance tradeoff study for horizontal versus vertical emplacement.

4. Data and Materials Needed

Task A.1. Preliminary Borehole and Drift Temperature Calculations.

Data Needed - Tuff thermal and mechanical properties, Yucca Mountain in-situ stress state and stratigraphy, thermal output of the waste, waste container dimensions, and drift dimensions.

Source of Data - Data will be obtained from the Reference Information Base (RIB) and the Subsystems Design Requirements (SDR).
Quality of Data - As defined in the Reference Information Base.

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

Task A.2. LAD Borehole and Drift Temperature Calculations

Data Needed - Tuff thermal and mechanical properties, Yucca Mountain in-situ stress state and stratigraphy, thermal output of the waste, waste container dimensions, and drift dimensions.
Source of Data - Data will be obtained from the Reference Information Base (RIB) and the Subsystems Design Requirements (SDR).
Quality of Data - As defined in the Reference Information Base.

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

Task A.3. Preliminary Waste Distribution Strategy Analysis.

Data Needed - Tuff thermal and mechanical properties, Yucca Mountain in-situ stress state and stratigraphy, thermal output of the waste, waste container dimensions, and drift dimensions.

Source of Data - Data will be obtained from the Reference Information Base (RIB) and the Subsystems Design Requirements (SDR).
Quality of Data - As defined in the Reference Information Base.

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

Task A.4. LAD Waste Distribution Strategy Analysis.

Data Needed - Tuff thermal and mechanical properties, Yucca Mountain in situ stress state and stratigraphy thermal output of the waste, waste container dimensions, and drift dimensions.
Source of Data - Data will be obtained from the Reference Information Base (RIB) and the Subsystems Design Requirements (SDR).
Quality of Data - As defined in the Reference Information Base.

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

Task B.1. Preliminary Documentation of Thermomechanical Stratigraphy of Yucca Mountain.

Data Needed - Tuff thermal and mechanical properties and Yucca Mountain in-situ stress state, stratigraphy, geologic contacts, and fault strike and slip.
Source of Data - Data will be obtained from the Reference Information Base (RIB), the Tuff Data Base, and the Subsystems Design Requirements (SDR).
Quality of Data - As defined in the Reference Information Base.

Task B.2. LAD Documentation of Thermomechanical Stratigraphy of Yucca Mountain.

Data Needed - Tuff thermal and mechanical properties and Yucca Mountain in-situ stress state, stratigraphy, geologic contacts, and fault strike and slip.
Source of Data - Data will be obtained from the Reference Information Base (RIB), the Tuff Data Base and the Subsystems Design Requirements (SDR).
Quality of Data - As defined in the Reference Information Base.

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

Task B.3. Preliminary Determination of Allowable Far-Field Areal Power Density.

Data Needed - Tuff thermal and mechanical properties, Yucca Mountain in-situ stress state and stratigraphy, and the thermal output of the waste.
Source of Data - Data will be obtained from the Reference Information Base (RIB) and the Subsystems Design Requirements (SDR).
Quality of Data - As defined in the Reference Information Base.

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

B.4. LAD Determination of Allowable Far-Field Areal Power Density.

Data Needed - Tuff thermal and mechanical properties, Yucca Mountain in-situ stress state and stratigraphy, and the thermal output of the waste.

Source of Data - Data will be obtained from the Reference Information Base (RIB) and the Subsystems Design Requirements (SDR).
Quality of Data - As defined in the Reference Information Base.

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

Task C.1. Preliminary Excavation Stability Analysis.

Data Needed - Tuff thermal and mechanical properties, Yucca Mountain in-situ stress state and stratigraphy, and the thermal output of the waste.
Source of Data - Data will be obtained from the Reference Information Base (RIB) and the Subsystems Design Requirements (SDR).
Quality of Data - As defined in the Reference Information Base.

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

Task C.2. LAD Excavation Stability Analysis.

Data Needed - Tuff thermal and mechanical properties, Yucca Mountain in-situ stress state and stratigraphy, and the thermal output of the waste.
Source of Data - Data will be obtained from the Reference Information Base (RIB) and the Subsystems Design Requirements (SDR).
Quality of Data - As defined in the Reference Information Base.

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

Task D.1 Preliminary Determination of Area Needed for the Underground Facility.

Data Needed - APD, waste quantities, areal requirements for non-waste areas, and drift dimensions based on equipment needs.
Quality of Data - Data will be obtained from the Reference Information Base (RIB) and the Subsystems Design Requirements (SDR).
Quality of Data - As defined in the Reference Information Base.

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

Task D.2. Preliminary Comparison of Layout to the 3-D Model of Yucca Mountain.

Data Needed - Thermomechanical stratigraphy of Yucca Mountain and the proposed layout.
Source of Data - Data will be obtained from the Reference Information Base (RIB) and the Subsystems Design Requirements (SDR).
Quality of Data - As defined in the Reference Information Base.

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

Task D.3. LAD Comparison of Layout to the 3-D Model of Yucca Mountain.

Data Needed - Thermomechanical stratigraphy of Yucca Mountain and the proposed layout.
Source of Data - Data will be obtained from the Reference Information Base (RIB) and the Subsystems Design Requirements (SDR).
Quality of Data - As defined in the Reference Information Base.

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

Task E. Horizontal and Vertical Emplacement Comparison and Performance Assessment in Support of ACD.

Data Needed - Material properties and reference designs
Source of Data - Data will be obtained from the Reference Information Base (RIB) and the Subsystems Design Requirements (SDR).
Quality of Data - As defined in the Reference Information Base.

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

5. Non-Standard Methods or Techniques

Tasks A.1, A.2, A.3 and A.4

Because of the fracturing of the welded tuff, developmental computer codes and material models (compliant joint model) must be used to evaluate what physics is important in the response of the rock mass to the thermal load. Methods need to be developed to evaluate how the interaction of fractures and thermal load affects stresses and hydrologic properties.

Tasks B.3 and B.4

Because of the fracturing of the welded tuff, developmental computer codes and material models (compliant joint model) must be used to evaluate what physics is important in the response of the rock mass to the thermal load. Methods need to be developed to evaluate how the interaction of fractures and thermal load affects stresses and hydrologic properties.

Tasks C.1 and C.2

Because of the fracturing of the welded tuff, developmental computer codes and material models (compliant joint model) must be used to evaluate what physics is important in the response of the rock mass to the thermal load. Methods need to be developed to evaluate how the interaction of fractures and thermal load affects stresses and hydrologic properties. Methods of interpretation will need to be developed to relate predicted mechanical behavior to excavation stability.

6. Location of Work Performance

Sandia National Laboratories, Albuquerque, NM.

Contractors: RE/SPEC, Inc., Albuquerque, NM
Agapito and Associates, Grand Junction, CO.

7. Quality Assurance Requirements

Quality Assurance Level Assignments:

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

Quality Assurance Level I: Tasks A.2, A.4, B.2, B.4, C.2, and D.3.
Quality Assurance Level II: Tasks A.1, A.3, B.1, B.3, C.1, D.1, D.2, and E.
Quality Assurance Level III: None.

8. Application of Results

For the repository as a whole, the two primary changes in the design process are the position of the underground facility and its loading (area power density-APD). This WBS element has the primary responsibility for determining APD and works with WBS 1.2.4.3.4 to determine the best position of the underground facility. Both position and loading will be important input data for demonstrating that waste isolation performance criteria can be met.

The thermal loading of the underground facility is an important design parameter that must be established before the number of boreholes. Lengths of drifts, and thus the volume of rock to be mined can be determined. Loading is also a critical parameter in determining the effect of the heat from the waste upon the ventilation system. This WBS element establishes the thermal loading of the underground facility for use in WBS 1.2.4.3.4.

A key factor in retrievability is that the drifts and boreholes must be stable through the retrieval period. The thermal stresses induced by the heat given off by the waste and the fractured nature of the host rock at Yucca Mountain require stability analysis techniques that are not standard in the mining industry. This WBS element will analyze the drifts and other excavations and designs in WBS 1.2.4.3.4 to ensure that preclosure stability criteria can be met.

9. Schedule

Starting date: 1983; anticipated ending date: 1989

10. Past and Expected Achievements

Past Achievements

During FY84, work was completed on "Preliminary Evaluation of the Subsurface Area Available for a Potential Nuclear-Waste Repository at Yucca Mountain." This report discusses the primary emplacement area within Yucca Mountain and surrounding area.

During FY85, "Underground Facility Area Requirements for a Nuclear Waste Repository" was completed. The area determined in this report has been compared to the area available in the EA. Also a report, "Thermal Analysis of Spent Fuel Disposal in Vertical Emplacement Boreholes in a Welded Tuff Repository," was completed. This report reviews approaches to thermal modeling for design of borehole spacing and drift environment.

During FY85, a keystone memo "Determination of Maximum Temperature as a Function of Distance From a Spent Fuel and a commercial High-Level Waste Repository," Keystone Memo 6312-84-1, was finalized.

A draft of a Keystone Report, reviewing past thermal calculations, has been prepared as a reference for expected thermal conditions for retrieval and sealing studies.

Analyses to date have shown that the placement of the canisters (layout of the underground facility) is controlled by the thermal constraints and not thermostructural stability considerations of the drifts. This fact allows the underground architectural engineer to design the underground facility using traditional mining engineering methods and thermostructural analyses to check this design.

To date, design analysis has assumed an areal power density of 47 kW/acre for spent fuel based upon work done during the unit evaluation study (corresponding number for CHLW has been determined to be 100 kW/acre). An updated finite element model of Yucca Mountain, including the latest geologic data available, has been built for reevaluating the areal power density.

Baseline thermal decay curves have been established and the effect of waste age on thermal loading has been evaluated. The results of this work show that the allowable canister spacing is not greatly affected by waste age.

Reference thermostructural analyses of drifts have been performed. These analyses show that the maximum stresses will be less than the unconfined compressive strength of the rock and that the drifts will be stable. These analyses have examined drift width and drift shape and have show that design factors are not critical.

Preliminary structural stability calculations of minimum borehole spacing (not including thermal effects) have been made and show that the boreholes can be placed close enough together that the inclusion of DHLW or reprocessing will not cause the size of the underground facility to increase. Thermal analyses have been done to show that thermal effects will be important; these effects will be included in future calculations.

Expected Achievements

FY86

- Repository Conceptual Design Reference Calculations
- Reevaluation far-field thermomechanical analyses including sensitivity study
- Finalize minimum borehole spacing
- Perform preliminary near-field sensitivity studies to establish approach for evaluating the effects of uncertainty in rock properties.
- Review RCD/SC: layout and thermal load

FY87

- Sensitivity studies
- Near-field studies to support APD decision
- Finalize APD and ACD
- Near-field thermal design strategy for waste age and burnup
- Code documentation in preparation for licensing
- Input to LAD design guidelines
- Blast cooling structural effects study
- Joint compliant reference calculations
- Ventilation system studies
- Establish relationship of thermal load to ventilation system load
- Initiate performance comparison of horizontal ad vertical emplacement

FY88

Review LAD A&E Work
- ES test support
- Review of significance of new geologic data gathered during site characterization
- Seismic stability analysis of advanced conceptual design
- Check ACD to see if it meets performance criteria

FY89

- Review LAD A&E work
- Review of significance of new rock properties gathered during site characterization
- Check LAD to see it meets performance criteria

11. Milestones and Deliverables

Milestone Number	Description and Criteria	Completion Date
N457	Preliminary Study of the Effects of Uncertainty in Geologic Data on Design of Underground Facility This deliverable will be met by submitting to WMPO/NVO a draft report outlining the approach to how the design analysis subtask will incorporate uncertainty in the geologic data into the analyses.	06/30/86

Milestone Number	Description and Criteria	Completion Date
M414	Shaft vs. Ramp Emplacement Panel Interaction This milestone will be completed by submitting to WMPO/NVO a draft report comparing the shaft and ramp emplacement panel interactions that result from thermally induced stresses.	03/30/86 (estimated)
M452	Thermomechanical Analysis of Access Drifts, Storage Drifts and Alcoves, and the Access Drift/Storage Drift Intersection. This milestone will be completed by submitting to WMPO/NVO a draft report analyzing three-dimensional effects of drift intersections and alcoves and comparing them to drifts.	04/30/86 (estimated)
M413	Near-Field Thermal Effects and Structural Stability Report The report describes the reference near-field analyses done as part of the conceptual design support of the SCP. It will be based upon the most recent set of geologic, waste package, waste characterization, and mining data. This deliverable will be met by submitting a draft report to WMPO/NVO for review.	04/30/86
M414	Report on Far-Field Thermal Mechanical Effects This deliverable will be a draft SAND report submitted to WMPO/NVO for policy review. This report describes the far-field analyses done to support establishing the advanced conceptual design waste loading. It will include rock-mass effects, updated stratigraphy, and other improvements over the unit evaluation study.	07/30/86
M413	Minimum Borehole Spacing This milestone will be completed by submitting report, SAND84-7214, "An Investigation to Determine the Minimum Spacing of Canister-Boreholes for Low-Level Waste in a Tuff Repository," to NVO/WMPO for policy review. The report will include the effects of thermal-induced stresses.	09/30/86

Milestone Number	Description and Criteria	Completion Date
M037	Design Analysis Report to Support the Advanced Conceptual Design This deliverable will be met by submitting to WMPO/NVO a draft report for policy review. This report describes the thermal and thermomechanical studies done to establish reference calculations pre-LAD. The near-field thermal design strategy for distributing the waste will be discussed, the APD decision will be reviewed, the three-dimensional model of the underground facility will be updated, and the effect of the thermal load on the ventilation system will be discussed.	06/30/87
N458	Study of the Effects of Uncertainty in Geologic Data on Design Analysis of Underground Facility This deliverable will be met by submitting to WMPO/NVO a draft report of the analyses that show the effect on uncertainty of geologic data and rock properties on the design analysis of the underground facility.	09/30/87
R147	Preliminary Performance Comparison of Vertical and Horizontal Emplacement of Waste The deliverable will be met by submitting a letter report to NVO/WMPO which outlines the preliminary results of the performance comparison of vertical and horizontal emplacement of waste.	03/31/87
R290	Design Analysis Progress Report on Performance Assessment of License Application Design This deliverable will be met by submitting to WMPO/NVO a draft report containing the preliminary performance assessment of the design analysis review of the LAD A&E's underground facility design.	09/30/88

Milestone Number	Description and Criteria	Completion Date
M063	Design Analysis Final Performance Assessment Report on the License Application Design This deliverable will be met by submitting to WMPO/NVO a draft report containing the final performance assessment of the design analysis review of the LAD A&E's underground facility design.	06/30/89
N451	Thermal Analysis of BWR - Spent Fuel Vertical Emplacement Scheme This milestone will be completed by submitting to WMPO/NVO a draft report analyzing the thermal effects of vertical emplacement.	07/12/85
N412	TRU Standoff Distance This milestone will be completed by submitting to WMPO/NVO a draft keystone memo on temperature versus distance. The memo forms the basis for deciding how far away to place TRU waste from the main repository.	02/28/85

12. Costs

Costs are in thousands of expenditure-year dollars.

FY86

SNL Labor Costs: $131 Other Costs: $ 424

FY87

SNL Labor Costs: $273 Other Costs: $1,000

FY88

SNL Labor Costs: $230 Other Costs: $ 842

FY89

SNL Labor Costs: $239 Other Costs: $ 820

13. Performance Measurement

Level of Effort

NNWSI QUALITY ASSURANCE LEVEL ASSIGNMENT SNL-QA-001

WP No. 12462-86
Rev. B

QALAS No. 109
Rev. B
Page 1 of 1

APPROVALS (Signature and Date)

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Supervisor Lee R Tillerson 7/25/86
TPO Thomas O Hunter 7/25/86
WMPO (PQM) James B Blaylock 7/24/86
WMPO (Tech) [illegible] 7/29/86

Activity: A. Design Parameter Evaluation

Task Description	QA Level	QA Criteria	Level Justification
A.1 Preliminary Borehole and Drift Temperature Calculations.	II	1-7, 15-18	Thermal analysis of near-field surrounding waste canister in support of ACD. Includes sensitivity studies and reference calculations. This task is assigned QA Level II because Step 10 of the logic diagram applies.
A.2 LAD Borehole and Drift Temperature Calculations.	I	1-7, 15-18	Thermal analysis of near-field surrounding waste package in support of LAD. This task is assigned QA Level I because Step 4 of the logic diagram applies.
A.3 Preliminary Waste Distribution Strategy Analysis.	II	1-7, 15-18	Parametric studies of the effect of waste age and burnup on emplacement spacing. This task is assigned QA Level II because Step 10 of the logic diagram applies.
A.4 LAD Waste Distribution Strategy Analysis.	I	1-7, 15-18	Study of effects of waste age and burnup on near-field environment for LAD. This task is assigned QA Level I because Step 4 of the logic diagram applies.

QUALITY LEVEL ASSIGNMENT CRITERIA SHEET

WP No. 12462-86 Rev. B

QALAS No. 109 Rev. B

Activity: A. Design Parameter Evaluation

Task: A.1 Preliminary Borehole and Draft Temperature Calculations

PI A. J. Manusure

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	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	No manufacturing or tests involved.
13. Handling, Shipping, and Storage		X	No instruments, hardware or samples involved.
14. Inspection, Test, and Operating Status		X	No inspection or tests involved.
15. Control of Nonconformances	X		
16. Corrective Action	X		
17. QA Records	X		
18. QA Audits	X		

QUALITY LEVEL ASSIGNMENT CRITERIA SHEET

WP No. 12462-86 Rev. B

QALAS No. 109 Rev. B

Activity: A. Design Parameter Evaluation

Task: A.2 LAD Borehole and Draft Temperature Calculations

PI A. J. Manusure

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	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	No manufacturing or tests involved.
13. Handling, Shipping, and Storage		X	No instruments, hardware or samples involved.
14. Inspection, Test, and Operating Status		X	No inspection or tests involved.
15. Control of Nonconformances	X		
16. Corrective Action	X		
17. QA Records	X		
18. QA Audits	X		

QUALITY LEVEL ASSIGNMENT CRITERIA SHEET

WP No. 12462-86 Rev. B

QALAS No. 109 Rev. B

Activity: A. Design Parameter Evaluation

Task: A.3 Preliminary Waste Distribution Strategy Analysis

PI A. J. Manusure

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	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	No manufacturing or tests involved.
13. Handling, Shipping, and Storage		X	No instruments, hardware or samples involved.
14. Inspection, Test, and Operating Status		X	No inspection or tests involved.
15. Control of Nonconformances	X		
16. Corrective Action	X		
17. QA Records	X		
18. QA Audits	X		

QUALITY LEVEL ASSIGNMENT CRITERIA SHEET

WP No. 12462-86 Rev. B

QALAS No. 109 Rev. B

Activity: A. Design Parameter Evaluation

Task: A.4 LAD Waste Distribution Strategy Analysis

PI A. J. Manusure

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	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	No manufacturing or tests involved.
13. Handling, Shipping, and Storage		X	No instruments, hardware or samples involved.
14. Inspection, Test, and Operating Status		X	No inspection or tests involved.
15. Control of Nonconformances	X		
16. Corrective Action	X		
17. QA Records	X		
18. QA Audits	X		

NNWSI QUALITY ASSURANCE LEVEL ASSIGNMENT SNL-QA-001

WP No. 12462-86
Rev. B

QALAS No. 110
Rev. B
Page 1 of 1

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Activity: B. Far-Field Thermomechanical Evaluation

Task Description	QA Level	QA Criteria	Level Justification
B.1 Preliminary Documentation of Thermomechanical Stratigraphy of Yucca Mountain.	II	1-7, 15-18	Assemble available geologic data into 3-D model for APD calculations in support of ACD. This task is assigned QA Level II because Step 10 of the logic diagram applies.
B.2 LAD Documentation of Thermomechanical Stratigraphy of Yucca Mountain.	I	1-7, 15-18	Refine 3-D model for APD calculations in support of LAD. This task is assigned QA Level I because Step 4 of the logic diagram applies.
B.3 Preliminary Determination of Allowable Far-Field APD.	II	1-7, 15-18	Determine allowable APD satisfying design criteria for ACD. This task is assigned QA Level II because Step 10 of the logic diagram applies.
B.4 LAD Determination of Allowable Far-Field APD.	I	1-7, 15-18	Determine allowable APD satisfying design criteria for LAD. This task is assigned QA Level I because Step 4 of the logic diagram applies.

QUALITY LEVEL ASSIGNMENT CRITERIA SHEET

WP No. 12462-86 Rev. B

QALAS No. 110 Rev. B

Activity: B. Far-Field Thermomechanical Evaluation

Task: B.1 Preliminary Documentation of Thermomechanical Stratigraphy of Yucca Mountain

PI A. J. Manusure

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	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	No manufacturing or tests involved.
13. Handling, Shipping, and Storage		X	No instruments, hardware or samples involved.
14. Inspection, Test, and Operating Status		X	No inspection or tests involved.
15. Control of Nonconformances	X		
16. Corrective Action	X		
17. QA Records	X		
18. QA Audits	X		

QUALITY LEVEL ASSIGNMENT CRITERIA SHEET

WP No. 12462-86 Rev. B

QALAS No. 110 Rev. B

Activity: B. Far-Field Thermomechanical Evaluation

Task: B.2 LAD Documentation of Thermomechanical Stratigraphy of Yucca Mountain

PI A. J. Manusure

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	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	No manufacturing or tests involved.
13. Handling, Shipping, and Storage		X	No instruments, hardware or samples involved.
14. Inspection, Test, and Operating Status		X	No inspection or tests involved.
15. Control of Nonconformances	X		
16. Corrective Action	X		
17. QA Records	X		
18. QA Audits	X		

QUALITY LEVEL ASSIGNMENT CRITERIA SHEET

WP No. 12462-86 Rev. B

QALAS No. 110 Rev. B

Activity: B. Far-Field Thermomechanical Evaluation

Task: B.3 Preliminary Determination of Allowable Far-Field Areal Power Density

PI A. J. Manusure

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	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	No manufacturing or tests involved.
13. Handling, Shipping, and Storage		X	No instruments, hardware or samples involved.
14. Inspection, Test, and Operating Status		X	No inspection or tests involved.
15. Control of Nonconformances	X		
16. Corrective Action	X		
17. QA Records	X		
18. QA Audits	X		

QUALITY LEVEL ASSIGNMENT CRITERIA SHEET

WP No. 12462-86 Rev. B

QALAS No. 110 Rev. B

Activity: B. Far-Field Thermomechanical Evaluation

Task: B.4 LAD Determination of Allowable Far-Field Areal Power Density PI A. J. Manusure

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	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	No manufacturing or tests involved.
13. Handling, Shipping, and Storage		X	No instruments, hardware or samples involved.
14. Inspection, Test, and Operating Status		X	No inspection or tests involved.
15. Control of Nonconformances	X		
16. Corrective Action	X		
17. QA Records	X		
18. QA Audits	X		

NNWSI QUALITY ASSURANCE LEVEL ASSIGNMENT SNL-QA-001

WP No. 12462-86
Rev. B

QALAS No. 111
Rev. B
Page 1 of 1

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WMPO (PQM) James B Lingford 7/29/86
WMPO (Tech) [signature] 7/29/86

Activity: C. Excavation Stability Analysis

Task Description	QA Level	QA Criteria	Level Justification
C.1 Preliminary Excavation Stability Analysis.	II	1-7, 15-18	Develop methods for analyses of long-term stability of boreholes and drifts in support of ACD and retrievability requirements. This task is assigned QA Level II because Step 9 of the logic diagram applies.
C.2 LAD Excavation Stability Analysis.	I	1-7, 15-18	Stability analysis methods applied to LAD to insure retrievability conditions are satisfied. This task is assigned QA Level I because Step 4 of the logic diagram applies.

QUALITY LEVEL ASSIGNMENT CRITERIA SHEET

WP No. 12462-86 Rev. B

QALAS No. 111 Rev. B

Activity: C. Excavation Stability Analysis

Task: C.1 Preliminary Excavation Stability Analysis

PI A. J. Manusure

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	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	No manufacturing or tests involved.
13. Handling, Shipping, and Storage		X	No instruments, hardware or samples involved.
14. Inspection, Test, and Operating Status		X	No inspection or tests involved.
15. Control of Nonconformances	X		
16. Corrective Action	X		
17. QA Records	X		
18. QA Audits	X		

QUALITY LEVEL ASSIGNMENT CRITERIA SHEET

WP No. 12462-86 Rev. B

QALAS No. 111 Rev. B

Activity: C. Excavation Stability Analysis

Task: C.2 LAD Excavation Stability Analysis PI A. J. Manusure

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	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	No manufacturing or tests involved.
13. Handling, Shipping, and Storage		X	No instruments, hardware or samples involved.
14. Inspection, Test, and Operating Status		X	No inspection or tests involved.
15. Control of Nonconformances	X		
16. Corrective Action	X		
17. QA Records	X		
18. QA Audits	X		

NNWSI QUALITY ASSURANCE LEVEL ASSIGNMENT SNL-QA-001

WP No. 12462-86
Rev. B

QALAS No. 124
Rev. B
Page 1 of 1

APPROVALS (Signature and Date)

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PQA Connie Choran 7/25/86
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WMPO (Tech) [signature] 7/29/86

Activity: D. Layout Analysis

Task Description	QA Level	QA Criteria	Level Justification
D.1 Preliminary Determination of Area Needed for Underground Facility	II	1-7, 15-18	Repository area needed will be determined based on ADP studies and other requirements. Provides data for ACD. This task is assigned QA Level II because Step 10 of the logic diagram applies.
D.2 Preliminary Comparison of Layout with 3-D Model of Yucca Mountain.	II	1-7, 15-18	Design study to insure compatibility of layout with local geology and stratigraphy in support of ACD. This task is assigned QA Level II because Step 10 of the logic diagram applies.
D.3 LAD Comparison of Layout with 3-D model of Yucca Mountain.	I	1-7, 15-18	Layout design will be compared with 3-D model to insure compatibility with local geology and to provide design guidance for LAD. This task is assigned QA Level I because Step 4 of the logic diagram applies.

QUALITY LEVEL ASSIGNMENT CRITERIA SHEET

WP No. 12462-86 Rev. B

QALAS No. 124 Rev. B

Activity: D. Layout Analysis

Task: D.1 Preliminary Determination of Area Needed for the Underground Facility

PI A. J. Manusure

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	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	No manufacturing or tests involved.
13. Handling, Shipping, and Storage		X	No instruments, hardware or samples involved.
14. Inspection, Test, and Operating Status		X	No inspection or tests involved.
15. Control of Nonconformances	X		
16. Corrective Action	X		
17. QA Records	X		
18. QA Audits	X		

QUALITY LEVEL ASSIGNMENT CRITERIA SHEET

WP No. 12462-86 Rev. B

QALAS No. 124 Rev. B

Activity: D. Layout Analysis

Task: D.2 Preliminary Comparison of Layout to the 3-D Model of Yucca Mountain

PI A. J. Manusure

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	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	No manufacturing or tests involved.
13. Handling, Shipping, and Storage		X	No instruments, hardware or samples involved.
14. Inspection, Test, and Operating Status		X	No inspection or tests involved.
15. Control of Nonconformances	X		
16. Corrective Action	X		
17. QA Records	X		
18. QA Audits	X		

QUALITY LEVEL ASSIGNMENT CRITERIA SHEET

WP No. 12462-86 Rev. B

QALAS No. 124 Rev. B

Activity: D. Layout Analysis

Task: D.3 LAD Comparison of Layout to the 3-D Model of Yucca Mountain

PI A. J. Manusure

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	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	No manufacturing or tests involved.
13. Handling, Shipping, and Storage		X	No instruments, hardware or samples involved.
14. Inspection, Test, and Operating Status		X	No inspection or tests involved.
15. Control of Nonconformances	X		
16. Corrective Action	X		
17. QA Records	X		
18. QA Audits	X		

NNWSI QUALITY ASSURANCE LEVEL ASSIGNMENT SNL-QA-001

WP No. 12462-86
Rev. B

QALAS No. 125
Rev. B
Page 1 of 1

APPROVALS (Signature and Date)

PI Stephen J Bauer 7/25/86
PQA Connie Chovan 7/25/86
Supervisor Joe R Tillerson 7/25/86
TPO Thomas O. Hunter 7/25/86
WMPO (PQM) James Blaylock 7/27/86
WMPO (Tech) [illegible] 7/29/86

Activity: E. Horizontal and Vertical Emplacement Comparison and Performance Assessment in Support of ACD

Task Description	QA Level	QA Criteria	Level Justification
E. Same as Activity	II	1-7, 15-18	Performance tradeoff study comparing characteristic of horizontal vs. vertical emplacement. This task is assigned QA Level II because Step 10 of the logic diagram applies.

QUALITY LEVEL ASSIGNMENT CRITERIA SHEET

WP No. 12462-86 Rev. B

QALAS No. 125 Rev. B

Activity: E. Horizontal and Vertical Emplacement Comparison and Performance Assessment in Support of ACD

Task: E. Same as Activity PI A. J. Manusure

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	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	No manufacturing or tests involved.
13. Handling, Shipping, and Storage		X	No instruments, hardware or samples involved.
14. Inspection, Test, and Operating Status		X	No inspection or tests involved.
15. Control of Nonconformances	X		
16. Corrective Action	X		
17. QA Records	X		
18. QA Audits	X		