WMPO QUALITY ASSURANCE AUDIT REPORT

NNWSI PROJECT AUDIT OF SANDIA NATIONAL LABORATORIES

AUDIT NUMBER: 87-5

CONDUCTED: 1 - 5 June 1987

Prepared by: H. H. Caldwell 3 Aug 87

H. H. Caldwell - Lead Auditor

Approved by: James Blaylock 8/3/87

James Blaylock - PQM (WMPO)

1.0 INTRODUCTION

This report presents the results of a Quality Assurance Audit of Sandia National Laboratories (SNL), Albuquerque, New Mexico. The audit was conducted to the requirements of the Waste Management Project Office (WMPO) Quality Assurance Program Plan (NVO-196-18) and Quality Management Procedure (QMP) 18-1, Rev. 1.

2.0 AUDIT SCOPE

The purpose of this audit was to evaluate the effectiveness of the SNL Department 6310 Quality Assurance Program and implementing procedures with respect to the requirements of NNWSI Project Quality Assurance Plan NVO-196-17, Rev. 4, and to verify the implementation of the Quality Assurance Program as it relates to activities of the NNWSI Project. At the time of this audit there were no open/outstanding audit findings from previous audits.

3.0 AUDIT TEAM PERSONNEL

The audit team consisted of the following members:

Henry H. Caldwell, Audit Team Leader, SAIC, Las Vegas, NV
Robert H. Klemens, Auditor, SAIC, Las Vegas, NV
Gerard Heaney, Auditor, SAIC, Las Vegas, NV
James M. Gromer, Auditor, SAIC, Las Vegas, NV
Forrest D. Peters, Auditor, SAIC, Las Vegas, NV
Theodore Vetter, Jr., Auditor, SAIC, Las Vegas, NV
Robert W. Clark, Auditor, DOE/HQ (Weston)
George D. Dymmel, Technical Specialist, SAIC, Las Vegas, NV
U Sun Park, Technical Specialist, SAIC, Las Vegas, NV
William R. Sublette, Technical Specialist, SAIC, Las Vegas, NV
Paul T. Prestholt, Observer, NRC/NV

4.0 SUMMARY OF AUDIT RESULTS

This evaluation of Sandia National Laboratories Department 6310 Quality Assurance Program and selected technical activities showed general compliance with NNWSI Project NVO-196-17, Rev. 4, requirements. A total of eight deficiencies, some of which cover more than one criterion, and twelve observations were identified during the course of the audit. In addition, the audit team generated two recommendations for the Department 6310 staff to consider. Deficiencies, observations, and recommendations are detailed in Section 6 of this report. The deficiencies identified by the audit team were, with one exception, distributed throughout the program. The exception was Criterion 5 (Instructions, Procedures, and Drawings), which had four deficiencies with their root cause being lack of adequate procedures to cover quality related activities. The number of SDRs identified in this area would indicate a need for evaluating the current system of implementing procedures for both scope of coverage and depth of coverage.

The following program elements were deemed to be in compliance with the requirements of the NNWSI Project Quality Assurance Program:

1. Organization

6. Document Control

8. Identification and Control of Samples and Items

9. Control of Processes

11. Experiment and Equipment Test Control

13. Handling, Storage, and Shipping

14. Inspection and Test Status

Program elements which the audit team identified as deficient were:

2. Quality Assurance Program

3. Design and Scientific Investigation Control

4. Procurement Document Control

5. Instructions, Procedures, and Drawings

7. Control of Purchased Material, Equipment, and Services

10. Inspection and Surveillances

12. Control of Measuring and Test Equipment

15. Nonconformances

16. Corrective Actions

17. Records

18. Audits

In addition to the programmatic areas outlined above, the following technical areas were reviewed as part of this audit:

WBS 1.2.1.3	Technical Data Base
WBS 1.2.1.4	Total Systems Performance Assessment
WBS 1.2.3.2.1.1	Site Geology
WBS 1.2.4.2.1.1	Rock Mechanics
WBS 1.2.4.2.1.2	Field Tests
WBS 1.2.4.2.1.3	Lab Properties
WBS 1.2.4.3	Facilities
WBS 1.2.7	Test Facilities (G-Tunnel)

The deficiencies were qualified by the application of severity levels which were tied to the significance of the finding. A discussion of the severity levels is provided in Enclosure 1. Seven of the eight SDRs issued were Severity Level 2, whereas the eighth was a Level 3 deficiency. In addition to the eight SDRs, twelve observations and two recommendations were written.

All eight of the deficiencies identified by the audit were in the programmatic area. These deficiencies were due either to the lack of adherence to procedural requirements or the lack of SNL implementing procedures needed to govern a specific task or activity. Two of the twelve observations were of a purely technical nature with the balance being programmatic. As with the deficiencies written against the programmatic area, the observations addressed perceived shortcomings in procedures and implementation of procedures.

5.0 AUDIT MEETINGS

5.1 PREAUDIT CONFERENCE

A preaudit conference was held with the Technical Project Officer (TPO) and his staff at 9:00 a.m. on June 1, 1987. The purpose, scope, and proposed agenda were presented. The TPO provided realignments in the proposed agenda consistent with the availability of his personnel and SNL escort requirements. A list of attendees for this meeting is provided in Enclosure 2.

5.2 POSTAUDIT CONFERENCE

The postaudit conference was held on June 5, 1987, at 10:00 a.m. The attendees are identified in Enclosure 2. SDRs, observations, and recommendations identified during the course of the audit were presented to the TPO and Department 6310 staff. Draft copies of the SDRs and observations were given to the TPO and cognizant members of his staff at this time.

6.0 SYNOPSIS OF SDRs/OBSERVATIONS/RECOMMENDATIONS

6.1 STANDARD DEFICIENCY REPORTS (SDRs)

1. A review of existing indoctrination and training records indicated that contrary to the SNL QAPP and NNWSI Project requirement that records be completed in black ink, numerous documents had entries in pencil and multicolored ink. Refer to SDR-025, Severity Level 3.

2. Contrary to NNWSI Project and SNL QAPP requirements to have established methods for acceptance of items or services furnished by a supplier, SNL Department 6310 does not have a procedure in place governing the methods for acceptance of same. Refer to SDR-026, Severity Level 2.

3. The SNL QAPP establishes the requirement for written procedures and policies for the preparation, review, and approval of procurement documents and procurement-document changes. Contrary to this

requirement, Department 6310 does not have in place a procedure(s) governing this activity. Refer to SDR-027, Severity Level 2.

4. An SNL QAPP requirement exists for "detailed technical documents to be developed and contain instructions for the actual performance of activities..." This audit identified that Department 6310 procedures were lacking in this required detail since they failed to address the processing and approval within SNL of exploratory shaft facility (ESF) Engineering Change Requests. Refer to SDR-028, Severity Level 2.

5. The assignment of QA levels within NNWSI Project programs requires that, once assigned, the QA level for a given activity or item will be applied by all NNWSI Project participants and subcontractors. Contrary to this requirement, a Design Investigation Memo was written with a QA level designation inconsistent with that of the WBS element for which it was intended to support. Refer to SDR-029, Severity Level 2.

6. The SNL NNWSI Project QAPP requires that written procedures be implemented to establish and govern a system of surveillances. At present QA Level I and II work is being performed for WBS elements. Purchasing activities are also underway in support of NNWSI Project activities. To date no system of surveillances is currently in place. Refer to SDR-030, Severity Level 2.

7. The training and qualifications of QA Audit personnel should be done in accordance with the requirements of an NNWSI Project approved procedure. Contrary to this requirement, no procedure is currently in place to govern this activity. Refer to SDR-031, Severity Level 2.

8. The calibration of measuring and test equipment (M&TE) at SNL and M&TE calibrated by SNL for NNWSI Project participants and subcontractors is not governed/controlled by procedures promulgated by Department 6310 (NNWSI Project). In addition, records providing traceability for this M&TE are not available for review and audit by NNWSI Project personnel, leaving the qualifications status of this equipment indeterminate. Refer to SDR-032, Severity Level 2.

6.2 OBSERVATIONS

Observation No. 1

The Reference Information Base (RIB) has been issued as a Sandia Letter Report (SLTR) in 1986 (SLTR 86-5005), and in 1987 (SLTR 87-6001).

According to Department Operating Procedures (DOP) 6-2, Paragraph 4.5, SLTRs cannot be referenced in SAND documents. Thus, the RIB cannot be referenced in SAND documents, despite the fact that the RIB, as stated in the modified work plan, is to "... serve as a common source of project controlled information for use in interim design and performance assessment activities." This is inconsistent with SNL Policy and would appear to indicate that SNL cannot use the RIB for its intended purpose.

Observation No. 2

The storage of samples in the SNL NNWSI Project Core Library is presently being guided by QAP XI-11, Rev. B, and DOP 8-1, "Sample Identification and Handling Requirements." There is an apparent need for a DOP on the storage of samples in the core library. DOP 8-2, which is presently in rough draft, addresses this subject and should be in place for the operation of the SNL Core Library.

Observation No. 3

SNL QAPP, Paragraph 4.1.2.2, requires procurement documents be reviewed by the SNL NNWSI Project Department (6310) to ensure that the technical and quality requirements of the purchase requisitions are correctly incorporated into the contract or purchase order. NNWSI-SOP-02-01, Rev. 1, Para. 4.2.2, specifies that reviews shall be performed by personnel who have access to pertinent information and who have adequate understanding of the requirements and intent of the procurement documents. The review shall include, as a minimum, the cognizant technical organizations and QA organization.

DOP 4-1, "Procurement Document Requirements," does not require verification of technical reviews of purchase requisitions and, as such, is inconsistent with the two upper tier documents cited.

Observation No. 4

Design studies under WBS 1.2.4.3 Activity are presently proceeding at QA Level II designation. However, it is not yet firmly determined if any of these studies are going to be used in advanced conceptual design (ACD) activity. Some of these QA Level II studies reference technical publications and SNL published reports. Data were collected to support these studies at a time when no NNWSI Project approved QA program was in place and the NNWSI Project QA levels had not been established. It is a concern of the audit team that these studies are proceeding without appropriate QA level data that may be used for ACD and any subsequent repository licensing activities. At present, there is no intention to qualify any data generated when QA levels were not in place or generated under an approved QA plan, until it is determined that the design studies are actually going to be used for ACD and/or licensing application design (LAD) activities. The audit team is concerned that some of the data previously generated will be used in design and licensing activities (i.e., seismic data, boreholes at the proposed locations of the repository, and waste form source terms). A delay in qualifying these data could have adverse ramifications in design activity if the data would fail to qualify for use in licensing and would have to be redone. The audit team does not agree with the present approach of not proceeding to qualify appropriate data pending the decision of which design studies are applicable to ACD and LAD activities. Based on the audit

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[1]Technical reports published by SNL.

observations and the requirement in licensing design activities to use appropriate data, a procedure to qualify applicable data under the provisions of SOP-03-03 should be initiated promptly by SNL (Department 6310).

Observation No. 5

Organization Chart, Figure 1, of Sandia National Laboratories QAPP SLTR 86-0001, Rev. A, and Section 1 of this same document, need elaboration in order to more fully comply with SOP-02-01, Rev. 1, requirements.

1. Organization Chart, Figure 1, of the QAPP should be revised to show the office of "Director of Nuclear Waste Management and Transportation" - this is the office to which SNL NNWSI Project Manager reports. A description of his responsibilities in relation to Department 6310 should be added to the body of Section 1 of the QAPP.

2. The Organization Chart should also show the title "Quality Assurance Coordinator" for the office presently held by R. R. Richards.

3. The chart should depict that QA direction from this QA Coordinators Office is given to the Divisions - this should also be described in the body of Section 1 of QAPP.

4. Lines of communication between the Divisions and upper management should be described in Section 1 of QAPP.

5. The Organization Chart should show the SNL corporate QA office and its functional relationship to Department 6310 should be described in Section 1 of QAPP.

Observation No. 6

QAPP, Rev. A, Section 2.5.2, and QAP 2-5, Section 5.2.1, provide the requirement that training be performed for changes to policies and procedures; however, the training documents themselves ("Familiarization Program Document" and QAP 2-5(1)) do not indicate the revision level of the procedures for which that training was provided. Specifically, the latest training of personnel on DOP 3-3, "Analysis Definition Requirements," and DOP 5-2, "Technical Procedure Requirements," is recorded on "Familiarization Program Documents." The revision level of both of these procedures was at Rev. A at the time the training was conducted, but the document does not indicate a revision level. This observation is generic to the training of all personnel in all procedures to date.

Observation No. 7

Sandia Letter Report 87-6001, "Reference Information Base (RIB)", identifies the quality levels associated with most of the information contained in the RIB as Quality Level III. This includes information and data from other participating organizations.

Reviews conducted during the audit indicate this grading appears to be inappropriate. SNL apparently cannot determine what QA levels, if any, were originally assigned to the activities which produced the information, or to the resulting data when it was produced by other participating organizations.

The problem identified is one of traceability, and there should be a procedure to determine the historical quality level associated with the information in the RIB. This can probably be confirmed only by the participating organization which produced the data or information.

Observation No. 8

DOP 3-7, "Technical Data Base," and DOP 3-8, "Reference Information Base," do not contain any definitive criteria or specifications for what is to be entered into either the Site Engineering Properties Data Base (SEPDB) or the Reference Information Base (RIB). As a result, the task leaders for these data bases have no definitive guidance for what belongs in these data bases. In addition, the SNL personnel do not have any acceptance guidelines for what they should submit for entry into these data bases. Furthermore, there is apparently no guidance provided by SNL to the other Participating Organizations as to what those organizations should submit for entry into these data bases.

Observation No. 9

Section 4.0, "Procurement Document Control," requires that purchase orders/contracts be reviewed to ensure that the requirements for items and services are specified in the procurement document. Documents released prior to the "Stop Work Order" do not contain the current quality levels and/or quality controls in the current system.

A review of PO/contract 95-8399 identified the following concerns from the records.

1. The quality levels have changed from II to I and III, which invalidates the original "QA Requirements for Purchase Requisitions" form from DOP 7-1.

2. EP-0002 does not address surveillances or audits.

3. The vendor is permitted to subcontract calibration without SNL's review and approval of the subcontractors QA program. (Ref. EP-0002, p. 14, para. 2.4.1; and QAPP 4.1.1(3), p. 34.)

Based upon this purchase order review, a concern exists that purchase orders/contracts released prior to the "Stop Work Order" may not identify the correct quality level or any QA requirements implemented since the lifting of the "Stop Work Order."

Observation No. 10

Reference: Modified Work Plan to Support Quality Assurance Level Assignments for Sandia National Laboratories, NNWSI Project WBS Element 1.2.4.2.1.3.s, Laboratory Properties, Page 13, Task B.1, Para. a, Sentences 2 & 4, and Task B.2, Para. a.

From discussions with cognizant Project personnel it was determined that QA approved procedures were not in place during the laboratory testing which produced most of the data proposed for use in the Laboratory Properties analyses of core samples described in Tasks B.1 and B.2. Due to the lack of procedures, the generated data is at most QA Level III data and cannot be used in Tasks B.1 and B.2 since their results will be used to support ACD.

It was also noted that previously developed empirical relationships would be confirmed or modified in Task B.1. These empirical relationships relate interpolated porosity values with mechanical properties. The use of interpolated porosity values in the development of these empirical relationships is questionable. To confirm this empirical relationship the porosity will be determined from the sample remnants of twenty previously conducted mechanical tests. The resulting porosity data will be QA Level II, but the mechanical data will still be QA Level III. Therefore, the resulting empirical relationship will still be QA Level III and not capable of supporting ACD.

Observation No. 11

During the period 1980-1986, technical procedures were generated (NNWSI L01B1. A-04/21/81, "Thermal Tests," and NNWSI L03.A-01/27/83, "Physical Properties Tests"). These procedures were used to govern the subject activities. Contrary to the requirement that approved procedures be developed and implemented for the control of activities affecting quality, these procedures were not reviewed/approved to a WMPO approved QA Program.

Also during this period tests were performed on core samples received designated as QA Level III or which had no QA level assigned. During the course of this audit, calibration reports and custody forms were reviewed at random and identified that the following tests were performed:

Thermal Tests: U12E-RM-P1 7.2-8.3; 14-2-14.9; 23-5-24.4

Physical Properties Tests: USWE4 2165.9-2166.2; 2571-9-2572.3; 2989.4-2989.75

Performance of the above tests to the referenced procedures constitutes the use of nongraded material and data in a currently graded system. As currently outlined in WBS 1.2.4.2.1.3.S, Subtasks B.1 and B.2, this ungraded material and test data would be used to generate QA Level II results to support the Advanced Conceptual Design (ACD). The condition outlined above also applies to WBS 1.2.4.2.1.1 Subtask A.4.

6.3 RECOMMENDATIONS

Recommendation No. 1

During review and discussion with SNL personnel of the Modified Work Plan for Site Geology (NNWSI Project WBS Element 1.2.3.2.1.1.S), several items contained within the work plan have changed since its latest revision.

1. Task A.4 Soil Properties, Hydrographic Data indicates that NRC Regulatory Guides 1.132 and 1.138 are technical procedures available for use. However, it is not the intent to endorse and implement all the requirements contained within these regulatory guides. It is recommended to revise the work plan to explain that these regulatory guides will be used as references to develop implementing technical procedures in carrying out soil property and hydrographic data activities.

2. Task A.4 B indicates that surveying is to be a QA Level III activity. Discussions with SNL personnel indicate that this activity is to be a QA Level I or II activity. Reviewing the work plan for QA level is indicated.

3. The work plan refers to the Tuff Data Base which has been renamed as the Site and Engineering Properties Data Base. It is recommended this change be reflected in the next revision of the work plan.

Recommendation No. 2

One of the technical specialists recommends the use of at least one spherical seated platen on all uniaxial or triaxial compression tests. The use of this platen will compensate for possible errors in the machining of the sample ends. If the sample ends are not parallel, eccentric or point loads can develop at the ends of the sample. The use of spherical seated platens is a recommended industry practice endorsed by the American Society for Testing Materials and the International Society for Rock Mechanics.

7.0 REQUIRED ACTION

A written response is required for each Standard Deficiency Report and Observation delineated in Section 6.0. Responses to SDRs are due 20 working days from the date of the SDR transmittal letter, while responses to observations are due within 20 working days of the date of the audit report transmittal letter. Upon response acceptance and satisfactory completion and verification of all remedial and corrective action, the SDRs will be closed and SNL will be notified by letter of the SDR closure.

Written responses are not required for recommendations contained herein. The recommendations were generated by the audit team to assist Department 6310 staff in implementing its QA program and technical support activities for the NNWSI Project.

Recommendation No. 2

One of the technical specialists recommends the use of at least one spherical seated platen on all uniaxial or triaxial compression tests. The use of this platen will compensate for possible errors in the machining of the sample ends. If the sample ends are not parallel, eccentric or point loads can develop at the ends of the sample. The use of spherical seated platens is a recommended industry practice endorsed by the American Society for Testing Materials and the International Society for Rock Mechanics.

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Enclosure 1

Description of Severity Levels and Related Corrective Actions

Severity Level 1 - Significant deficiencies considered of major importance. These deficiencies require remedial, investigative, and corrective actions to prevent recurrence.

Severity Level 2 - A deficiency which is not of major importance, but may also require remedial, investigative, and/or corrective action to prevent recurrence.

Severity Level 3 - A minor deficiency in that only remedial action is required. These deficiencies are generally isolated in nature or have a very limited scope. In addition, the integrity of the end result of the activity is not affected nor does the deficiency affect the ability to achieve those results.

Remedial Action - Actions taken to correct the specific deficiencies noted on the SDR.

Investigative Action - Actions taken to further examine the deficient condition to determine the extent and depth. This action should identify all conditions similar to the examples listed on the SDR.

Corrective Action - Actions taken to identify the cause of the condition and to prevent recurrence of the condition identified on the SDR.

Enclosure 2

Personnel contacted during the conduct of the audit (87-5) (page 1 of 2)

Name	Organization	Title	Preaudit conference	During audit	Post audit conference
Arana, Christopher R.	SNL 7251	QA Engineer	x		x
Baehr, Richard M.	SNL 6310	QA Assistant	x	x	x
Bauer, Stephen	SNL 6314	MTS	x	x	x
Blejvas, Thomas E.	SNL 6313	Div Supervisor		x	x
Brochman, Dorothy T.	SNL 6310	Financial Assistant		x	x
Caldwell, Henry H.	SAIC	QA Engineer/Lead Auditor	x		x
Clark, Robert W.	DOE/HQ (Weston)	Auditor	x		x
Dymmel, George	SAIC	Tech Specialist	x		x
Gromer, James M.	SAIC	Auditor	x		x
Heaney, Gerard	SAIC	Auditor	x		x
Hunter, Thomas O.	SNL 6310	TPO	x	x	x
Klemens, Robert H.	SAIC	Auditor	x		x
Maese, Alice	SNLA 132-1	Audit Coordinator	x		x
MacDougall, Hugh R.	SNL 6311	MTS		x	x
Nimmick, Fran	[illegible]	[illegible]			
Park, U Sun	SAIC	Tech Specialist	x		x
Peters, Forrest D.	SAIC	Auditor	x		x
Pope, Ronald B.	SNL 6316	Div. Supervisor	x	x	x
Price, Ron	SNL			x	x
Prindle, Robert W.	SNL 6312	MTS	x	x	x
Prestholt, Paul J.	NRC/NV	OSR	x		x
Rautman, C. A.	SNL 6315	MTS	x	x	x
Richards, R. R.	SNL 6310	QA Coordinator	x	x	x
Schwartz, Barry	SNL 6313	STA	x	x	x
Sharpton, Sarah	SNL 6316	MLS			x
Shaw, Debra	SNL 6316	Record Mgmt		x	x
Shepherd, Edward W.	SNL 6316	Project Integration		x	x
Shepherd, L. E.	SNL 6316	MTS			x

Enclosure 2

Personnel contacted during the conduct of the audit (87-5) (page 2 of 2)

Name	Organization	Title	Preaudit conference	During audit	Post audit conference
Stinebaugh, R. E.	SNL 6314	MTS		x	x
Sublette, William	SAIC	Tech Specialist	x		x
Subramanian, C. V.	SNL 6311	MTS	x	x	x
Tang, Mary A.	SNL 6316	MLS	x	x	x
Vetter, Theodore	SAIC	Auditor	x		x
Yeager, James G.	SNL 6312	MTS		x	x
Zimmerman, Roger	SNL 6313	MTS		x	

WMPO STANDARD DEFICIENCY REPORT

N-QA-038
3/87

Completed by Originating QA Organization

1 Date 6/5/87 | 2 Severity Level ☐ 1 ☐ 2 ☒ 3 | Page 1 of 2

3 Discovered During: WMPO Audit 87-5

3c Identified By: R. Clark

3b Branch Chief Concurrence Date: N/A

4 SDR No. 025 Rev. 0

5 Organization: SNL

6 Person(s) Contacted: R. Richards

7 Response Due Date is 20 Working Days from Date of Transmittal

8 Requirement (Audit Checklist Reference, if Applicable)

SOP-02-01, Rev. 1, Section 17.0, 17.2.2
SNL QAPP Section 2.1.5 (cont'd)

9 Deficiency

SOP-02-01, Rev. 1, requires that QA records be reproducible and microfilmable. (cont'd)

10 Recommended Action(s): ☒ Remedial ☐ Investigative ☐ Corrective

Determine extent of identified condition and document baseline. Conduct indoctrination of all Project personnel on use of (cont'd)

Aprvl.

11 QAE/Lead Auditor Date: [signature] JUN 24 1987

12 Branch Manager Date: [signature] 7/15/87

13 Project Quality Mgr. Date: [signature] 7/15/87

Completed by Organization in Block 5

14 Remedial/Investigative Action(s) (Rev. 1)

15 Effective Date 10/1/87

The documents reviewed during the audit, while illustrating the implementation of our training and familiarization efforts, had not been processed by our Records Management System (RMS) so had not as yet been inspected for acceptability by RMS personnel. Remedial action (cont'd)

16 Cause of the Condition & Corrective Action to Prevent Recurrence

17 Effective Date N/A

N/A

18 Signature/Date

Felton W. Bingham for T.O. Hunter 9/2/87

Thomas O. Hunter, Manager
NNWSI Project Department

Comp. by Orig. QA Org.

19 Response: ☒ Accept ☐ Reject | ☐ Amended Response | QAE/Lead Auditor/Date: [signature] 15 Sep 87 | Branch Manager/Date: W R Karr 9/15/87

20 Amended Response: ☐ Accept ☐ Reject | QAE/Lead Auditor/Date | Branch Manager/Date

21 Verification: ☒ Satisfactory ☐ Unsatisfactory | QAE/Lead Auditor/Date: [signature] JAN 07 1988 | Branch Manager/Date: R. Klemens / Walter F. Karr 1/7/88

22 Remarks

Reviewed objective evidence called for in Block #10

23 QA CLOSURE | QAE/Lead Auditor/Date: [signature] JAN 07 1988 | Branch Manager/Date: R Klemens / W.R. Karr 1/7/88 | PQM/Date: James Blaylock 1/7/88

Requirement (cont'd)

Audit Checklist No. 87-5-1, Audit Item No. 17.0-2

SNL QAPP SLTR86-0001, Rev. A, requires, as part of receipt inspection of records, that records be completed in indelible media.

Deficiency (cont'd)

Review of all existing indoctrination and training records, "Familiarization Programs Document" and Form QAP 2.-5 (1), revealed that a number of these documents had entries in pencil, as well as entries in multi-colored ink, i.e., red, green, blue.

Recommended Action (cont'd)

indelible media for QA records as outlined in existing SNL procedures. Conduct and document periodic inspection of QA records to determine compliance to procedures.

Remedial/Investigative Action(s) (cont'd)

to address the problem at its source will consist of:

- Information concerning the "black ink" requirement contained in QA and records management procedures and its rationale will be redisseminated to Project personnel (QA Coordinator by 9/2/87).

- As a part of the process of revising the SNL NNWSI QA Program Plan to be consistent with Rev. 5 of the NNWSI QA Plan, this "black ink" requirement will be changed to simply require that completed records be microfilmable and reproducible (QA Coordinator, by 10/1/87).

- Correction of the specific documents identified as unacceptable during the audit will occur during the implementation of the "records retrofit plan" carried out by SNL to properly integrate documents generated prior to December 24, 1986, into the SNL NNWSI RMS. A schedule for implementation of the retrofit plan will be developed and, with the actions stated above, will serve to close out this SDR (M. A. Tang, by 9/30/87).

Completed by Originating QA Organization

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1 Date 6/5/87	2 Severity Level ☐ 1 ☒ 2 ☐ 3		Page 1 of 2
3 Discovered During WMPO Audit 87-5	3a Identified By R. Klemens	3b Branch Chief Concurrence Date N/A	4 SDR No. 026 Rev. 0
5 Organization SNL	6 Person(s) Contacted R. Richards, R. Prindle, D. Brockman		7 Response Due Date is 20 Working Days from Date of Transmittal

8 Requirement (Audit Checklist Reference, if Applicable)

NNWSI SOP-02-01, Rev. 1, para. 7.2.7, and SNL QAPP, para. 7.2.2.3, require that methods shall be established for the acceptance of an item or service (cont'd)

9 Deficiency

SNL does not have a procedure covering the methods for the acceptance of purchased items and services. DOP 7-2 has been drafted but not issued.

10 Recommended Action(s): ☒ Remedial ☒ Investigative ☒ Corrective

Develop and issue procedure DOP 7-2 covering SOP-02-01, Rev. 1, "Requirements for Evaluation for Acceptance of Purchased Items and Services." (cont'd)

Aprvl.

11 QAE/Lead Auditor Date	12 Branch Manager Date	13 Project Quality Mgr. Date
[signature] JUN 24 1987	[signature] 7/15/87	[signature] 7/15/87

Completed by Organization in Block 5

14 Remedial/Investigative Action(s)

Issue DOP 7-2. Responsible party is J. T. George, designated author.

15 Effective Date 9/18/87

16 Cause of the Condition & Corrective Action to Prevent Recurrence

17 Effective Date Complete

The deficiency, as stated above, is not quite accurate; at the time of the audit there was no NNWSI-specific procedure for acceptance of purchased items and services. However, there was an SNL procedure covering this activity which was, and is, being observed. The cause of the deficiency was prioritization of SNL NNWSI QA activities in (cont'd)

18 Signature/Date

[signature] 8/27/87 for TOH

Thomas O. Hunter, Manager
NNWSI Project Department

Comp. by Orig. QA Org.

19 Response	☑ Accept ☐ Reject ☐ Amended Response	QAE/Lead Auditor/Date [signature] 15 Sept 87	Branch Manager/Date [signature] 9/15/87
20 Amended Response	☐ Accept ☐ Reject	QAE/Lead Auditor/Date	Branch Manager/Date
21 Verification	☑ Satisfactory ☐ Unsatisfactory	QAE/Lead Auditor/Date [signature] JAN 07 1988	Branch Manager/Date RKlemens/WRKarr 1/7/88

22 Remarks

Received objective evidence called for in block 10

23 QA CLOSURE	QAE/Lead Auditor/Date	Branch Manager/Date	PQM/Date
	[signature] JAN 07 1988	RKlemens/WRKarr 1/7/88	[signature] 1/7/88

Requirement (cont'd)

being furnished by a supplier, including certificate of conformance, source verification, receiving inspection, or post installation test at the facility site.

Audit Item No. 7.0-2

Recommended Action (cont'd)

Perform a review of all NNWSI specific procurements to determine:

1. if any items or services were purchased.

2) impact (if any) of procuring these items or services without methods for evaluating acceptance of same.

Provide and document training given to cognizant personnel on Procedure DOP 7-2.

Condition & Corrective Action (cont'd)

light of the existing SNL-wide procedure.

Corrective action has consisted of conducting an evaluation of the SNL NNWSI procurement process to determine the impact of this deficiency. This evaluation is complete; no specific corrective actions were determined to be necessary.

Recurrence of this situation will be prevented by issuance of DOP 7-2, as stated above.

WMPO STANDARD DEFICIENCY REPORT

N-QA-038
3/87

Completed by Originating QA Organization

1 Date 6/5/87 | 2 Severity Level ☐ 1 ☒ 2 ☐ 3 | Page 1 of 2

3 Discovered During	3a Identified By	3b Branch Chief Concurrence Date	4 SDR No.
WMPO Audit 87-5	R. Klemens	N/A	027 Rev. 0

5 Organization	6 Person(s) Contacted	7 Response Due Date is
SNL	D. Brockman, R. Richards	20 Working Days from Date of Transmittal

8 Requirement (Audit Checklist Reference, if Applicable)

SNL QAPP, para. 4.1 and para. 4.1.3 require written procedure and policies to be established by SNL for the preparation, review, and approval of (cont'd)

9 Deficiency

Contrary to the above requirement, SNL has no written procedures covering "changes to procurement documents."

10 Recommended Action(s): ☑ Remedial ☐ Investigative ☑ Corrective

Write and issue procedure DOP 4-2 to include how all changes to procurement documents are handled by SNL for the NNWSI Project. (cont'd)

Aprvl.

11 QAE/Lead Auditor Date	12 Branch Manager Date	13 Project Quality Mgr. Date
[signature] JUN 24 1987	[signature] 7/15/87	James Blaylock 7/15/87

Completed by Organization in Block 5

14 Remedial/Investigative Action(s)

A major change to DOP 4-1, "Procurement Document Requirements," was approved and issued on August 21, 1987. This procedure change specifies methods for initiating and processing changes to procurement documents.

15 Effective Date Complete

16 Cause of the Condition & Corrective Action to Prevent Recurrence

Training of SNL NNWSI Project Department personnel on the content of the above-mentioned procedure change will be conducted (and documented) by September 30, 1987. Responsible Parties: R. Richards and D. Brockman

17 Effective Date ~~[illegible]~~ 10/16/87 [initials]

18 Signature/Date

Joe R. Tillerson 8/27/87 for TOH

Thomas O. Hunter, Manager
NNWSI Project Department

Comp. by Orig. QA Org.

			QAE/Lead Auditor/Date	Branch Manager/Date
19 Response	☑ Accept ☐ Reject	☐ Amended Response	[signature] 15 Sept 87	[signature] 9/15/87
20 Amended Response	☐ Accept ☐ Reject			
21 Verification	☑ Satisfactory ☐ Unsatisfactory		[signature] JAN 07 1988	R Klemens/W R Kazor 1/7/88

22 Remarks

Block 17 amended per SNL ltr of 2 Sept 87. [initials] 15 Sept 87

Received objective evidence called for in Block 10

23 QA CLOSURE	QAE/Lead Auditor/Date	Branch Manager/Date	PQM/Date
	[signature] JAN 07 1988	R Klemens/W Kazor 1/7/88	James Blaylock 1/7/88

Requirement (cont'd)

procurement documents and procurement document changes.

Audit Item No. 4.0-1

Recommended Action (cont'd)

All changes to procurement documents, including negotiated changes, should be included in DOP 4-2.

Develop and conduct DOP 4-2 specific training for all cognizant SNL personnel and document same.

WMPO STANDARD DEFICIENCY REPORT

N-QA-038
3/87

Completed by Originating QA Organization

1 Date 2/2/88	2 Severity Level ☐ 1 ☒ 2 ☐ 3	Page 1 of 1	
3 Discovered During WMPO Audit 87-5	3a Identified By G. Dymmel/ G. Heaney	3b Branch Chief Concurrence Date N/A	4 SDR No. 028 Rev. 1
5 Organization SNL	6 Person(s) Contacted R. Stinebaugh, R. Hill, C. Subramanian		7 Response Due Date is 20 Working Days from Date of Transmittal

8 Requirement (Audit Checklist Reference, if Applicable)

1) See original SDR
2) Corrective actions must be completed by effective dates specified or extension obtained.

9 Deficiency

1) See original SDR
2) Non responsive to committed corrective action within specified time.

10 Recommended Action(s): ☐ Remedial ☒ Investigative ☒ Corrective

1) Complete committed corrective actions.
2) Determine cause for"non responsiveness" to committed corrective actions and corrective action to preclude recurrence.

Aprvl.

11 QAE/Lead Auditor Date	12 Branch Manager Date	13 Project Quality Mgr. Date
H Caldwell FEB 03 1988	2/3/88	James Blaylock 2/3/88

Completed by Organization in Block 5

14 Remedial/Investigative Action(s)

15 Effective Date N/A

1) Please see SNL letter, subject: "Request to Close SDR No. 028 (WMPO Audit 87-5)," dated February 11, 1988.

16 Cause of the Condition & Corrective Action to Prevent Recurrence

17 Effective Date N/A

The cause of non-responsiveness in carrying out the actions specified in blocks 14 and 16 of Revision 0 of this SDR was repeated and incremental revision of the priorities of the responsible party and lack of aggressive follow-up by the SNL NNWSI QA organization in detecting the delays and resolving the cause of the delays. General corrective action will consist of more

18 Signature/Date R.R. Richards 4/25/88
R.R. Richards, QA Coordinator, SNL NNWSI Project Dept.

Comp. by Orig. QA Org.

19. Response	☑ Accept ☐ Reject ☐ Amended Response	QAE/Lead Auditor/Date H Caldwell 4/28/88	Branch Manager/Date [illegible] 4/28/88
20 Amended Response	☐ Accept ☐ Reject	QAE/Lead Auditor/Date	Branch Manager/Date
21 Verification	☑ Satisfactory ☐ Unsatisfactory	QAE/Lead Auditor/Date H Caldwell 4/28/88	Branch Manager/Date [illegible] 4/28/88

22 Remarks

23 QA CLOSURE	QAE/Lead Auditor/Date H Caldwell 4/28/88	Branch Manager/Date [illegible] 4/28/88	PQM/Date [illegible] 5/2/88

ENCLOSURE

Completed by Originating QA Organization

WA O STANDARD DEFICIENC. REPORT

N-QA-038
3/87

1 Date 6/5/87	2 Severity Level ☐ 1 ☒ 2 ☐ 3	Page 1 of 2

3 Discovered During	3a Identified By	3b Branch Chief Concurrence Date	4 SDR No.
WMPO Audit 87-5	G. Dymmel / G. Heaney	N/A	028 Rev. 0

5 Organization	6 Person(s) Contacted	7 Response Due Date is
SNL	R. Stinebaugh, R. Hill, C. Subramanian	20 Working Days from Date of Transmittal

8 Requirement (Audit Checklist Reference, if Applicable)

Sandia National Laboratories NNWSI Quality Assurance Program Plan Rev. A, Para. 5.1.2, states in part "Detailed technical documents will be (cont'd)

9 Deficiency

Contrary to the above requirement, SNL Department Operating Procedures (DOP) 3-6 "Design Change Control" and DOP 3-9 "Interface Control of NNWSI (cont'd)

10 Recommended Action(s): ☒ Remedial ☐ Investigative ☒ Corrective

1. Revise DOPs 3-6 and 3-9 to reference and include the processing of SOP-03-05 generated documents. (cont'd)

Aprvl.

11 QAE/Lead Auditor Date	12 Branch Manager Date	13 Project Quality Mgr. Date
[signature] JUN 24 1987	[signature] 7/15/87	James Blaylock 7/15/87

Completed by Organization in Block 5

14 Remedial/Investigative Action(s)

15 Effective Date 9/30/87

NNWSI SOP 03-05 will be evaluated for its impact on SNL NNWSI QA implementing procedures related to design and interface control. The affected procedures will be appropriately revised, if necessary. Responsible party is R. R. Hill

16 Cause of the Condition & Corrective Action to Prevent Recurrence (Rev. 1)

17 Effective Date 10/30/87

If required due to possible revisions to procedures, the effects and details of those revisions will be disseminated to personnel involved with ESF design via a training vehicle to be determined. The cause of this situation was simply that, between receipt of SOP-03-05 and the audit visit, this organization had not evaluated the SOP for its impact on our procedures, due to work on the CDR and other activities.

18 Signature/Date

[signature] 8/27/87 for TOH

Thomas O. Hunter, Manager
NNWSI Project Department

Comp. by Orig. QA Org.

19 Response	☑ Accept ☐ Reject ☐ Amended Response	QAE/Lead Auditor/Date [signature] 15 Sept 87	Branch Manager/Date [signature] 9/16/87
20 Amended Response	☐ Accept ☐ Reject	QAE/Lead Auditor/Date	Branch Manager/Date
21 Verification	☐ Satisfactory ☑ Unsatisfactory	QAE/Lead Auditor/Date [signature] 5 Feb 88	Branch Manager/Date [signature] 2/5/88

22 Remarks

23 QA CLOSURE	QAE/Lead Auditor/Date	Branch Manager/Date	PQM/Date
	[signature] FEB 05 1988	[signature] 2/5/88	James Blaylock 2/5/88

WM.. O STANDARD DEFICIENCY ..EPORT CONTINUATION SHEET

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10/86

SDR No. 028 Rev. 0 Page 2 2

Requirement (cont'd)

developed and contain instructions for the actual performance of activities that include but are not limited to design, testing, experiments, and analysis (refer to audit checklist item T-4).

Deficiency (cont'd)

Engineering Design" do not make reference to the NNWSI Standard Operations Procedure SOP-03-05 "ESF Project Interface Control Procedure." The DOPs do not address the processing and approvals within SNL of ESF Engineering Change Requests which are generated in accordance with SOP-03-05.

The SOP-03-05 is a procedure used by the ESF Project group to establish and implement inerface control of ESF design changes between NNWSI Project participants. SNL would be sent ESF Engineering Change Requests for evaluation and review for impact on SNL surface and subsurface designs.

Recommended Actions (cont'd)

2. Reinstruct appropriate personnel to the revised procedures.

SDR 028 Rev. 1, cont. (block 16)

Cause

frequent and routine follow-up by QA facilitated by the SNL NNWSI audit/ surveillance/NCR tracking systems now in place.

ENCLOSURE

WMPO STANDARD DEFICIENCY REPORT

N-QA-038
3/87

Completed by Originating QA Organization

1 Date 2/2/88	2 Severity Level ☐ 1 ☒ 2 ☐ 3		Page 1 of 1
3 Discovered During WMPO Audit 87-5	3a Identified By G. Dymmel/ G. Heaney	3b Branch Chief Concurrence Date N/A	4 SDR No. 029 Rev. 1
5 Organization SNL	6 Person(s) Contacted R. Stinebaugh		7 Response Due Date is 20 Working Days from Date of Transmittal

8 Requirement (Audit Checklist Reference, if Applicable)

1) See original SDR
2) Corrective actions must be completed by effective dates specified or extension obtained.

9 Deficiency

1) See original SDR
2) Non responsive to committed corrective action within specified time.

10 Recommended Action(s): ☐ Remedial ☒ Investigative ☒ Corrective

1) Complete committed corrective actions.
2) Determine cause for "non responsiveness" to committed corrective actions and corrective action to preclude recurrence.

Aprvl.

11 QAE/Lead Auditor Date	12 Branch Manager Date	13 Project Quality Mgr. Date
[signature] FEB 03 1988	[signature] 2/3/88	James Blaylock 2/3/88

Completed by Organization in Block 5

14 Remedial/Investigative Action(s)

Complete actions specified in SDR 029, Rev. 0, blocks 14 and 16.

15 Effective Date Feb. 18, 1988

16 Cause of the Condition & Corrective Action to Prevent Recurrence

17 Effective Date N/A

The cause of "non-responsiveness" in carrying out actions specified in block 16 of SDR 029, Rev. 0, was simply continuing assessment and adjustment of QA priorities, resulting in a number of delays in performance of the actions. This is a normal aspect of the management of a dynamic work effort and requires no action to preclude its recurrence.

18 Signature/Date

[signature] R. R. Richards, QA Coordinator, Feb 24, 1988

Comp. by Orig. QA Org.

19 Response	☒ Accept ☐ Reject ☐ Amended Response	QAE/Lead Auditor/Date [signature] APR 20 1988	Branch Manager/Date 4/20/88 R Klemens for W Karsn
20 Amended Response	☐ Accept ☐ Reject	QAE/Lead Auditor/Date	Branch Manager/Date
21 Verification	☒ Satisfactory ☐ Unsatisfactory	QAE/Lead Auditor/Date [signature] APR 20 1988	Branch Manager/Date 4/30/88 R Klemens for W. Karsn

22 Remarks Reviewed objective evidence needed to confirm that committed corrective actions were completed.

23 QA CLOSURE	QAE/Lead Auditor/Date [signature] APR 20 1988	Branch Manager/Date 4/30/88 R Klemens for W. Karsn	PQM/Date 5/2/88 [signature]

ENCLOSURE

WMPO STANDARD DEFICIENCY REPORT

N-QA-038
3/87

Completed by Originating QA Organization

1 Date: 6/5/87	2 Severity Level ☐ 1 ☒ 2 ☐ 3	Page 1 of 2	
3 Discovered During: WMPO Audit 87-5	3a Identified By: R. Tynmet / G. Heaney	3b Branch Chief Concurrence Date: N/A	4 SDR No. 029 Rev. 0
5 Organization: SNL	6 Person(s) Contacted: R. Stinebaugh		7 Response Due Date is 20 Working Days from Date of Transmittal

8 Requirement (Audit Checklist Reference, if Applicable)

SOP-02-02, "Assignment of QA Levels to NNWSI Activities and Items," Rev. 1, Sec. 5.1.2, requires in part that once assigned, the QA level for a (cont'd)

9 Deficiency

Contrary to this requirement WBS subtask 1.2, "Emplacement Orientations," was approved by Design Investigation Memo (DIM) 102 (2/19/87) as a QA (cont'd)

10 Recommended Action(s): ☐ Remedial ☒ Investigative ☒ Corrective

1. Review all DIMs issued and determine if QA level is consistent with level assigned to related WBS or Modified Work Plan. (cont'd)

Approval

11 QAE/Lead Auditor Date	12 Branch Manager Date	13 Project Quality Mgr. Date
[signature] JUN 24 1987	[signature] 7/15/87	James Blaylock 7/15/87

Completed by Organization in Block 5

14 Remedial/Investigative Action(s)

A request to revise the QA Level Assignment will be submitted to redesignate the work specified by DIM 102 as QA Level 3 by September 11, 1987. Responsible party: R. E. Stinebaugh.

15 Effective Date 9/11/87

16 Cause of the Condition & Corrective Action to Prevent Recurrence (Rev. 1)

17 Effective Date 9/30/87

a. All DIMs will be reviewed for consistency of QA levels in the DIMS, with QA level assignments (QA Coordinator, by September 11, 1987).

b. Based on result of a., revise other DIMs, if necessary (responsible Task Leaders).

18 Signature/Date

Thomas O. Hunter 8-28-87

Thomas O. Hunter, Manager
NNWSI Project Department

Comp. by Orig. QA Org.

19 Response	☒ Accept ☐ Reject ☐ Amended Response	QAE/Lead Auditor/Date: [signature] 15 Sept 87	Branch Manager/Date: [signature] 9/15/87
20 Amended Response	☐ Accept ☐ Reject	QAE/Lead Auditor/Date	Branch Manager/Date
21 Verification	☐ Satisfactory ☒ Unsatisfactory	QAE/Lead Auditor/Date: [signature] 5 Feb 88	Branch Manager/Date: [signature] 2/5/88

22 Remarks

23 QA CLOSURE	QAE/Lead Auditor/Date: [signature] FEB 05 1988	Branch Manager/Date: [signature] 2/5/88	PQM/Date: James Blaylock 2/5/88

Requirement (cont'd)

particular activity or item will be applied by all NNWSI Project participating organizations and any NTS support contractors who are involved in the activity. (Refer to audit checklist Item No. T-8)

Deficiency (cont'd)

Level III activity. This is inconsistent with the QA Level II designation given to the parent WBS 1.2.4.3.

Recommended Actions (cont'd)

2. Revise DIM 102 under approved procedures to the required QA Level II.
3. SNL to verify with subcontractors that work will be completed to QA Level II as specified by revised DIM 102.
4. Revise any other DIMs identified by the above review as being inconsistant.
5. Determine and report impact (if any) on both inhouse and subcontractor activities
6. Determine root cause for inconsistant assignment of QA Levels to DIMs. Provide and document training given to preclude recurrence.

Condition & Corrective Action (cont'd) (Rev. 1)

c. Based on result of a., determine impact of inconsistent QA levels (responsible Task Leaders and QA).

d. The cause of this condition was lack of understanding on the part of the DIM author of the requirement stated in 8, above, and his confusion about how to control preliminary, scoping activities (based on a policy statement by the Project Quality Manager). This has all been clarified to the individual involved. If the result of 16a, above, indicates the need, more widespread training will be conducted.

WMPO STANDARD DEFICIENCY REPORT

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Completed by Originating QA Organization

1 Date: 6/5/87	2 Severity Level ☐ 1 ☒ 2 ☐ 3	Page 1 of 2	
3 Discovered During: WMPO Audit 87-5	3a Identified By: T. Vetter	3b Branch Chief Concurrence Date: N/A	4 SDR No. 030 Rev. 0
5 Organization: SNL	6 Person(s) Contacted: Project Quality Coordinator for SNL		7 Response Due Date is 20 Working Days from Date of Transmittal

8 Requirement (Audit Checklist Reference, if Applicable)

SNL NNWSI QAPP, Rev. 0 (SLTR86-0001), para. 2.3, page 13, requires written procedures to implement the QAPP. Para. 2.8, page 18, states that (cont'd)

9 Deficiency

Quality Level I and II activities are currently being implemented within the WBS elements and purchasing activities. To assure compliance with the (cont'd)

10 Recommended Action(s): ☒ Remedial ☒ Investigative ☒ Corrective

Complete and implement the procedures on surveillances, nonconformances, and corrective actions. (cont'd)

Aprvl.

11 QAE/Lead Auditor Date	12 Branch Manager Date	13 Project Quality Mgr. Date
[signature] JUN 24 1987	[signature] 7/14/87	James Blaylock 7/15/87

Completed by Organization in Block 5

14 Remedial/Investigative Action(s)

15 Effective Date: 9/30/87

- QAP 10-1, "Surveillance Requirements," was issued on July 29, 1987.
- QAP 16-1, "Corrective Action Reporting," was approved for issue on August 24, 1987.
- QAP 15-1, "Nonconformance Reporting and Controls," is in preparation, to be issued by September 30, 1987. (cont'd)

16 Cause of the Condition & Corrective Action to Prevent Recurrence

17 Effective Date: 9/30/87

The cause of this situation was prioritization of SNL NNWSI QA activities. Issuance of the subject procedures will prevent recurrence.

18 Signature/Date

[signature] for TOH 8/27/87

Thomas O. Hunter, Manager
NNWSI Project Department

Comp. by Orig. QA Org.

19 Response	☑ Accept ☐ Reject ☐ Amended Response	QAE/Lead Auditor/Date: [signature] 15 Sept 87	Branch Manager/Date: [signature] 9/16/87
20 Amended Response	☐ Accept ☐ Reject	QAE/Lead Auditor/Date	Branch Manager/Date
21 Verification	☑ Satisfactory ☐ Unsatisfactory	QAE/Lead Auditor/Date: [signature] JAN 13 1988	Branch Manager/Date: [signature] 2-19-88

22 Remarks

23 QA CLOSURE	QAE/Lead Auditor/Date	Branch Manager/Date	PQM/Date
	[signature] FEB 19 1988	[signature] 2/14/88	James Blaylock 3/4/88

WMPO STANDARD DEFICIENCY REPORT CONTINUATION SHEET

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SDR No. 030 Rev. 0

Requirement (cont'd)

a system for surveillances will be established.

Deficiency

quality program, surveillances are required to be performed in accordance with written procedures. In the event that reportable conditions are found during surveillances, nonconformances, and corrective action request procedures would be necessary to assure that these conditions are reported and processed in accordance with the controls identified in the quality program. The surveillance, nonconformance, and corrective action procedures have not been approved and implemented at this time. The nonconformance procedure OAP 15-1 and corrective action reports are in "draft" form being circulated for review.

Recommended Action (cont'd)

Once implemented, conduct a review of all Project areas governed by these procedures to determine if technical or procurement activities were performed. If performed without benefit of procedures, determine and report to WMPO the impact

Establish a program of initial and recurrent training on these procedures for cognizant project personnel.

Remedial/Investigative Action (cont'd)

Investigative actions: Lack of the surveillance and corrective action procedures has had no impact on technical work performed by or for the SNL NNWSI Project Department. Nonconformance reporting and control has been conducted in accordance with NNWSI-SOP-15-01, which is itself a procedure, in the absence of an SNL NNWSI QA procedure.

WMPO STANDARD DEFICIENCY REPORT

N-QA-038
3/87

Completed by Originating QA Organization

1 Date 6/5/87	2 Severity Level ☐ 1 ☒ 2 ☐ 3		Page 1 of 2
3 Discovered During WMPO Audit 87-5	3a Identified By R. Klemens	3b Branch Chief Concurrence Date N/A	4 SDR No. 031 Rev. 0
5 Organization SNL	6 Person(s) Contacted R. Richards		7 Response Due Date is 20 Working Days from Date of Transmittal

8 Requirement (Audit Checklist Reference, if Applicable)

SNL QAPP, Para. 2.5.4, requires that audit personnel be trained and qualified in accordance with a QAP which is consistent with the requirements (cont'd).

9 Deficiency

Contrary to this requirement SNL does not have a procedure which covers the requirements for certification, qualification, and training of (cont'd)

10 Recommended Action(s): ☒ Remedial ☐ Investigative ☒ Corrective

Develop and issue procedure QAP 2-7 covering SOP-02-01, Rev. 1 - Appendix D requirements for the certification, qualification, and training of auditors. (cont'd)

Aprvl.

11 QAE/Lead Auditor Date	12 Branch Manager Date	13 Project Quality Mgr. Date
[signature] JUN 24 1987	[signature] 7/15/87	[signature] 7/15/87

Completed by Organization in Block 5

14 Remedial/Investigative Action(s)

Develop and issue QAP 2-7 covering NVO 196-17, Rev. 5, Appendix F. Responsible party: R. Richards or R. Baehr

15 Effective Date 9/4/87

16 Cause of the Condition & Corrective Action to Prevent Recurrence

Adhere to above-mentioned QAP 2-7 for future audit personnel qualification and certification.

17 Effective Date ongoing

18 Signature/Date

[signature] 9-28-87

Thomas O. Hunter, Manager
NNWSI Project Department

Comp. by Orig. QA Org.

19 Response	☒ Accept ☐ Reject ☐ Amended Response	QAE/Lead Auditor/Date [signature] 15 Sept 87	Branch Manager/Date [signature] 9/16/87
20 Amended Response	☐ Accept ☐ Reject	QAE/Lead Auditor/Date	Branch Manager/Date
21 Verification	☒ Satisfactory ☐ Unsatisfactory	QAE/Lead Auditor/Date [signature] JAN 07 1988	Branch Manager/Date R Klemens/WRKaiser 1/7/88

22 Remarks

Remedial Objective evidence called for in Block 10

23 QA CLOSURE	QAE/Lead Auditor/Date [signature] JAN 07 1988	Branch Manager/Date R Klemens/WRKaiser 1/7/88	PQM/Date [signature] 1/7/88

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CONTINUATION SHEET

N-QA-03? 10/86

SDR No. 031 Rev. 0 Page 2 of 2

Requirement (cont'd)

of Appendix D of NNWSI SOP-02-01.

Audit Item No. D-1

Deficiency (cont'd)

auditors and lead auditors to SOP-02-01, Rev. 1 - Appendix D.

Recommended Action (cont'd)

Establish auditor training status board or other mechanism to monitor certification and qualification currency of auditors. These records should be accessable to all auditors and QA coordinators to facilitate self monitoring.

Note: Although procedures were not in place for qualifying audit personnel, no adverse impact occurred since SNL did not perform QA audits for the time period covered by this audit.

WMPO STANDARD DEFICIENCY REPORT

N-QA-038
3/87

Completed by Originating QA Organization

1 Date 2/2/88	2 Severity Level ☐ 1 ☒ 2 ☐ 3	Page 1 of 1	
3 Discovered During: WMPO Audit 87-5	3a Identified By: G. Dymmel/ G. Heaney	3b Branch Chief Concurrence Date: N/A	4 SDR No. 032 Rev. 1
5 Organization: SNL	6 Person(s) Contacted: R. Richards		7 Response Due Date is 20 Working Days from Date of Transmittal

8 Requirement (Audit Checklist Reference, if Applicable)

1) See original SDR
2) Corrective actions must be completed by effective dates specified or extension obtained.

9 Deficiency

1) See original SDR
2) Non responsive to committed corrective action within specified time.

10 Recommended Action(s): ☐ Remedial ☒ Investigative ☒ Corrective

1) Complete committed corrective actions.
2) Determine cause for "non responsiveness" to committed corrective actions and corrective action to preclude recurrence

Aprvl.

11 QAE/Lead Auditor Date	12 Branch Manager Date	13 Project Quality Mgr. Date
[signature] FEB 03 1988	[signature] 2/3/88	[signature] 2/3/88

Completed by Organization in Block 5

14 ~~Remedial~~/Investigative Action(s)

15 Effective Date Complete

An evaluation was conducted to the cause of "non-responsiveness" to committed corrective actions. The results of this evaluation are provided below.

a) The original effective date for remedial/investigative action was missed due to lower reprioritization of these actions in order to accomplish SCP-related

16 Cause of the Condition & Corrective Action to Prevent Recurrence

17 Effective Date April 15, 1988

The cause of "non-responsiveness" to original due dates was reprioritization of actions (a normal management function which requires no corrective action) and poor attention to details in providing objective evidence of completed actions.

18 Signature/Date [signature] R.R. Richards, SNL NNWSI QA Coordinator Mar. 17, 1988

Comp. by Orig. QA Org.

19 Response	☐ Accept ☐ Reject ☐ Amended Response	QAE/Lead Auditor/Date	Branch Manager/Date
20 Amended Response	☐ Accept ☐ Reject	QAE/Lead Auditor/Date	Branch Manager/Date
21 Verification	☐ Satisfactory ☐ Unsatisfactory	QAE/Lead Auditor/Date	Branch Manager/Date

22 Remarks

23 QA CLOSURE	QAE/Lead Auditor/Date	Branch Manager/Date	PQM/Date

ENCLOSURE

Investigative Action(s) (Cont'd.)

activities, as well as lack of clarity during September-November 1987 concerning the Project's calibration policy.

b) A response intended to address these remedial and investigative actions, the root cause, and corrective actions was submitted from SNL to the WMPO on November 6, 1987. This response was not clearly linked to this SDR, Rev.0, however.

c) A letter which explained the linkeage between the November 6 submittal and the SDR was submitted to the WMPO from SNL on December 23, 1987. It was concluded that the facts stated in both the November 6 and December 23 letters were not supported by adequate objective evidence. Resultant corrective action is stated in Block 16.

Cause of the Condition and Corrective Action (Cont'd.)

General corrective action concerning non-responsiveness will consist of specific screening of SDR/NCR close-out requests by the SNL NNWSI QA staff for inclusion of adequate objective evidence of all completed actions.

Corrective action concerning the original remedial/investigative actions for this SDR will consist of assembling and submitting objective evidence that summarizes the review of past and current QA Level I or II activities and the evaluation of the impact of data collected therein, by the date shown in Block 17.

WMPO STANDARD DEFICIENCY REPORT

N-QA-038
3/87

Completed by Originating QA Organization

1 Date 6/5/87	2 Severity Level ☐ 1 ☒ 2 ☐ 3	Page 1 of 2

3 Discovered During	3a Identified By	3b Branch Chief Concurrence Date	4 SDR No.
WMPO Audit 87-5	G. Heaney	N/A	032 Rev. 0

5 Organization	6 Person(s) Contacted	7 Response Due Date is 20 Working Days from Date of Transmittal
SNL	R. Richards	

8 Requirement (Audit Checklist Reference, if Applicable)

1. SNL NNWSI QAPP, Rev. A, para. 5.1, states in part "all activities affecting quality on the NNWSI Project will be performed utilizing approved (cont'd)

9 Deficiency

Contrary to the above requirements, the Calibration Lab at SNL does not utilize calibration procedures which are reviewed or approved by SNL NNWSI (cont'd)

10 Recommended Action(s): ☒ Remedial ☒ Investigative ☒ Corrective

1. Review to determine if SNL has performed Quality Level I and II work with calibrated instruments for which traceability to the National (cont'd)

Aprvl.

11 QAE/Lead Auditor Date	12 Branch Manager Date	13 Project Quality Mgr. Date
[signature] JUN 24 1987	[signature] 7/15/87	James Blaylock 7/15/87

Completed by Organization in Block 5

14 Remedial/Investigative Action(s)

15 Effective Date 10/15/87

Past and current work will be reviewed to determine if any Q Level I or II work has been done wherein measurements have been taken and data recorded using SNL-calibrated devices. If so, an evaluation will be completed to determine the impact of this situation. Issuance of NCRs which document individual data or types of data which have resulted from SNL-calibrated devices will complete this action. Responsible party is T. E. Bleiwas

16 Cause of the Condition & Corrective Action to Prevent Recurrence

17 Effective Date TBD

The cause of this situation lies in the DOE decision to utilize the same assets - the National Laboratories - to perform work on both the OCRWM Program, which requires open public and project access to records because of licensability concerns, and the nuclear weapons program, which precludes public access to records due to security needs. This dilemma, which in fact affects areas (cont'd)

18 Signature/Date

[signature] 8/27/87 for TOH

Thomas O. Hunter, Manager
NNWSI Project Department

Comp. by Orig. QA Org.

			QAE/Lead Auditor/Date	Branch Manager/Date
19 Response	☒ Accept ☐ Reject	☐ Amended Response	[signature] 15 Sept 87	[signature] 9/16/87
20 Amended Response	☐ Accept ☐ Reject		QAE/Lead Auditor/Date	Branch Manager/Date
21 Verification	☐ Satisfactory ☒ Unsatisfactory		QAE/Lead Auditor/Date [signature] 5 Feb 88	Branch Manager/Date [signature] 2/5/88

22 Remarks

23 QA CLOSURE	QAE/Lead Auditor/Date	Branch Manager/Date	PQM/Date
	[signature] FEB 05 1988	[signature] 2/5/88	James Blaylock 2/5/88

Requirement (cont'd)

written procedures."

2. SNL NNWSI QAPP, Rev. A, Para. 12.2, requires that "all measuring and test equipment calibration will be accomplished using written procedures and will be traceable either to the National Bureau of Standards or to other nationally recognized physical standards."

Deficiency (cont'd)

personnel in accordance with the SNL NNWSI QAPP, Rev. A, and implementing procedures. Additionally, records indicating traceability to the National Bureau of Standards or other nationally recognized physical standards are not available for review and audit by NNWSI QA personnel. Therefore, the calibration status of measuring and testing instruments is indeterminant.

Recommended Action (cont'd)

Bureau of Standards or to other nationally recognized physical standards cannot be determined.

2. Provide a corrective action plan to resolve above deficiencies.

Condition & Corrective Action (cont'd)

beyond calibration control, cannot be fully resolved at the SNL level. Upon receipt of guidance concerning calibration control from the WMPO, SNL will pursue a course of action consistent with that guidance.

A.I. 727

WMPO STANDARD DEFICIENCY REPORT

N-QA-038
3/87

1 Date MARCH 16, 1988 | 2 Severity Level ☐ 1 ☒ 2 ☐ 3 | Page 1 of 2

3 Discovered During: DOCUMENT REVIEW

3a Identified By: P. KARNOSKI

3b Branch Chief Concurrence Date

4 SDR No. 103 Rev. 1

5 Organization: SANDIA NATIONAL LABORATORIES

6 Person(s) Contacted: R. R. RICHARDS

7 Response Due Date is 20 Working Days from Date of Transmittal

8 Requirement (Audit Checklist Reference, if Applicable)
SNL-NNWSI QAPP, Rev. 0 Section 3.6.8.1(3) Design output documents will: ...As a minimum the review and approval cycle will include the participation of the technical and quality assurance elements of both the SNL-NNWSI Project Department and the WMPO.

9 Deficiency (a) Sandia National Laboratories Drawing R07048A, issued on 1/21/88 by WMPO letter DHI-950 as a Quality Level II drawing shows no evidence of a Quality Assurance approval, (b) SNL Department Operation Procedure 3-1 Preparing, Reviewing, Approving, and Issuing Engineering drawings has no provision for participation of

10 Recommended Action(s): ☐ Remedial ☐ Investigative ☒ Corrective
1. Reissue drawing R07048A after performing a review and signed approval by QA.
2. Revise D.O.P. 3-1 to include QA in the review and approval operation.

Completed by Originating QA Organization

Aprvl.

11 QAE/Lead Auditor Date: [signature] 3/16/88

12 Branch Manager Date: [signature] 3/21/88

13 Project Quality Mgr. Date: [signature] 3/25/88

14 Remedial/Investigative Action(s)
Not Applicable

15 Effective Date N/A

16 Cause of the Condition & Corrective Action to Prevent Recurrence

1) Drawing R07048A was resubmitted to the WMPO, after review and approval by QA, on March 10, 1988. (See SNL letter: Stinebaugh to Irby; subject: ESF/Repository Interface Drawing R07048A; dated March 10, 1988; with enclosures.)

(cont'd.)

17 Effective Date June 1, 1988

18 Signature/Date [signature] Apr. 1 25, 1988
R.R. Richards QA Coordinator SNL NNWSI Project Dept.

Completed by Organization in Block 5

19 Response	☒ Accept ☐ Reject ☐ Amended Response	QAE/Lead Auditor/Date [signature] 5/25/88	Branch Manager/Date [signature] 5/25/88
20 Amended Response	☐ Accept ☐ Reject	QAE/Lead Auditor/Date	Branch Manager/Date
21 Verification	☐ Satisfactory ☐ Unsatisfactory	QAE/Lead Auditor/Date	Branch Manager/Date

Orig. QA Org.

22 Remarks

Comp.

23 QA CLOSURE	QAE/Lead Auditor/Date	Branch Manager/Date	PQM/Date

ENCLOSURE 2

WM) STANDARD DEFICIENCY ..EPORT
CONTINUATION SHEET

N-QA-038
10/86

SDR No. 103 Rev. 1

Continued

9.(b) Quality Assurance in the review and approval of engineering drawings.

16. 2) SNL Department Operating Procedure 3-1 will be revised to address QA review and approval of engineering drawings that are design outputs.

WMPO Audit 87-5
Sandia National Laboratories
Responses to Observations

Observation No. 1

The Reference Information Base (RIB) has been issued as a Sandia Letter Report (SLTR) in 1986 (SLTR 86-5005), and in 1987 (SLTR 87-6001).

According to Department Operating Procedures (DOP) 6-2, Paragraph 4.5, SLTRs cannot be referenced in SAND documents. Thus, the RIB cannot be referenced in SAND documents, despite the fact that the RIB, as stated in the modified work plan, is to "...serve as a common source of project controlled information for use in interim design and performance assessment activities." This is inconsistent with SNL Policy and would appear to indicate that SNL cannot use the RIB for its intended purpose.

SNL Response:

In its current status the RIB, as a Sandia letter report, is not intended to be, and should not be, used by participant organizations and NTS contractors as a reference in their work. The RIB should not be so used until, as is quoted above, it becomes a "common source of project-controlled information" (emphasis added). Once the RIB becomes a Project document, by means of the baselining process, it will have a Project identity, will no longer be an SLTR, and may be referenced in SAND documents and other Project-related technical reports.

Observation No. 2

The storage of samples in the SNL NNWSI Project Core Library is presently being guided by QAP XI-11, Rev. B, and DOP 8-1, "Sample Identification and Handling Requirements." There is an apparent need for a DOP on the storage of samples in the core library. DOP 8-2, which is presently in rough draft, addresses this subject and should be in place for the operation of the SNL Core Library.

SNL Response:

DOP 8-2 will be completed and issued.

Observation No. 3

SNL QAPP, Paragraph 4.1.2.2, requires procurement documents be reviewed by the SNL NNWSI Project Department (6310) to ensure that the technical and quality requirements of the purchase requisitions are correctly incorporated into the contract or purchase order. NNWSI-SOP-02-01, Rev. 1, Para. 4.2.2, specifies that reviews shall be performed by personnel who have access to pertinent information and who have adequate understanding of the requirements and intent of the procurement documents. The review shall include, as a minimum, the cognizant technical organizations and QA organization.

DOP 4-1, "Procurement Document Requirements," does not require verification of technical reviews of purchase requisitions and, as such, is inconsistent with the two upper tier documents cited.

SNL Response:

DOP 4-1 has been revised to specifically require that both Purchase Requisitions and purchasing Change Requisitions be reviewed for technical accuracy. In addition, the requirements in the procedure that assure that the final contract or purchase order correctly incorporate the technical and quality requirements stated in Purchase/Change Requisitions have been strengthened.

Observation No. 4

Design studies under WBS 1.2.4.3 Activity are presently proceeding at QA Level II designation. However, it is not yet firmly determined if any of these studies are going to be used in Advanced Conceptual Design (ACD) activity. Some of these QA Level II studies reference technical publications

and SNL published reports. Data were collected to support these studies at a time when no NNWSI Project-approved QA program was in place and the NNWSI Project QA levels had not been established. It is a concern of the audit team that these studies are proceeding without appropriate QA level data that may be used for ACD and any subsequent repository licensing activities. At present, there is no intention to qualify any data generated when QA levels were not in place or generated under an approved QA plan, until it is determined that the design studies are actually going to be used for ACD and/or Licensing Application Design (LAD) activities. The audit team is concerned that some of the data previously generated will be used in design and licensing activities (i.e., seismic data, boreholes at the proposed locations of the repository, and waste form source terms). A delay in qualifying these data could have adverse ramifications in design activity if the data would fail to qualify for use in licensing and would have to be redone. The audit team does not agree with the present approach of not proceeding to qualify appropriate data pending the decision of which design studies are applicable to ACD and LAD activities. Based on the audit observations and the requirement in licensing design activities to use appropriate data, a procedure to qualify applicable data under the provisions of SOP-03-03 should be initiated promptly by SNL (Department 6310).

SNL Response:

A plan is currently being formulated to identify which of the data mentioned above (not collected under an NNWSI-Project-approved program) should be qualified and how to go about it. Provisions of this plan are intended to be consistent with NNWSI-SOP-03-03 (or its successor document) and the NRC Generic Technical Position on "Qualifying Existing Data."

<u>Observation No. 5</u>

Organization Chart, Figure 1, of Sandia National Laboratories QAPP, SLTR 86-0001, Rev. A, and Section 1 of this same document, need elaboration in order to more fully comply with SOP-02-01, Rev. 1, requirements.

1. Organization Chart. Figure 1, of the QAPP should be revised to show the office of "Director of Nuclear Waste Management and Transportation" - this is the office to which the SNL NNWSI Project Manager reports. A description of his responsibilities in relation to Department 6310 should be added to the body of Section 1 of the QAPP.

2. The Organization Chart should also show the title, "Quality Assurance Coordinator," for the office presently held by R. R. Richards.

3. The chart should depict that QA direction from this QA Coordinator's Office is given to the Divisions - this should also be described in the body of Section 1 of QAPP.

4. Lines of communication between the Divisions and upper management should be described in Section 1 of QAPP.

5. The Organization Chart should show the SNL corporate QA office and its functional relationship to Department 6310 be described in Section 1 of QAPP.

SNL Response:

The suggestions offered above will be carefully considered in the next revision of the SNL NNWSI QAPP. Some specific notes concerning the observations follow:

1. A previous comment from the WMPO QA review of the draft SNL NNWSI QAPP was that the Office of the Director, Nuclear Waste Management and Transportation, should not be shown on the Organization Chart nor described in the text, as this office is not a part of the Project. The audited version of the chart was in response to that comment.

2. The "Quality Assurance" block on the Organization Chart is intended to illustrate the SNL NNWSI QA organization, not just the position of QA Coordinator. For clarity (and less frequent revision), individual names will be removed from the chart at the next revision.

3. At the next revision, dotted lines to indicate "QA guidance and direction" will be added to the chart.

4. Lines of communication between the Divisions and the SNL NNWSI Project Manager are clearly shown on the Organization Chart.

Observation No. 6

QAPP, Rev. A, Section 2.5.2, and QAP 2-5, Section 5.2.1, provide the requirement that training be performed for changes to policies and procedures; however, the training documents themselves ("Familiarization Program Document" and QAP 2-5(1)) do not indicate the revision level of the procedures for which that training was provided. Specifically, the latest training of personnel on DOP 3-3, "Analysis Definition Requirements," and DOP 5-2, "Technical Procedure Requirements," is recorded on "Familiarization Program Documents." The revision level of both of these procedures was at Rev. A at the time the training was conducted, but the document does not indicate a revision level. This observation is generic to the training of all personnel in all procedures to date.

SNL Response:

Training conducted for individuals as part of their Familiarization Programs is based upon the revisions of procedures that are current at that time. As changes to policies or procedures occur, training is provided, as necessary, for those personnel who must understand those changes. This system keeps personnel informed of current policies and practices, with no need to record revisions on familiarization documents.

Observation No. 7

Sandia Letter Report 87-6001, "Reference Information Base (RIB)," identifies the quality levels associated with most of the information contained in the RIB as Quality Level III. This includes information and data from other participating organizations.

Reviews conducted during the audit indicate this grading appears to be inappropriate. SNL apparently cannot determine what QA levels, if any, were originally assigned to the activities which produced the information, or to the resulting data when it was produced by other participating organizations.

The problem identified is one of traceability, and there should be a procedure to determine the historical quality level associated with the information to the RIB. This can probably be confirmed only by the participating organization which produced the data or information.

SNL Response:

This observation is valid; QA Level III had been arbitrarily assigned to RIB items which had no known QA level under the concept that Level III was representative of their quality. These QA level identifiers will be changed to "to be determined" or "indeterminate" in the RIB. Concurrently, a plan to establish their appropriate QA levels is being developed and will be pursued, as stated under Observation No. 4.

Observation No. 8

DOP 3-7, "Technical Data Base," and DOP 3-8, "Reference Information Base," do not contain any definitive criteria or specifications for what is to be entered into either the Site Engineering Properties Data Base (SEPDB) or the Reference Information Base (RIB). As a result, the task leaders for these data bases have no definitive guidance for what belongs in these data bases. In addition, the SNL personnel do not have any acceptance guidelines for what they should submit for entry into these data bases. Furthermore, there is

apparently no guidance provided by SNL to the other Participating Organizations as to what those organizations should submit for entry into these data bases.

SNL Response:

Regarding the Site and Engineering Properties Data Base, the content of individual submittals to be entered into the data base is determined by means of consultation between the TPOs (or their representatives) and the data base manager. No rigid, a priori criteria can, or should, be established to provide acceptance guidelines; control and acceptance of these submittals is most appropriately left vague and established through consultation on a case-by-case basis. Nevertheless, the "definitive" criterion exists, in DOP 3-7, that the SEPDB manager will only accept data submittals approved by the respective TPO. Additionally, work is underway to compile a list of needed data from performance and design issues of the SCP to provide some guidance on data types suitable for the SEPDB.

Concerning the Reference Information Base, DOP 3-8, titled "Reference Information Base Change Control," is concerned only with the change control process itself, rather than with specifically providing definitive criteria or specifications regarding RIB content. Paragraph 2 of Section 4.0 of DOP 3-8 notes that the procedure is for temporary use"...until it (the RIB) is baselined by the NNWSI Project", and outlines the change control process once an individual "...identifies information which should be included in the RIB...".

The RIB is intended to be a Project-baselined document which will evolve with the Project and has been released as a draft version until baselining occurs. This has been done in order to provide current information for use in ongoing activities and to allow the content to become relatively stable prior to baselining. It is the responsibility of the Project, not SNL alone, to develop guidance on the content of the RIB and on input acceptance criteria. Specifically, the introductory material of the draft version 02.001 of the RIB, issued in May 1987 for review by Project participants and by DOE/NVO/WMPO, states:

> "The scope and content of the RIB will be determined by both the Principal Investigators (P.I.s) primarily responsible for providing the information and by those who require the information for use in design and performance assessment activities. As more fully described below. change control procedures for the RIB are being developed and will be implemented by the Systems Engineering Integration Group (SEIG), the Project Change Control Board (CCB), and the Technical Project Officers (TPOs)."

At this time, developing "definitive guidance for what belongs in" this information base is hampered by many factors, including delays in reviewing and approving the Systems Engineering Management Plan (SEMP) to allow the SEIG to function in a formal manner and delays in issuing a comprehensive Baseline Change Control procedure to allow the RIB to be placed under baseline change control by the NNWSI Project. Following approval of the SEMP, the SEIG will be looked to as the body recommending and implementing the definitive guidance on what belongs in the RIB; in the interim the SEIG (in its current unofficial status) is being used to guide input and changes to the RIB. The RIB introductory material states:

> "Until the RIB is baselined, anyone desiring to submit information to be considered for inclusion in the RIB should contact their SEIG member."

In summary, the actions necessary to provide definitive guidance on content of the RIB currently reside at the Project level. Those actions include approval of the SEMP, establishment of a baseline change control procedure applicable to technical documents such as the RIB, and baselining the RIB.

<u>Observation No. 9</u>

Section 4.0, "Procurement Document Control," requires that purchase orders/contracts be reviewed to ensure that the requirements for items and services are specified in the procurement document. Documents released prior to the "Stop Work Order" do not contain the current quality levels and/or quality controls in the current system.

A review of PO/contract 95-8399 identified the following concerns from the records.

1. The quality levels have changed from II to I and III, which invalidates the original "QA Requirements for Purchase Requisitions" form from DOP 7-1.

2. EP-0002 does not address surveillances or audits.

3. The vendor is permitted to subcontract calibration without SNL's review and approval of the subcontractors QA program. (Ref. EP-0002, p. 14, para. 2.4.1; and QAPP 4.1.1(3), p. 34.)

Based upon this purchase order review, a concern exists that purchase orders/contracts released prior to the "Stop Work Order" may not identify the correct quality level or any QA requirements implemented since the lifting of the "Stop Work Order."

SNL Response:

Contracts that were in effect prior to imposition of work suspension (June 10, 1986) have either run out, or they have been or are being renewed by means of purchasing Change Requisitions which implement QA requirements appropriate to the approved QA level of the work. The cited contract, 95-8399, is an excellent example of the latter case. At the time of the audit, work under this contract was on hold by the Sandia contract monitor, who was in the process of developing revised technical and QA specifications that were necessitated by the change in QA level assignment. Since the audit, a Change Requisition has been issued to implement those revised technical and QA requirements (in the form of EP-0002), and EP-0002 has been refined to address surveillances, audits, and all other applicable QA Program aspects.

Attachment

Observation No. 10

Reference: Modified Work Plan to Support Quality Assurance Level Assignments for Sandia National Laboratories, NNWSI Project WBS Element 1.2.4.2.1.3.S, Laboratory Properties, Page 13, Task B.1, Para. a, Sentences 3 & 4, and Task B.2, Para. a.

From discussions with cognizant Project personnel it was determined that QA-approved procedures were not in place during the laboratory testing which produced most of the data proposed for use in the Laboratory Properties analyses of core samples described in Tasks B.1 and B.2. Due to the lack of procedures, the generated data is, at most, QA Level III data and cannot be used in Tasks B.1 and B.2, since their results will be used to support ACD.

It was also noted that previously developed empirical relationships would be confirmed or modified in Task B.1. These empirical relationships relate interpolated porosity values with mechanical properties. The use of interpolated porosity values in the development of these empirical relationships is questionable. To confirm this empirical relationship, the porosity will be determined from the sample remnants of twenty previously conducted mechanical tests. The resulting porosity data will be QA Level II, but the mechanical data will still be QA Level III. Therefore, the resulting empirical relationship will still be QA Level III and not capable of supporting ACD.

SNL Response: See response following Observation No. 11

Observation No. 11

During the period 1980-1986, technical procedures were generated (NNWSI L0131.A-04/21/81, "Thermal Tests," and NNWSI L03.A-01/27/83, "Physical Properties Tests"). These procedures were used to govern the subject activities. Contrary to the requirement that approved procedures be developed and implemented for the control of activities affecting quality, these procedures were not reviewed/approved to a WMPO-approved QA Program.

Also during this period, tests were performed on core samples received designated as QA Level III or which had no QA level assigned. During the course of this audit, calibration reports and custody forms were reviewed at random and identified that the following tests were performed:

Thermal Tests: U12E-RM-P1 7.2-8.3; 14.2-14.9; 23.5-24.4

Physical Properties Tests: USWE4 2165.9-2166.2; 2571.9-2572.3; 2989.4-2989.75

Performance of the above tests to the referenced procedures constitutes the use of nongraded material and data in a currently graded system. As currently outlined in WBS 1.2.4.2.1.3.S, Subtasks B.1 and B.2, this nongraded material and test data would be used to generate QA Level II results to support the Advanced Conceptual Design (ACD). The condition outlined above also applies to WBS 1.2.4.2.1.1, Subtask A.4.

SNL Response to Observations 10 and 11

Both of the cited observations involve data generated during a time period when there was not a WMPO-approved SNL NNWSI QA Program Plan. This data is in turn linked, although somewhat indirectly, with a QA Level II activity, Advanced Conceptual Design. For these and similar situations, there is a recognized need to provide for the credibility and availability of technical data for use in Project activities. The SNL approach is to be vigorously involved in current Project level efforts to clarify and provide structure to the processes of qualifying existing data and entering technical data into Technical Data Bases (TDB) and the Reference Information Base (RIB). Additionally, within SNL, we are refining an internal procedure for entering data into our TDB. We are also systematically reviewing all our data, including that discussed in these observations, to provide for the appropriate acceptance of the data for future project application. That data will then be "ready" for baselining into the Project RIB and "qualified," if necessary, when the Project-level procedures for those processes are available.

Sandia National Laboratories
Nevada Nuclear Waste Storage Investigations Project Department
Monthly Highlights and Status Report
December 1987

DISCLAIMER

Quality assurance checks on data contained in this report have been performed only to determine that the data have been obtained and documented properly. The SNL NNWSI Project Department cautions that any information is preliminary and subject to change as further analyses are performed or as an enlarged and perhaps more representative data base is accumulated. These data and interpretations should be used accordingly.

1.2.1.3.1 Site and Engineering Properties Data Base (1561.110)

(C. A. Rautman)

The Site and Engineering Properties Data Base (SEPDB) task will provide a controlled data base that will be used in the design and in the performance assessments needed for licensing a mined geologic disposal system at Yucca Mountain.

PLANNING AND SCHEDULING ACCOUNT STATUS

SLTR87-5003, "Data Base Plan for the NNWSI Site and Engineering Properties Data Base," has completed peer review and begun line review. This report, which will satisfy Milestone M297, should be sent to NVO/WMPO in early January.

PLANNED WORK

Agreement has been reached with the Computer Support task (WBS 1.2.1.3.4) that the INGRES-based data base management system will be installed, documented, and ready for use by the SEPDB by the first of January. Entry of material now contained in the "interim" SEPDB will commence at that time.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
M297	06/01/87	Letter Report to NVO/WMPO summarizing the Technical Data Base plan for the Site and Engineering Properties Data Base	Delayed; estimated submission to NVO/WMPO 01/15/88

1.2.1.3.3 Reference Information Base (1561.160) (J. Schelling)

The Reference Information Base (RIB) task will provide a controlled data base that will serve as a common source for technical information to be used in developmental analyses and project documents. The objective of the task is to ensure that all investigators within the NNWSI program are using internally consistent technical data in their activities.

PLANNING AND SCHEDULING ACCOUNT STATUS

Version 03.001 of the RIB, containing Version 02.002 information which was identified by F&S and SNL as necessary for initiating Title I ESF design, was prepared and submitted for technical review and approval to NVO/WMPO on December 4, 1987. A meeting was held on December 15, 1987 with NVO/WMPO and T&MSS staff to resolve the technical review comments. A modified version of RIB Version 03.001 incorporating the resolved comments was prepared and submitted to NVO/WMPO on December 18, 1987 for final approval as a Project document, satisfying Milestone M367.

Controlled copies of draft RIB Version 02.002 that have been distributed outside of SNL are being recalled in anticipation of distribution by the NVO/WMPO of Version 03.001 as the NNWSI Project RIB.

All information presented in Version 03.001 is being reevaluated to certify that the information is appropriate for ESF design, to improve documentation of the origin of the information, and to replace information as necessary with more appropriate information via future update page sets (Version 03.002, 03.003, etc.).

PLANNED WORK

In January, staff will coordinate the RIB Version 03.001 reevaluation effort and prepare and submit for technical review and approval the update page set for Version 03.002. Staff will also enhance the level of involvement of other participant organizations with the RIB, assist in the development of Project RIB change control and information management procedures, and determine satisfactory solutions to several outstanding problems with the existing RIB.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
M763	05/15/87	Incorporates NVO/WMPO and TPO comments into annual version of Reference Information Base	Completed 12/18/87

1.2.1.4.1 Flow and Radionuclide Transport (1561.210) (P. G. Kaplan)

The Flow and Radionuclide Transport task will evaluate the natural hydrologic and geochemical features along flow paths from the prospective mined geologic disposal system at Yucca Mountain to determine their contributions to the performance of the overall system. This task will provide the information necessary to define the appropriate ranges of site conditions to be considered in assessing potential radionuclide releases to the accessible environment.

PLANNING AND SCHEDULING ACCOUNT STATUS

Much of the effort this month was devoted to planning exercises in support of the Surfaced Based Test Plan (SBTP). A meeting to revise the draft edition of the plan was held on December 14, 1987. Staff from SNL met with staff from the USGS and SAIC to complete the revision. Agreement was reached upon five activities addressing performance assessment calculations of pre-emplacement groundwater travel time.

An exercise to calibrate flow meters for very low rates of flow is being conducted in the unsaturated flow lab. It is not clear that the meters will provide a constant rate of flow over periods of several days to weeks.

A meeting was held at Lawrence Berkeley Laboratory on December 9, 1987 to discuss their current contract. Completion of the report "Processes, Mechanisms, and Parameters Governing Partially Saturated Flow in Soil and Rock Medium," by J. Wang and T.N. Narasimhan, is expected by February 28, 1988, the end of the contract period.

PLANNED WORK

A performance assessment exercise using the activities described in the SBTP will commence.

The one-dimensional, steady-state flow code LLUVIA will be documented in a SAND report. The code will be used for base case ground-water travel time calculations in support of a performance assessment simulation exercise. The code has been installed in our RS/1 environment. Details of that installation will be documented as part of the exercise.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
M034	09/30/87	Report entitled "Hydrologic Modeling of Vertical and Lateral Movement of Partially Unsaturated Fluid Flow Near a Fault Zone at Yucca Mountain," SAND87-7070	Delayed; in management review; estimated completion 02/15/88

1.2.4.1.2 Basis for Design (1561.570) (R. R. Hill)

The Basis for Design task will produce the basic criteria and requirements, such as the Repository Design Requirements (RDR) document, for design activities. The RDR will provide a single-point focus to control the requirements and criteria for NNWSI Project designers.

PLANNING AND SCHEDULING ACCOUNT STATUS

All sections (except one) of the RDR have been drafted and are undergoing review and technical editing. The structure of the RDR is as follows:

1.0	Introduction
2.0	Site Location and Characteristics
3.0	Waste Descriptions
4.0	General Design Requirements
5.0	Surface Service and Utility Systems
6.0	Surface Facilities
7.0	Shafts and Ramps
8.0	Underground Excavation
9.0	Underground Service and Utility Systems
10.0	Seals
11.0	Exploratory Shaft Interface
12.0	Equipment
13.0	Operations
14.0	Performance Confirmation
15.0	Decommissioning
16.0	Retrievability
App A	Codes, Standards, and Regulations
App B	Interfaces

PLANNED WORK

Efforts will concentrate on review and technical editing to issue a peer review draft in February.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
P152	04/01/87	Incorporate comments from NVO/WMPO and TPOs into SAND85-0260; precursor to N433	Delayed; milestone being reevaluated; estimated completion 03/31/88

1.2.4.2.1.1 Rock Mass Analysis (1561.710) (S. J. Bauer)

This subtask includes evaluation of intact and rock mass thermomechanical properties based on analysis of available laboratory and field experiments and finite element analyses.

PLANNING AND SCHEDULING ACCOUNT STATUS

The analysis of the thermal and mechanical loading cycles of the G-Tunnel heated block experiment (PDM 71-021 and PDM 71-028) have been completed. The results of these analyses have been reported in SLTR87-7006 (mechanical loading) and SLTR87-4003 (thermomechanical loading). In addition, a report (SAND87-2699) covering the details of the analyses and results along with recommendations concerning the design and conduct of the experiment is being prepared. Abbreviated versions of this report have been accepted for presentation at the 29th U.S. Rock Mechanics Symposium (SAND87-1938C) and at the spring meeting of the American Society of Civil Engineers (SAND87-2781A).

The RE/SPEC Quality Assurance Program Plan (QAPP) was approved by the 6310 QA coordinator, allowing RE/SPEC to work on other tasks, as directed through PDMs and other vehicles.

SAND87-7072 entitled "The Joint Empirical Model - An Equivalent Continuum Model for Jointed Rock Masses," by Mark Blanford and Jan Key of RE/SPEC, completed peer review and was returned to the authors so that comments could be addressed.

A draft of a SLTR entitled "Preliminary Analyses of the G-Tunnel Mining Evaluations Experiment," by R. Johnson and S.J. Bauer, is near completion and will be submitted for peer review.

PLANNED WORK

A report is being written to document the results of the heated block analyses. This report will include recommendations for the design of future block experiments and for the corresponding code validation analyses.

Work will be directed to support the ESF. This work will include contributing to development of the Reference Information Base (RIB) for use with ESF design activities and performance of design analyses.

Revision of SAND87-7072 will commence.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
		No FY88 milestones defined	

1.2.4.2.1.3 Laboratory Properties (1561.730) (F. B. Nimick)

The Laboratory Properties task will determine the bulk, thermal, and mechanical properties of tuff through laboratory measurements. These data are used to support thermal and mechanical analyses, to enhance the capability to predict the response of tuff to excavation of subsurface repository facilities, and to evaluate effects of heat released by the waste.

PLANNING AND SCHEDULING ACCOUNT STATUS

Work continued on compiling data for the ESF design process. Data for thermal conductivity, thermal expansion, and bulk properties (density and porosity) obtained by SNL or SNL contractors have been compiled. Compilation of SNL data on mechanical properties is approximately 25 percent complete.

In addition, requests for equivalent data (and the associated documentation) have been submitted to LANL, LLNL, and USGS. Preliminary responses indicate data will be received at SNL by mid-January for incorporation in the data-compilation process.

Work on all Study Plans for this WBS has been delayed by the data-compilation effort. It is anticipated that work on the Study Plans will resume in early January.

PLANNED WORK

Compilation of data for the ESF-design process will continue. Study Plans 8.3.1.15.1.1, entitled "Laboratory Thermal Properties," and 8.3.1.15.1.3, entitled "Laboratory Mechanical Properties of Intact Rock," will be submitted to NVO/WMPO/NVO for review.

Study Plans 8.3.1.15.1.2, entitled "Laboratory Thermal Expansion Testing," and 8.3.1.15.1.4, entitled "Laboratory Mechanical Properties of Fractures," and Experiment Procedure EP-0010, entitled "Bulk Property Measurements on Post-Test Mechanical Samples," will be written.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
P567	04/01/87	Study Plan 8.3.1.15.1.1, "Laboratory Thermal Properties"	Delayed; estimated completion 01/31/88
P568	04/01/87	Study Plan 8.3.1.15.1.3, "Laboratory Mechanical Properties of Intact Rock"	Delayed; estimated completion 01/22/88
P569	05/01/87	Study Plan 8.3.1.15.1.2, "Laboratory Thermal Expansion Testing"	Delayed; estimated completion 03/15/88

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
P570	05/01/87	Study Plan 8.3.1.15.1.4, "Laboratory Mechanical Properties of Fractures"	Delayed: estimated completion 03/15/88

1.2.4.3.2 Surface Facilities (1561.420) (H. R. MacDougall)

The Surface Facilities task will prepare a conceptual design for the repository surface facilities and coordinate this design activity with the conceptual design of the repository underground facilities and repository-equipment development activities.

PLANNING AND SCHEDULING ACCOUNT STATUS

Staff is completing tasks required to close Contract 52-9817.

Several documents, SLTRs and SAND reports which were initiated under Contract 52-9817, are nearing completion. Work for these documents will continue under the new Contract 23-9599. Fee negotiations for the new contract were rescheduled for January 1988, and Contract placement is expected in January 1988.

PLANNED WORK

Negotiations for fee award for Contract 23-9599 are scheduled.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
		No FY88 milestones are defined	

1.2.4.3.3 Shaft/Ramps (1561.430) (R. E. Stinebaugh)

The Shaft/Ramps task will establish shaft and ramp design criteria using the engineering studies and design guidelines completed to date and will supply input for use in preparing a conceptual design for a Yucca Mountain repository.

PLANNING AND SCHEDULING ACCOUNT STATUS

The hoist being considered for use on ES-2 of the Exploratory Shaft Facility has been analyzed to verify that it will provide the necessary capacity for use in the ESF. The analyses performed include the determination of rope loads, duty cycles, and safety factors.

Staff is preparing definitions of unacceptable conditions and failures for the shafts of the ESF and the repository. These definitions provide a criteria for judging the results of analyses performed on these structures. The definitions will be submitted to the Interface Coordinating Working Group (ICWG) for approval and adoption by the NNWSI Project.

Reference configuration drawings are being prepared to guide the start of the design of the Exploratory Shaft Facility. These drawings include (1) a vertical cross section of the shafts, (2) horizontal cross sections of the shafts showing shaft equipment, (3) details of the main test level, the upper demonstration breakout room, and the Calico Hills drill room, and (4) a ventilation schematic.

The ESF/Repository interface control drawing is being modified to include additional detail on the lateral exploration drifts of the ESF main test level and to show the vertical positioning of the ESF with respect to geological strata of Yucca Mountain.

A methodology is being developed for design of the ground support for the ESF openings that will be used by the repository. This methodology will be presented to the ICWG for concurrence.

Review of the Shaft Design Guide has been completed. Review comments are being resolved and resulting changes are being made to the document.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
		Milestones are being redefined	

1.2.4.3.4 Underground Excavations (1561.440) (R. E. Stinebaugh)

The Underground Excavations task will prepare a conceptual design for the repository subsurface excavations and will coordinate this design activity with other repository conceptual-design activities.

PLANNING AND SCHEDULING ACCOUNT STATUS

An evaluation is in progress to determine the potential impact of the new choices for the top of the candidate horizon of the repository. The preliminary results of this work indicate that the plane of the repository could be changed in a manner that would result in a significant decrease in the grades in the haulage and emplacement drifts. If the new choices are accepted and these changes are made, the result could dictate that the current vertical positioning of the ESF be modified to provide an acceptable interface with the repository.

The analyses to support the retrieval strategy paper have been completed. The major analysis effort was centered on the ventilation system. Analyses included the prediction of conditions at start of retrieval preparation and the analysis of the ability to cool the emplacement drifts to achieve safe working conditions.

The cost estimate for constructing, equipping, and storing of waste in short horizontal boreholes has been completed. This analysis will be used to support the evaluation of an emplacement concept that uses horizontal boreholes that are less than 100 feet in depth.

The first draft of the report evaluating the impact of seismic loading on underground structures has been received. The report is currently being reviewed.

An analysis of the impact on the area needed for waste disposal, based on the various scenarios of waste inventory, configuration, and emplacement density controls, is underway at PBQ&D. The early results of the analysis indicate that none of the combinations predicted to this point make a significant change to the total area need for waste disposal. The goal of this work is to show that the various iterations of the waste inventory, delivery schedules, and emplacement density control schemes have little impact on the repository underground design; thus a design basis can be set at this time that will suffice until the start of the License Application Design.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
T089	10/30/87	Report on retrievability compliance strategy; precursor to R848	To be delayed; estimated completion 01/30/88

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
T145	12/15/87	Incorporate comments from NVO/WMPO into the retrievability compliance strategy document; precursor to R848	On schedule
P129	04/30/87	Report entitled "Report on the Welded Tuff Mining Demonstration Performed at the G-Tunnel Facility on the NTS," SAND86-7009	To be deleted; work to be incorporated in Milestone M434

1.2.4.3.5 Underground Service System (1561.450) (R. E. Stinebaugh)

The Underground Service System task will establish shop and warehouse designs and locations and will identify utility and general support requirements.

PLANNING AND SCHEDULING ACCOUNT STATUS

The final draft of a report detailing a method for determining radon emission rates has been received. This report details a method that can be used to determine radon emission rates in underground openings; also included are an equipment list, facility construction details, and detailed procedures.

A parametric analysis that predicts cool-down times for emplacement drifts as a function of air quantities has been completed for inclusion in the retrieval strategy paper. The report predicts that reasonable cool-down times can be achieved with reasonable quantities of ventilation air.

The tradeoff study evaluating various combinations of hoists, shaft collar designs, and ventilation accesses has been completed. The report is in technical review by the contractor prior to submittal to SNL.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
		No FY88 milestones are defined	

1.2.4.6.1 Repository Performance Code Development/Certification (1561.750)
(S. J. Bauer)

In this subtask, material models which are intended to approximate the rock mass response to thermomechanical loading are developed, verified, validated, and evaluated.

PLANNING AND SCHEDULING ACCOUNT STATUS

Review of the draft Problem Definition (PDM 71-032) of the first benchmark problem has been completed and all comments have been resolved. The PDM will be issued to all participants in January with the first report covering the thermal calculations due at the end of February. This initial benchmark exercise is intended to be a "shake down" for the proposed benchmarking methodology (detailed in a March 3, 1987 memo), as well as to provide some initial documentation relating to verification and validation of the three continuum rock mass models currently under development for eventual use in repository design.

Work is in progress on developing an overall strategy for verification and validation of the thermomechanical codes and models being developed for repository design. This strategy will fit within the framework of SOP 03-02 and DOP 03-02, but will be tailored specifically to the needs of the thermal and mechanical modeling efforts. The plan will provide sufficient detail of the type of documentation required and the methods available for demonstrating verification and validation. Benchmarking exercises are an important part of this strategy. As such, the planned benchmarking activities will be discussed in detail as to their specific goals and products. In conjunction with this effort, a series of meetings was held with the authors of DOP 3-2, entitled "Documentation for Software Quality Assurance," to assist them in developing a workable system for software QA which will be incorporated in the DOP.

A preliminary investigation into the use of bench or laboratory scale experiments as a tool for model validation is in progress. A literature search is being conducted to examine the types of laboratory scale experiments that have been performed to examine the response of jointed rock masses. If the methodology of running small scale tests on real or model materials proves adequate, this type of testing would add a very powerful tool to our model validation program. Further work on this project has been delayed until January due to the need to complete other reports and to get the benchmark exercise underway.

SAND87-7072, entitled "The Joint Empirical Model - An Equivalent Continuum Model for Jointed Rock Masses" by Mark Blanford and Sam Key of RE/SPEC, completed peer review and was returned to the authors so that comments could be addressed.

Preliminary analyses in support of the Yucca Mountain heated room experiment were completed. The results were presented at a meeting to discuss the experiment held December 8, 1987. Participants included representatives from other organizations within the Project and DOE. A validation strategy and process for running "validation" analyses was presented. The Yucca Mountain heated room experiment will be used to help validate certain thermal and mechanical models being considered for design and performance activities.

PLANNED WORK

In the next month, a final PDM for the first benchmark exercise will be issued and participants will begin the initial thermal calculations.

Analyses in support of the design of the Yucca Mountain heated room experiment will continue.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
T152	09/15/87	Report entitled "The Joint Empirical Model--An Equivalent Continuum Model for Jointed Rock Masses," SAND87-7072	Delayed; estimated completion 06/88

1.2.4.6.2 Design Analysis (1561.760) (B. L. Ehgartner)

The Design Analysis subtask establishes the analytical 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 underground openings, and (3) the establishment of design parameters that are criteria for design of the layout and underground openings.

PLANNING AND SCHEDULING ACCOUNT STATUS

During December, the thermal and mechanical analyses and responsibilities required for the design of the Exploratory Shaft Facility were defined.

Peer review comments were discussed and resolution reached for both SAND87-1075, entitled "Effects of the Deviation Characteristics of Nuclear Waste Emplacement Boreholes on Borehole Liner Stresses," and the "Shaft Liner Design Criteria and Methodology Guide" being prepared by PBQ&D.

The results of three-dimensional linear thermoelastic scoping calculations were presented to a working group for the proposed Yucca Mountain heated room experiment.

Improved estimates of rock mass strength and elastic modulus were proposed based on empirical evaluations, joint compliant modeling, and additional information on intact material behavior for the Topopah Springs welded tuff (TPS2).

Agapito and Associates completed the NNWSI training and familiarization program.

Draft SAND87-7075, entitled "HEFF - A User's Manual and Guide for the HEFF Code for Thermal-Mechanical Analysis Using the Boundary Element Method," was modified to include a number of improvements made to the code to enhance solution stability and accuracy.

PDM 75-12, entitled "NNWSI Approach for Evaluating Excavation Stability" was issued to Agapito and Associates; subsequent Acceptance of Task and Authorization to Proceed Memorandums followed.

PLANNED WORK

During January, the major emphasis of work will be on improving the rock mass properties needed for the ESF analyses, preparing PDMs for the ESF analyses, and review of the NNWSI Approach for Evaluating Excavation Stability.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
M414	09/30/87	Report entitled "A Thermomechanical Far-Field Model of Yucca Mountain," SAND85-7101	Delayed; in peer review; estimated completion 06/01/88

1.2.4.6.3 Preclosure Safety Analysis (1561.770) (T. Laub)

The Preclosure Safety Analysis task consists of the analysis and assessment of the radiological safety of the repository and the activities conducted there during the period that begins with the start of construction and ends with the completion of closure and decommissioning. Results obtained and information developed under this task will provide a basis for developing and updating the baselined requirements for the Yucca Mountain Mined Geologic Disposal System; the information will become input to the Safety Analysis Report for the License Application to the NRC.

PLANNING AND SCHEDULING ACCOUNT STATUS

Work on extending underground accident analyses to cover underground facilities in more detail continues.

SNL staff met with BNI staff this month to discuss a proposed approach to improve structural modeling of an aircraft crash at Yucca Mountain and possible approaches to be taken in performing a Seismic Design Cost-Benefit Assessment of the repository structures.

Preliminary responses to SAIC comments on SLTR87-7014 (Aircraft Crash Consequence Analyses) have been developed and are ready for discussion with SAIC. Responses were based on the meeting with BNI staff, as well as work with the SNL Transportation Technology Center (TTC) representative to prepare a PDM to initiate work by the TTC to determine the response of spent fuel shipping casks to aircraft impacts and subsequent fire.

Staff met to discuss further work for BNI. Plans were made to write DIMS for proposed work.

PLANNED WORK

SLTR87-7013 will be approved for publication, improvement of structural modeling of aircraft crashes and TTC work on response of shipping casks to aircraft impacts will begin, staff will meet with SAIC to discuss responses to SAIC comments on SLTR87-7014 (January 11th), and tasks for BNI for the remainder of the fiscal year will be developed.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
P159	09/30/87	Letter report entitled "Preclosure Radiological Safety Analysis for Normal Conditions of the Yucca Mountain Repository," SLTR87-7013	Delayed; in peer review; estimated completion 01/15/88

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
P160	09/30/87	Report entitled "Preclosure Radiological Safety Analysis for Accident Conditions of the Yucca Mountain Repository, Phase II"	Delayed; estimated completion 01/15/88

1.2.1.3.3 Reference Information Base (1561.160) (J. Schelling)

The Reference Information Base (RIB) task will provide a controlled data base that will serve as a common source for technical information to be used in developmental analyses and Project documents. The objective of the task is to ensure that all investigators within the NNWSI program are using internally consistent technical data in their activities.

PLANNING AND SCHEDULING ACCOUNT STATUS

Reevaluation of the information content of RIB Version 03.001 continues. Review comments on some items have been received and are being addressed, several new items have been initiated, and development of replacement items continues. Release of an update set continues to be delayed due to the magnitude of the effort involved, other staff priorities, and delays in receiving review comments from Project participants.

Revision A of DOP 3-8 (RIB Change Control) received approval and is being implemented. As a result, a SNL RIB Change Board is being established, and a database system for logging and tracking the status of information items is being developed.

Action items arising from the March 8th Technical Design Advisory Group (TDAG) meeting are being addressed in preparation for the April 19th meeting of this group. These action items cover a number of topics, including development and review of information and data flow procedures, organization of working groups, and discussion of quality assurance requirements through the Technical Systems Advisory Group (TSAG).

PLANNED WORK

Substantial action toward implementing structural changes for the RIB, resolving QA concerns, and improving processing of information for the RIB is expected early in April if proposals introduced during the past month are adopted by the Project.

Work will continue to focus on the RIB reevaluation and development effort, and in completing responses to TDAG action items.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
M763	05/15/87	Incorporate NVO/WMPO and TPO comments into annual version of Reference Information Base	Completed 12/18/87

1.2.4.1.2 Basis for Design (1561.570) (R. R. Hill)

The Basis for Design task will produce the basic criteria and requirements, such as the Repository Design Requirements (RDR) document, for design activities. The RDR will provide a single-point focus to control the requirements and criteria for NNWSI Project designers.

PLANNING AND SCHEDULING ACCOUNT STATUS

All sections of the RDR have been submitted for peer review; three-quarters of the peer reviews were completed by the end of March. Resolution of peer review comments is underway. Meetings were held to ensure department understanding of the purpose, function, and scope of the RDR.

PLANNED WORK

Peer review and comment resolution will continue in April. A series of meetings will be held to ensure that Project personnel understand the purpose, function, and scope of the SR and RDR documents and their relationship to design.

PROBLEM AREAS

The RDR requires firm waste characterization data to be provided by DOE/HQ. Current RDR descriptions of waste characteristics are based on best estimates.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
P152	04/01/87	Incorporate comments from NVO/WMPO and TPOs into SAND85-0260; precursor to N433	Delayed; milestone being reevaluated; estimated completion 04/29/88

1.2.4.2.1.1 Rock Mass Analysis (1561.710) (S. J. Bauer)

This subtask includes evaluation of intact and rock mass thermomechanical properties based on analysis of available laboratory and field experiments and finite element analyses.

PLANNING AND SCHEDULING ACCOUNT STATUS

SAND87-2699, "An Analysis of the G-Tunnel Heated-Block Thermal-Mechanical Response Using a Compliant-Joint Rock Mass Model," by L. Costin and E. Chen, was submitted for management review. Abbreviated versions of this report were accepted for presentation at the 29th U.S. Rock Mechanics Symposium (SAND87-1938C) and at the Spring meeting of the American Society of Civil Engineers (SAND87-2781A).

Regarding the Thermal Stress experiment, large flatjacks placed in thin slots in the walls or floors of drifts may be used to measure in situ and thermal stresses as well as estimate the local deformation modulus of the rock mass. A review of analyses is in progress aimed at evaluating the proposed technique. Two-dimensional finite element analyses of both plan and elevation views of a flatjack being pressurized in a slot located in the wall of a drift with an imposed horizontal in situ stress are being run. Thus far, elastic solutions have been obtained and solutions using the compliant-joint rock mass model are in progress. Initial results indicate that the flatjack cancellation method will result in a large overestimation of the stress if displacement measurements are made too near the slot. However, if the displacements are measured between pins located one meter to either side of the slot, the measured stress corresponds closely to the imposed value. Further analyses using anisotropic jointed rock models are being run to determine the effect of joint slip during slot cutting and flatjack inflation on the measured results.

SAND88-0810, "Preliminary Analyses of the G-Tunnel Mining Evaluations Experiment," by R. Johnson and S. J. Bauer, was completed and is being readied for peer review.

The peer review comments of SAND87-7072, entitled "The Joint Empirical Model - An Equivalent Continuum Model for Jointed Rock Masses," by M. Blanford and S. Key of RE/SPEC, are being addressed.

6314 staff submitted a final symposium agenda, entitled "Thermal-Mechanical Problems Associated with Nuclear Waste Disposal in Geologic Media," to the meeting organizers for the ASME-SES Joint Applied Mechanics conference in Berkeley, CA, June 20-22, 1988. Approximately twenty speakers from the U.S., Canada, England, and West Germany have agreed to participate in the day-long symposium. The four sessions for the symposium are entitled "Analytical and Design Methods," "In Situ Experimentation," "Experimental/Analytical Methods for Determining In Situ Thermal/Mechanical Rock Properties," and "Numerical Modeling of In Situ and Laboratory Experiments."

Work was initiated to revise the analyses to determine the dip and frequency of fractures from the five sources of available corehole data.

A draft of SAND87-1575, "Preliminary Analyses of the Excavation Investigation Experiments Proposed for the Exploratory Shaft at Yucca Mountain, Nevada Test Site," by L. S. Costin and S. J. Bauer, was completed.

PLANNED WORK

Work will be directed to support the ESF. This work will include contributing to development of the Reference Information Base (RIB) for use with ESF design activities and performance of design analyses.

Revision of SAND87-7072 will continue.

Further analysis of the proposed experimental technique using flatjacks in slots to determine the rock-mass deformation modulus and to measure stresses resulting from thermal loading will be pursued. The purpose of the analysis is to determine the effects of nonsymmetric jointing and anisotropic rock behavior on the interpretation of the flatjack pressure-displacement data. A journal article will be prepared that reviews the results of a previous analysis of a slot pressurization test in G-Tunnel.

A draft of SAND88-0810, "Preliminary Analysis of the G-Tunnel Mining Evaluation Experiment," nears completion. Work on this report will continue.

Work will continue on the analysis of the flatjack cancellation method of measuring in situ and thermal stresses. Analyses will concentrate on determining the effect of joint stiffness and orientation on the measured stresses.

Work will be completed to document the analyses which were used to determine the dip and frequency of fractures which will be submitted for the RIB.

SAND87-1575 will be submitted for peer review.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
		No FY88 milestones defined	

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1.2.4.2.1.3 Laboratory Properties (1561.730) (F. B. Nimick)

The Laboratory Properties task will determine the bulk, thermal, and mechanical properties of tuff through laboratory measurements. These data are used to support thermal and mechanical analyses, to enhance the capability to predict the response of tuff to excavation of subsurface repository facilities, and to evaluate effects of heat released by the waste.

PLANNING AND SCHEDULING ACCOUNT STATUS

Work continued on statistical analysis of data for the ESF design process. A draft memo summarizing the results of analysis of thermal-expansion data has been reviewed and is being revised. Bulk-property and mechanical data have been analyzed; a draft memo summarizing the results of analysis of bulk-property data has been written.

A data report summarizing SNL thermal-conductivity data has been written and peer-reviewed. In addition, the available thermal-conductivity data for the welded, devitrified portion of the Topopah Spring Member have been analyzed and a draft analysis report has been written and submitted for peer review. Also, a data report summarizing SNL bulk-property data has been written and is being revised for peer review.

Study Plan 8.3.1.15.1.1, "Laboratory Thermal Properties," was transmitted to NVO/WMPO, satisfying Milestone P567. The revised version of SAND87-1685, "Preliminary Evaluation of the Exploratory Shaft Representativeness for the Nevada Nuclear Waste Storage Investigations Project," was transmitted to NVO/WMPO on March 10th for policy approval. EP-0015, "Preliminary Investigation of the Mechanical Anisotropy in Samples of the Topopah Spring Member," and EP-0016, "Fracture Properties Testing: Comparison of Triaxial and Rotary Shear Techniques," were approved and issued.

PLANNED WORK

Analysis of data for the ESF-design process will be completed and the results will be submitted to the RIB. Study Plans 8.3.1.15.1.2, "Laboratory Thermal Expansion Testing," and 8.3.1.15.1.4, "Laboratory Mechanical Properties of Fractures," will be written.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
P567	04/01/87	Study Plan 8.3.1.15.1.1, "Laboratory Thermal Properties"	Completed 03/17/88
P568	04/01/87	Study Plan 8.3.1.15.1.3, "Laboratory Mechanical Properties of Intact Rock"	Completed 02/08/88

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MILE-STONE	DUE DATE	DESCRIPTION	STATUS
P569	05/01/87	Study Plan 8.3.1.15.1.2, "Laboratory Thermal Expansion Testing"	Delayed; estimated completion 07/15/88
P570	05/01/87	Study Plan 8.3.1.15.1.4, "Laboratory Mechanical Properties of Fractures"	Delayed; estimated completion 06/15/88

1.2.4.3.2 Surface Facilities (1561.420) (H. R. MacDougall)

The Surface Facilities task will prepare a conceptual design for the repository surface facilities and coordinate this design activity with the conceptual design of the repository underground facilities and repository-equipment development activities.

PLANNING AND SCHEDULING ACCOUNT STATUS

Pre-ACD studies have been identified and those scheduled to be started this FY are being implemented. General arrangement drawings for the pre-ACD study entitled "Impact of Waste Characteristics and Receipt Rates on Repository and Waste Package (WP) Design" are being prepared and reviewed.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
		No FY88 milestones are defined	

1.2.4.3.3 Shaft/Ramps (1561.430) (R. E. Stinebaugh)

The Shaft/Ramps task will establish shaft and ramp design criteria using the engineering studies and design guidelines completed to date and will supply input for use in preparing a conceptual design for a Yucca Mountain repository.

PLANNING AND SCHEDULING ACCOUNT STATUS

All ESF shaft design configuration definition drawings have been completed. These drawings reflect sufficient design detail to prove design feasibility and to provide specific guidance to the Architect and Engineer responsible for Title I and Title II design.

The final draft of SAND88-7060, "Preliminary Shaft Liner Design Criteria and Methodology Guide" by R. Stinebaugh and A. Richardson (PBQ&D) has been received from PBQ&D and is in review.

PLANNED WORK

The report entitled "Shaft Liner Design Criteria and Methodology Guide" will be reviewed and released.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
		Milestones are being redefined	

1.2.4.3.4 Underground Excavations (1561.440) (R. E. Stinebaugh)

The Underground Excavations task will prepare a conceptual design for the repository subsurface excavations and will coordinate this design activity with other repository conceptual-design activities.

PLANNING AND SCHEDULING ACCOUNT STATUS

Work is being done by the PBQ&D staff to evaluate the potential benefits to be derived from the new geological "picks" for the top of the TSw2 formation. Current work is directed to determining the possible improvements of the grades within the waste-emplacement drifts. The first evaluation indicated that the grades in the emplacement drifts could be lessened significantly.

Plans are being made to tour the Misty Rain and Middle Note test facilities at the "N" tunnel complex on the Nevada Test Site. The purpose of the tour is to examine the structural damage resulting from underground nuclear explosions.

A data sheet for the underground facilities of the repository is being prepared, summarizing the data pertinent to the design and operation of the underground facilities as depicted in the SCP-CDR. Data relative to the ESF will also be included.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
T089	10/30/87	Report on retrievability compliance strategy; precursor to R848	To be delayed; estimated completion 04/15/88
T145	12/15/87	Incorporate comments from NVO/WMPO into the retrievability compliance strategy document; precursor to R848	On schedule
P129	04/30/87	Report entitled "Report on the Welded Tuff Mining Demonstration Performed at the G-Tunnel Facility on the NTS," SAND86-7009	To be deleted; work to be incorporated in Milestone M434

1.2.4.3.5 Underground Service System (1561.450) (R. E. Stinebaugh)

The Underground Service System task will establish shop and warehouse designs and locations and will identify utility and general support requirements.

PLANNING AND SCHEDULING ACCOUNT STATUS

The design basis waste emplacement chronology has been developed for use in developing the thermal loading inputs for the ESF analyses. The chronology identifies the repository fill sequence by year and location as well as the characteristics of the waste emplaced.

Two reports, SAND87-7076, "An Analysis of Air Cooling Prior to Reentering a Drift Containing Emplaced Commercial Nuclear Waste," and SAND86-7020, "Ventilation Planning for a Proposed Nuclear Waste Facility," have been received from Mine Ventilation Services.

A draft of SAND88-7057, "Effects of Moisture on the Emplacement Drift Environment at the Prospective Repository in Tuff," by R. Stinebaugh and K. Wallace (Mine Ventilation Services) has been received from Mine Ventilation Services. The report is now being reviewed.

Planning of the analyses to support the Title I and Title II design of the ESF has been completed. The analyses to be done by SNL include verifying opening stability over the operational period of the repository and examining the potential for design impacts on the postclosure performance of the repository.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
P017	01/30/88	Hoist Selection	Completed 03/17/88

1.2.4.6.1 Repository Performance Code Development/Certification (1561.750)
(S. J. Bauer)

In this subtask, material models which are intended to approximate the rock mass response to thermomechanical loading are developed, verified, validated, and evaluated.

PLANNING AND SCHEDULING ACCOUNT STATUS

Work is continuing on the Preliminary Benchmark Problem (PDM 71-032). Thermal analysis results have been received and compared, with very good agreement among the three finite-element thermal codes. The thermoelastic solution (using the thermal solutions already completed) will be initiated. A SAND report is being written to document the thermoanalysis phase of the benchmark exercise. Technical and peer reviews of this report will satisfy the QA Level II requirements for analysis review set forth in the PDM.

The forms are being completed and the documentation collected for the thermal and mechanical codes to be used for QA Level I or II analyses in the future. These codes will be entered into the configuration management system specified by DOP 3-2. Codes being used in the current benchmark exercise will be the first entered into the system.

A preliminary investigation into the use of bench or laboratory scale experiments as a tool for model validation is in progress. A literature search for laboratory-scale experiments examining the response of jointed rock masses is underway. One such experiment used small cubes of plaster to form a larger jointed block. The jointed blocks were tested in compression with varying lateral confinement and different joint orientations. Analyses are being performed using the compliant-joint rock-mass model to simulate the response of the jointed blocks of plaster in these experiments. Data from compression tests on unjointed plaster and tests on jointed blocks with 90° and 45° joint orientations were used to determine a set of model parameters for the compliant-joint model. The model will be used to predict the results of tests on jointed blocks with 15° and 30° joint orientations and with different confining pressures. Calculations are in progress.

Analyses in support of the Yucca Mountain heated room experiment, proposed for the Exploratory Shaft Facility, continued. Four sets of thermomechanical analyses are nearing completion: isotropic-elastic, orthotropic-elastic, compliant joint with one set of vertical joints, and compliant joint with one set each of vertical and horizontal joints. Results (predicted stress and displacement fields) will be used to assist in designing the proposed experiment.

An outline of SAND87-7071, "User's Manual for SPECTROM-31," by S. Key and D. Labreche (RE/SPEC), was submitted for management review. Meanwhile, development of text for this report and completion of verification problems

continued. Also, an outline of SAND88-7058, "Description, Verification, and User's Guide of SPECTROM-349: A Three-Dimensional Linear Superpositive, Heat-Conductive Computer Program," was submitted for management review.

PLANNED WORK

In the next month, the results from the thermoelastic analysis portion of the benchmark exercise will be received and processed. Work will continue on the bench-scale experiment calculations. The results will be documented in a SAND report.

Study of bench-scale experiments simulating jointed rock-like materials will continue. These calculations are considered preliminary to the design of laboratory experiments which may be used as part of the model validation effort.

Work on revising SAND87-7072, writing SAND87-7071, and completing documentation on SPECTROM-31 will continue.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
T152	09/15/87	Report entitled "The Joint Empirical Model--An Equivalent Continuum Model for Jointed Rock Masses," SAND87-7072	Delayed; estimated completion 06/88

1.2.4.6.2 Design Analysis (1561.760) (B. L. Ehgartner)

The Design Analysis subtask establishes the analytical 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 underground openings, and (3) the establishment of design parameters that are criteria for design of the layout and underground openings.

PLANNING AND SCHEDULING ACCOUNT STATUS

During March, draft reports entitled "Ground Control Methodology and Criteria for Drifts in the Underground Repository Facility in Tuff" and "Evaluation of Excavation Stability - A Proposed Approach for the NNWSI Project" were received from PBQ&D and Agapito and Assoc., respectively. The reports were reviewed and selected content combined to propose a new report entitled "Preliminary Drift Design Methodology." The outline, content, and logic diagram for the new report were developed and agreed upon during a meeting with PBQ&D, Agapito and Assoc., and staff.

Problem Definition Memo PDM 75-14, entitled "Thermal Effects on Rock Bolts," was written and issued to Agapito and Assoc. Subsequent Acceptance of Task and Authorization to Proceed Memos were exchanged to initiate work on the task. The analyses results will define the interaction of the ground support components with the emplacement drift due to thermal loading of the host rock and become part of the "Preliminary Drift Design Methodology" report.

Design Investigation Memo (DIM) 133, "Criteria and Analysis for Design of Subsurface Openings," DIM 148, "Empirical Analyses of Opening Stability," and DIM 147, "Case History Evaluations," were drafted and submitted for approval. The DIMs define work related to the ESF analyses.

Contract 57-0881 was initiated with RE/SPEC, who submitted a QA plan for approval and the first two tasks of the contract were defined: "Documentation and Finalization of Prior Studies" and "ESF-Related Output from the Far-Field Sensitivity Study."

The waste emplacement sequencing for repository panels was defined by PBQ&D, as required by the three-dimensional ESF far-field analyses.

Planning for the borehole systems study (thermal, mechanical, and hydrologic interaction of the waste package, borehole liner, host rock, and emplacement drift) was initiated.

Planning Costs Accounts, milestones, budget, and pre-Advanced Conceptual Design (ACD) study refinements were made for this WBS.

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PLANNED WORK

During April, the major emphasis of work will be on the ESF analyses and related activities, SCP revisions, and interfacing with PBQ&D, RE/SPEC, and Agapito and Associates.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILESTONE	DUE DATE	DESCRIPTION	STATUS
M414	09/30/87	Report entitled "A Thermomechanical Far-Field Model of Yucca Mountain," SAND85-7101	Delayed; in peer review; estimated completion 06/01/88

1.2.4.6.3 Preclosure Safety Analysis (1561.770) (T. Laub)

The Preclosure Safety Analysis task consists of the analysis and assessment of the radiological safety of the repository and the activities conducted there during the period that begins with the start of construction and ends with the completion of closure and decommissioning. Results obtained and information developed under this task will provide a basis for developing and updating the baselined requirements for the Yucca Mountain Mined Geologic Disposal System; the information will become input to the Safety Analysis Report for the License Application to the NRC.

PLANNING AND SCHEDULING ACCOUNT STATUS

In March, staff attended two working meetings in Washington, D.C., in support of DOE-HQ efforts to develop a Petition for Rulemaking to add an accident dose guideline to 10 CFR 60. Staff also attended a Nuclear Regulatory Commission (NRC) presentation in Washington, DC, to the Advisory Committee on Reactor Safeguards (ACRS) on the NRC's resolution of public comments on the Q-list Generic Technical Position (GTP), an indoctrination meeting for the SCP scrubdown activities in Las Vegas, and a presentation of the SNL repository simulation-modeling efforts in Albuquerque.

SAND88-7061, entitled "Preclosure Radiological Safety Analysis for Accident Conditions of the Yucca Mountain Repository: Underground Facilities," was received from BNI for review and comment and a draft PRAM Procedures Guide was received from DOE/HQ for review and comment.

SLTR87-7007, "Preliminary Yucca Mountain Repository Criticality Safety Study," was submitted for printing and SLTR87-7013 is being printed.

PLANNED WORK

Participation in Working Group 5 activities associated with the SCP revision will begin, requiring a large staff commitment.

NRC comments and questions concerning Sections 8.3.2.3, 8.3.5.1, 8.3.5.3, 8.3.5.9, and 8.3.5.5 of the SCP will be addressed and work with DOE-HQ preparing the Petition for Rulemaking will continue.

Also, SAND88-7061 will be reviewed and comments returned to BNI, the Petition for Rulemaking and PRAM Procedures Guide review will be initiated, and papers will be completed for the ANS Annual Meeting in June.

PROBLEM AREAS

Activities associated with the SCP scrubdown effort are expected to use almost all of the staff time in the coming months, thus causing delays in the completion of other planned work.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
P159	09/30/87	Letter report entitled "Preclosure Radiological Safety Analysis for Normal Conditions of the Yucca Mountain Repository," SLTR87-7013	Gone to printer expected publication April 30, 1988
P160	09/30/87	Report entitled "Preclosure Radiological Safety Analysis for Accident Conditions of the Yucca Mountain Repository, Phase II"	In peer review

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1.2.1.4.1 Flow and Radionuclide Transport (1561.210) (P. G. Kaplan)

The Flow and Radionuclide Transport task will evaluate the natural hydrologic and geochemical features along flow paths from the prospective mined geologic disposal system at Yucca Mountain to determine their contributions to the performance of the overall system. This task will provide the information necessary to define the appropriate ranges of site conditions to be considered in assessing potential radionuclide releases to the accessible environment.

PLANNING AND SCHEDULING ACCOUNT STATUS

Publication of SAND87-7070, "Hydrologic Modeling of Vertical and Lateral Movement of Partially Unsaturated Fluid Flow Near a Fault Zone at Yucca Mountain," by J. Wang and T. N. Narasimhan of Lawrence Berkeley Laboratories, is delayed while figures are being revised.

Draft copies of SAND88-7054, "Processes, Mechanisms, and Parameters Governing Partially Saturated Flow in Soil and Rock Medium," by J. Wang and T. N. Narasimhan of Lawrence Berkeley Laboratories, are being held prior to final review until the authors forward missing sections.

SNL review of SAND88-0265, "Reduction of Well Test Data for Test Well USWG-4, Yucca Mountain, Nye County, Nevada," by G. E. Barr of SNL, has been completed.

Documentation of the code LLUVIA in SAND88-0558, "LLUVIA - A One-Dimensional, Steady-State Program for Flow Through Partially Saturated Porous Media," by P. Hopkins and R. Eaton of SNL, is in review.

SAND88-0580, "Estimating the Probability Density Functions of the Hydraulic Parameters of the Calico Hills Tuff Using the Beta Probability Function," by P. Kaplan and L. Yarrington of SNL, is under review.

Staff participated in the working groups formed to review the Consultation Draft of the Site Characterization Plan.

Training of new staff in the application of RS/1 software commenced.

Initial thermocouple psychrometer calibration measurements were taken in preparation to support WBS 1.2.1.4.3, Validation.

Staff have implemented a procedure to run the flow code NORIA in a batch mode on the Cray XMP/416. The user subroutines for NORIA have been modified to allow the use of 10 solid materials, thus taking advantage of the main code's capability to handle anisotropic hydraulic conductivities.

Two codes that support the use of NORIA have been modified. MERLIN has been modified to transfer NORIA pressure solutions from one mesh to another. The TRINITY data-base translator has been modified to include additional parameters

of interest for plotting and improved display of two-dimensional particle tracking results.

The report documenting the COVE 2A benchmarking of flow codes for one-dimensional isothermal analyses will include both preliminary and final results, thus showing potential difficulties of these analyses and what can be done to improve confidence in calculated results. Participants from SNL using LLUVIA, NORIA, and TOSPAC, from LANL using TRACR3D, and from LBL using TRUST, are preparing their final analyses of the 12 COVE 2A cases. SNL staff is preparing final plots of the preliminary results and has begun internal review of its final report on the results of their COVE 2A analyses using NORIA.

Preliminary analyses for HYDROCOIN Level 3 Case 2 have been reported previously. Some of the solutions show high fracture fluxes that vary rapidly in space. The original finite-element mesh used for these analyses contained 1998 elements but still was not sufficiently refined to produce stable numerical results in the regions of high fracture flow. Even very slightly unstable pressure-field results can lead to very unstable velocity fields and erratic particle-tracking results. Staff has designed a new mesh to try to improve the quality of the results.

A conference paper describing the effects of material heterogeneities on effective conductivities for unsaturated flow has been technically reviewed and is now in management review.

Within the RS/1 software environment, beta probability density function graphs can now be overlayed on the sample population histograms.

PLANNED WORK

Efforts to document recent accomplishments, training in RS/1 software, and participation in the SCPCD working groups will continue.

Measurement of standard samples and reproduction of the calibration curves for the thermocouple psychrometer will commence.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
M034	09/30/87	Report entitled "Hydrologic Modeling of Vertical and Lateral Movement of Partially Unsaturated Fluid Flow Near a Fault Zone at Yucca Mountain," SAND87-7070	Delayed; in management review; estimated completion 04/30/88

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
M133	01/20/88	Problem Definition Memo for COVE2A Benchmarking Problem for Isothermal Flow	Completed 03/04/88

1.2.1.3.1 Site and Engineering Properties Data Base (1561.110)
(C. A. Rautman)

The Site and Engineering Properties Data Base (SEPDB) task will provide a controlled data base that will be used in the design and in the performance assessments needed for licensing a mined geologic disposal system at Yucca Mountain.

PLANNING AND SCHEDULING ACCOUNT STATUS

Work is continuing on transferring files from the interim SEPDB to INGRES data structures and on QA verification of data tables. Data transferred to the INGRES-based SEPDB is tabulated in Appendix B.

Development work designing "dual-table" storage formats for parameters requiring summary information and supported by detailed backup began this month. As examples, several actual measurements of remnant magnetism support a single determination of paleomagnetic orientation for a sample or the detail data of water level versus time values during a well test support a measurement of transmissivity. On-line data entry and retrieval of such "master-detail" information is easily accomplished using INGRES; however, reporting hard-copy listings of the same material requires additional programming efforts. Software development will be undertaken after the storage format has been tested by potential users.

SEPDB tables containing geochemical data appear to require restructuring from a "column-oriented" format to a "row-based" design. This represents a departure from the single-parameter table approach used by the SEPDB to date. Implications of this potential change are being investigated.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
M297	06/01/87	Letter Report to NVO/WMPO summarizing the Technical Data Base plan for the Site and Engineering Properties Data Base	Completed 02/15/88

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DISCLAIMER

Quality assurance checks on data contained in this report have been performed only to determine that the data have been obtained and documented properly. The SNL NNWSI Project Department cautions that any information is preliminary and subject to change as further analyses are performed or as an enlarged and perhaps more representative data base is accumulated. These data and interpretations should be used accordingly.

1.2.1.3.3 Reference Information Base (1561.160) (J. Schelling)

The Reference Information Base (RIB) task will provide a controlled data base that will serve as a common source for technical information to be used in developmental analyses and Project documents. The objective of the task is to ensure that all investigators within the NNWSI program are using internally consistent technical data in their activities.

PLANNING AND SCHEDULING ACCOUNT STATUS

Twenty-one RIB Change Requests (RIBCRs), initiating consideration of candidate information for the RIB, were submitted to the TSAG for concurrence and guidance on development strategies. RIB Development Requests (RIBDRs) were initiated on fourteen RIBCRs, further development of two RIBCRs was rejected, and consideration of the remaining five was delayed until the June TSAG meeting. Most proposed items are essentially complete, requiring only review and comment resolution prior to resubmission to the TSAG for final approval. Development of RIBDRs for rock properties and meteorological information is less complete, but work is proceeding.

Efforts continued on development of Project administrative procedures and plans for technical data and information management, centralization of Project information flow, establishment of technical data working groups, and implementation of the technical element of the Project baseline.

PLANNED WORK

Efforts in May will be directed toward completion of open RIB Development Requests in anticipation of release of a RIB update set. The cooperation of the Repository DIG, the ESF-ICWG, and particular PIs will be required to complete this work.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
M763	05/15/87	Incorporate NVO/WMPO and TPO comments into annual version of Reference Information Base	Completed 12/18/87

1.2.4.1.2 Basis for Design (1561.570) (R. R. Hill)

The Basis for Design task will produce the basic criteria and requirements, such as the Repository Design Requirements (RDR) document, for design activities. The RDR will provide a single-point focus to control the requirements and criteria for NNWSI Project designers.

PLANNING AND SCHEDULING ACCOUNT STATUS

Peer review and comment incorporation on the RDR was nearly complete, with resolution between the RDR and SR documents underway. Work plans were developed for this WBS element.

PLANNED WORK

The remaining RDR peer review comments will be resolved in a draft by the end of May.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
P152	04/01/87	Incorporate comments from NVO/WMPO and TPOs into SAND85-0260; precursor to N433	Delayed; milestone being reevaluated; estimated completion 08/15/88

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1.2.4.2.1.1 Rock Mass Analysis (1561.710) (S. J. Bauer)

This subtask includes evaluation of intact and rock mass thermomechanical properties based on analysis of available laboratory and field experiments and finite element analyses.

PLANNING AND SCHEDULING ACCOUNT STATUS

SAND87-2699, "An Analysis of the G-Tunnel Heated Block Thermal-Mechanical Response Using a Compliant-Joint Rock Mass Model," by L. Costin and E. Chen, was submitted for management review. SAND88-0810, "Preliminary Analyses of the G-Tunnel Mining Evaluations Experiment," by R. Johnson and S. Bauer, and SAND87-1575, "Preliminary Analyses of the Excavation Investigation Experiments Proposed for the Exploratory Shaft at Yucca Mountain, Nevada Test Site," by L. S. Costin and S. J. Bauer, were submitted for peer review.

Analyses of jointed rock response in the vicinity of flatjacks placed in thin slots cut in the walls or floors of drifts continued. Flatjacks may be used to measure in situ and thermal stresses during the proposed Thermal Stress Experiment. Two-dimensional finite element analyses of both plan and elevation views of a flatjack being pressurized in a slot located in the wall of a drift with an imposed horizontal in situ stress are being run. Solutions have been obtained using an elastic rock-mass model; solutions are in progress using the compliant-joint rock-mass model. Initial results indicate the flatjack cancellation method may result in a large overestimation of the stress if displacement measurements are made too near the slot. However, if the displacements are measured between pins located at least one meter to either side of the slot, the measured stress corresponds closely to the imposed value. Further analyses using anistropic jointed rock models are being run to determine the effect of joint orientation, relative to the plane of the slot, on the measured results. The results of these analyses are being used to improve the flatjack measurement technique.

Work is in progress to revise the analyses used to estimate the dip and frequency of fractures in the rock mass from data obtained from five coreholes at Yucca Mountain.

PLANNED WORK

Work will continue on the analysis of the flatjack cancellation method of measuring in situ and thermal stresses. Analyses will concentrate on determining the effect of joint stiffness and orientation on the measured stress.

Additional work is planned to support the ESF including development of information for the Reference Information Base (RIB) for use with ESF design activities and design performance analyses.

Revision of SAND87-7020 will continue.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
		No FY88 milestones defined	

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1.2.4.2.1.3 Laboratory Properties (1561.730) (F. B. Nimick)

The Laboratory Properties task will determine the bulk, thermal, and mechanical properties of tuff through laboratory measurements. These data are used to support thermal and mechanical analyses, to enhance the capability to predict the response of tuff to excavation of subsurface repository facilities, and to evaluate effects of heat released by the waste.

PLANNING AND SCHEDULING ACCOUNT STATUS

Work continued on statistical analysis of data for the ESF design process. Three draft memos are in various stages of review. The memo on thermal expansion will be issued by May 3. The memo on bulk properties was reviewed and is being revised, and the memo on mechanical data was written. Anticipated completion date for this effort is May 20.

SNL thermal conductivity data for thermal/mechanical units TCw, PTn, TSw1, TSw2, TSw3, CHn1v, and CHn2v have been analyzed. Data for units CHn1z and CHn2z will be analyzed; when this last analysis is completed, a draft analysis report on the above units, except TSw1 and TSw2, will be written and submitted for peer review. (An equivalent report on units TSw1 and TSw2 is in SNL management review.) In addition, thermal-conductivity entries in the RIB will be revised as appropriate.

SAND87-2684J, entitled "The Occurrences of Silica Phases in Welded Ash Flows on the Paintbrush Tuff," was transmitted to The American Mineralogist for consideration for publication.

A data report summarizing SNL heat capacity information (calculated rather than experimental values) is being written. The data in this report will provide the basis for an analysis report for the heat capacities of the thermal/mechanical units at Yucca Mountain, which in turn will contribute heat capacity information to the RIB.

Five tensile-strength experiments were completed in support of EP-0014, "Development of Tensile Strength Techniques in the Geomechanics Laboratory."

PLANNED WORK

Analysis of data for the ESF design process will be completed and the results will be submitted to the RIB. Study Plans 8.3.1.15.1.2, "Laboratory Thermal Expansion Testing," and 8.3.1.15.1.4, "Laboratory Mechanical Properties of Fractures," will be written.

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NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
P567	04/01/87	Study Plan 8.3.1.15.1.1, "Laboratory Thermal Properties"	Completed 03/17/88
P568	04/01/87	Study Plan 8.3.1.15.1.3, "Laboratory Mechanical Properties of Intact Rock"	Completed 02/08/88
P569	05/01/87	Study Plan 8.3.1.15.1.2, "Laboratory Thermal Expansion Testing"	Delayed; estimated completion 07/15/88
P570	05/01/87	Study Plan 8.3.1.15.1.4, "Laboratory Mechanical Properties of Fractures"	Delayed; estimated completion 06/15/88

1.2.4.3.2 Surface Facilities (1561.420) (H. R. MacDougall)

The Surface Facilities task will prepare a conceptual design for the repository surface facilities and coordinate this design activity with the conceptual design of the repository underground facilities and repository-equipment development activities.

PLANNING AND SCHEDULING ACCOUNT STATUS

DIM 36 was issued to BN1 to prepare and review general arrangement drawings in support of Pre-ACD Study I.A.4, "Impact of Waste Characteristics and Receipt Rates on Repository and WP Design." Work on this activity is to be started on or about May 1, 1988.

Status of reports being written for this WBS are as follows:

SLTR 87-7015 "Evaluation of the Impact of the Revised Mission Plan on the Tuff Repository Surface Facilities" is in management review.

SAND87-7082 "Potential Drop of Cask, Container, and Fuel Assembly During Waste-Handling Operations" is being reviewed by the SNL Transportation Systems Development and Testing Division, Organization 6323.

SAND88-7051 "Probable Maximum Flood (PMF) Control Study" is being editorially reviewed and corrected in preparation for management review.

SLTR 88-7002 "Ventilation System Investigation for the Tuff Repository Surface Facilities" has been peer reviewed and requires technical and editorial correction prior to management review.

The work plan for this WBS element is being updated.

PLANNED WORK

Work for DIM 36 will continue through this fiscal year and into next year. The work plan update is expected to be completed during May 1988.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
		No FY88 milestones are defined	

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1.2.4.3.3 Shaft/Ramps (1561.430) (R. E. Stinebaugh)

The Shaft/Ramps task will establish shaft and ramp design criteria using the engineering studies and design guidelines completed to date and will supply input for use in preparing a conceptual design for a Yucca Mountain repository.

PLANNING AND SCHEDULING ACCOUNT STATUS

The report documenting the selection of the methods for underground facility access and egress for the repository is being prepared. This report will provide the basis for the recommendation of a shaft for personnel and material access and a ramp for waste haulage.

Editorial and final peer review comments were received on SAND88-7052, "A Concrete Shaft Liner Design Criteria and Methodology Guide," by R. Stinebaugh (SNL) and A. Richardson (PBQ&D). Resolution of the comments is scheduled for May 5th.

A parametric analysis examining the impact of a varying seismic load on the design and performance of the repository shafts was initiated. This report will evaluate the impact of acceleration loads varying from 0.3 to 1.0 g. This work will be completed by May 31.

PLANNED WORK

SAND88-7052 will be available for management review by May 15th and for WMPO policy review by May 31st. The report on Access and Egress methods and the parametric study impact of seismic events on the exploratory shafts will be completed.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILESTONE	DUE DATE	DESCRIPTION	STATUS

Milestones are being redefined

1.2.4.3.4 Underground Excavations (1561.440) (R. E. Stinebaugh)

The Underground Excavations task will prepare a conceptual design for the repository subsurface excavations and will coordinate this design activity with other repository conceptual-design activities.

PLANNING AND SCHEDULING ACCOUNT STATUS

A report was prepared for presentation at the next Interface Control Working Group meeting on May 2nd in Las Vegas, NV regarding the impact of the new geological picks for the top of the TSw2 formation on the design of the repository. The report will provide the basis for the new picks, the potential impact on the repository, and recommendations for future work. The work completed to this point includes an assessment of the potential for decreasing the grades in the waste emplacement drifts to grades that will allow the use of rail equipment.

Numerous mines were identified that may be geologically similar to the repository. The mines are being screened to select those warranting further investigation and a possible on-site examination.

Staff from SNL and PBQ&D toured the "N" tunnel complex at the NTS to observe the damage to underground facilities and structures resulting from UNEs. Findings will be used in the planned report on the potential impact of UNEs on the repository at Yucca Mountain.

The first draft of the repository underground contingency plan was completed. This report describes means proposed for dealing with bad ground and geological structures.

PLANNED WORK

The contingency plan for the underground repository facilities will be completed.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
T089	10/30/87	Report on retrievability compliance strategy; precursor to R848	Delayed; estimated completion 05/30/88
T145	12/15/87	Incorporate comments from NVO/WMPO into the retrievability compliance strategy document; precursor to R848	Delayed; estimated completion 06/30/88

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
P129	04/30/87	Report entitled "Report on the Welded Tuff Mining Demonstration Performed at the G-Tunnel Facility on the NTS," SAND86-7009	To be deleted; work to be incorporated in Milestone M434

1.2.4.6.1 Repository Performance Code Development/Certification (1561.750)
(S. J. Bauer)

In this subtask, material models which are intended to approximate the rock mass response to thermomechanical loading are developed, verified, validated, and evaluated.

PLANNING AND SCHEDULING ACCOUNT STATUS

Work continued on the Preliminary Benchmark Problem (PDM 71-032). Results from the thermal analysis portion of the exercise have been received from all participants and processed for comparison. The comparisons show very good agreement among the results from the three finite elements thermal codes. SAND88-1221, "NNWSI Thermal and Mechanical Codes First Benchmark Exercise, Part I: Thermal Analysis," by L. S. Costin and S. J. Bauer, was written and submitted for technical review. Results from the second phase of the exercise were received from all participants and are being processed for comparison. This second phase is a thermomechanical analysis of the benchmark drift geometry using the thermal analysis completed under the first phase of the exercise as input and using a linear elastic rock-mass model.

An effort is underway to complete the forms and collect the documentation available for all thermal and mechanical codes to be used for QA Level I and II analyses in the near future. These codes will be entered into the configuration management system specified by DOP 3-2. Codes being used in the current benchmark exercise will be the first entered into the system. The Software Category Forms for each of these codes were completed and submitted to the software coordinator so that record files for each code can be opened.

A preliminary investigation into the use of bench or laboratory scale experiments as a tool for model validation is in progress. A literature search is being conducted to examine the types of laboratory scale experiments performed to examine the response of jointed rock masses. One such experiment reported in some detail used small cubes of plaster to form a larger jointed block. The jointed blocks were then tested in compression with varying degrees of lateral confinement and with different orientations of joints with respect to the major loading axis. A series of analyses is being performed using the compliant-joint rock mass model to simulate the response of the jointed blocks of plaster in these experiments. Data from compression tests on unjointed plaster and tests on jointed blocks with 90° and 45° joint orientations were used to determine a set of model parameters for the compliant-joint model. Next the model will be used to predict the results of tests on jointed blocks with 15° and 30° joint orientations and with different confining pressures. Calculations with 30° joints are in progress. At low confining pressure (200 psi), displacement on the joints is large enough to cause problems with solution convergence. Analyses at higher confining pressures (up to 2000 psi) will be run in order to determine whether the model predictions agree with experimental data and to determine the conditions under which the code/model fails to converge to a solution.

Analyses in support of the Yucca Mountain heated room experiment, proposed for the Exploratory Shaft Facility, are in progress. Four sets of thermomechanical analyses are being completed. Results from these analyses will be used in completing the design for the proposed experiment.

Outlines for SAND87-7071, "User's Manual for SPECTROM-31," by S. Key and D. Labreche (RE/SPEC), and SAND88-7058, "Description, Verification, and User's Guide of SPECTROM-349: A Three-Dimensional Linear Superpositive, Heat-Conductive Computer Program," by S. J. Bauer (SNL) and D. Svalstad (RE/SPEC), have been submitted for management review.

PLANNED WORK

The results from the thermoelastic analysis portion of the benchmark exercise will be processed and a preliminary result memo will be issued to the participants. Participants will review the results; this phase of the benchmark exercise will then be documented in a SAND report.

Work will continue on the bench-scale experiment calculations.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
T152	09/15/87	Report entitled "The Joint Empirical Model--An Equivalent Continuum Model for Jointed Rock Masses," SAND87-7072	Delayed; estimated completion 06/88

1.2.4.6.2 Design Analysis (1561.760) (B. L. Ehgartner)

The Design Analysis subtask establishes the analytical 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 underground openings, and (3) the establishment of design parameters that are criteria for design of the layout and underground openings.

PLANNING AND SCHEDULING ACCOUNT STATUS

A draft SLTR report, "An Assessment of the Design Loads on the ESF Excavation Openings for Title I Design," was received from LATA and reviewed. The report was restructured and a heavier reliance on existing text from the SCP-CD report (specifically analyses synopsis) was recommended.

DIMs 147, "Case History Evaluations," and 148, "Empirical Analyses of Opening Stability," were revised following supervisory review comments and resubmitted for approval. DIM 149, "Access Analyses," was drafted and submitted for approval. All three DIMs are related to the ESF analysis effort.

"Addition of a Finite Cylinder Heat Source to SPECTROM 349" was submitted to RE/SPEC. This code enhancement will be documented as part of SAND88-7058. (See WBS 1.2.4.6.1.) A task entitled "Documentation of the SHAFT Code" was submitted to Agapito and Assoc. The code and draft documentation was developed for the Salt Repository Program. This task will certify the code and document it as a SAND report.

A logic diagram for Issue 1.11 (Postclosure Design) was developed that networked milestones for each information need of the Issue.

Annotation was developed for each outline section of the SAND report "Preliminary Drift Design Methodology" and submitted for review to the authoring participants. The analyses for PDM 75-13 entitled "Three-Dimensional Far-Field Analyses for the Exploratory Shaft Facility," were completed. Results are being documented in an SLTR.

PLANNED WORK

The major emphasis of work will be on the ESF analyses and related activities, SCP revisions, the work plan, and QALAS.

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NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
M414	09/30/87	Report entitled "A Thermomechanical Far-Field Model of Yucca Mountain," SAND85-7101	Delayed; in peer review; estimated completion 06/01/88

1.2.4.6.3 Preclosure Safety Analysis (1561.770) (T. Laub)

The Preclosure Safety Analysis task consists of the analysis and assessment of the radiological safety of the repository and the activities conducted there during the period that begins with the start of construction and ends with the completion of closure and decommissioning. Results obtained and information developed under this task will provide a basis for developing and updating the baseline requirements for the Yucca Mountain Mined Geologic Disposal System; the information will become input to the Safety Analysis Report for the License Application to the NRC.

PLANNING AND SCHEDULING ACCOUNT STATUS

SLTR87-7013, "Preclosure Radiological Safety Analysis for Normal Conditions of the Yucca Mountain Repository," by T. Laub (SNL) and L. Jardine (BNI), was printed, completing Milestone P159.

Staff attended three SCP Completion Working Group 5 meetings in Las Vegas, NV.

SLTR87-7007, "Preliminary Yucca Mountain Criticality Safety Study," by C. Subramanian (SNL) and L. Jardine (BNI), is being printed. SAND88-7061, "Preclosure Radiological Safety Analysis for Accident Conditions of the Yucca Mountain Repository: Underground Facilities," by T. Laub (SNL) and L. Jardine (BNI), is awaiting peer review and was delayed by staff commitments to SCP Completion activities. A paper for the American Nuclear Society meeting in June, SAND88-0292C, "Assessment of Worker and Non-Worker Radiological Safety of a Repository," by T. Laub (SNL) is undergoing editorial changes before peer review.

Work with DOE-HQ on preparing the Petition for Rulemaking continued. Reviews of the work plan, the PRAM Procedures Guide, and QA Level assignments were delayed by SCP activities.

Work on the Aircraft Crash Consequences report by the T.T.C. and BNI continued.

PLANNED WORK

The draft "Aircraft Crash Consequences" report will be completed and the review of PRAM Procedures Guide will begin. The review of SAND88-7061 will continue, and staff commitments to SCP Completion Activities will continue. Revision of the work plan will be completed.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
P159	09/30/87	Letter report entitled "Preclosure Radiological Safety Analysis for Normal Conditions of the Yucca Mountain Repository," SLTR87-7013	Completed 04/25/88
P160	09/30/87	Report entitled "Preclosure Radiological Safety Analysis for Accident Conditions of the Yucca Mountain Repository: Underground Facilities," SAND88-7061	In peer review; estimated completion 06/15/88

1.2.1.3.1 Site and Engineering Properties Data Base (1561.110)
(C. A. Rautman)

The Site and Engineering Properties Data Base (SEPDB) task will provide a controlled data base that will be used in the design and in the performance assessments needed for licensing a mined geologic disposal system at Yucca Mountain.

PLANNING AND SCHEDULING ACCOUNT STATUS

Development of the SEPDB continued. Data transferred to INGRES data structures is tabulated in Appendix B. Also, a draft Administrative Procedure (AP 5.2Q) was prepared for Project comment and discussion, and a new work plan was started for this WBS element.

Development of the "dual table" storage format for parameters requiring summary information supported by detailed back-up was completed. Water chemistry data stored in this format can be converted to water chemistry tabulations suitable for publication. Specialized reporting software was developed for this conversion.

Staff delivered a detailed presentation on the workings, design, and structure of the SEPDB to the Technical Data Advisory Group (TDAG). Implications of several common data problems, such as disparate units of measure, missing test conditions, and mixed numeric and alphabetic data, were discussed.

SNL-generated rock properties data were extracted from the abandoned Tuff Data Base and transferred to the interim SEPDB environment of RS/1. As new data submittals are received, the interim SEPDB will be checked to ensure all previous data are either authorized or formally discarded for cause. The same data-checking process will be followed for USGS- and LANL-originated data. Once this information has been extracted, the Tuff Data Base will cease to exist.

PLANNED WORK

Data entry and transfer will continue. The new work plan for this element will be completed.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
M297	06/01/87	Letter Report to NVO/WMPO summarizing the technical Data Base plan for the Site and Engineering Properties Data Base	Completed 02/15/88

1.2.1.4.1 Flow and Radionuclide Transport (1561.210) (P. G. Kaplan)

The Flow and Radionuclide Transport task will evaluate the natural hydrologic and geochemical features along flow paths from the prospective mined geologic disposal system at Yucca Mountain to determine their contributions to the performance of the overall system. This task will provide the information necessary to define the appropriate ranges of site conditions to be considered in assessing potential radionuclide releases to the accessible environment.

PLANNING AND SCHEDULING ACCOUNT STATUS

Publication of SAND87-7070, "Hydrologic Modeling of Vertical and Lateral Movement of Partially Unsaturated Fluid Flow Near a Fault Zone at Yucca Mountain," by J. Wang and T. N. Narasimhan of LBL was delayed until figures are revised. Draft copies of SAND88-7054, "Processes, Mechanisms, and Parameters Governing Partially Saturated Flow in Soil and Rock Medium," by J. Wang and T. N. Narasimhan of LBL were held, prior to final review, until the authors provide missing sections. Documentation of the code LLUVIA in SAND88-0558, "LLUVIA - A One-Dimensional, Steady-State Program for Flow Through Partially Saturated Porous Media," by P. Hopkins and R. Eaton of SNL, and SAND88-0580, "Estimating the Probability Density Functions of the Hydraulic Parameters of the Calico Hills Tuff Using the Beta Probability Function," by P. Kaplan and L. Yarrington of SNL entered the review process.

Staff participated in the working groups formed to review and cost the Consultation Draft of the Site Characterization Plan and training of new staff in the application of RS/1 software continued.

The steady-state base cases and one-dimensional transient base cases of HYDROCOIN Level 3 Case 2 were run using the method-of-lines (MOL) code. The code was modified to write a standard plot file that could be post-processed using the plot package TRINITY. Travel times were computed using the particle-tracking capability of TRINITY. (See WBS 1.2.1.3.2.) The latest extension of HYDROCOIN Level 3 Case 7 was run by reversing the relative magnitudes of hydraulic conductivity between the inclusion and surrounding medium. All three grids were repeated using both analytical velocities and the computed solution. Error measures were computed.

An exact, analytical solution for the one-dimensional, steady-state, Richard's equation using the Brooks-Corey form of the relative permeability was obtained. The solution satisfied the boundary condition on the pressure head at the bottom of each layer to which it was applied. This solution allows a simple, algebraic evaluation of the pressure head and saturation without approximating assumptions.

Staff ran several new two-dimensional flow analyses for the unsaturated zone sensitivity analyses of HYDROCOIN Level 3 Case 2. As a result of these analyses, a problem was found and corrected in the method used to calculate flow velocities in the two-dimensional finite-element flow code NORIA. Flow

velocities were being calculated at the Gauss points within the elements and then extrapolated to the nodes at the element corners. The extrapolation used linear functions to represent the variation of velocity across the elements. When the velocity at the Gauss point was very close to zero and to the corner node sometimes resulted in a velocity that was close to zero (as it should be) but that had the wrong sign. This error caused problems for the particle-tracking algorithm in TRINITY. The flow code NORIA was modified so that velocities are now calculated directly at the corner nodes and no extrapolations are required. The calculated velocity fields are now smoother and the resulting particle trajectories and travel times are more accurate.

A procedure was developed to extract groundwater travel times between arbitrarily chosen surfaces using the particle-tracking results from TRINITY.

Staff attended the Alternate Conceptual Models of the Groundwater System at Yucca Mountain meeting the Las Vegas, NV.

Staff continued familiarization with the thermocouple psychrometer including calibration of the device. Work entailed obtaining additional salts for standard solution preparation and the design and creation of PC RS/1 models that will be used to calculate the required weights of salts to prepare predetermined modal solutions for high water potential standards; allow systematic data entry for determination of the psychrometer constant based on measurements of the standard solutions; and, facilitate systematic data entry and automatic calculations of water activities/potentials of material samples with results organized in tables for ease of review and display as wetting/drying curves.

Staff started a new Work Plan.

The PUMP code for well tests is being rewritten for the case of recovery to avoid certain instabilities in the calculation which generate singularities. The rewrite allows the number of well tests in certain fractured porous media to be reduced to supply hydraulic parameters and model information for performance assessment.

Staff participated in the review of a document by J. Szymanski. A review comment document was prepared and is in final review by the contributors.

PLANNED WORK

Efforts to document recent accomplishments will continue. Participation on the SCPCD working group will continue. The Work Plan will be completed.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
M034	09/30/87	Report entitled "Hydrologic Modeling of Vertical and Lateral Movement of Partially Unsaturated Fluid Flow Near a Fault Zone at Yucca Mountain," SAND87-7070	Completed 11/27/87
M133	01/20/88	Problem Definition Memo for COVE2A Benchmarking Problem for Isothermal Flow	Completed 03/04/88

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DISCLAIMER

Quality assurance checks on data contained in this report have been performed only to determine that the data have been obtained and documented properly. The SNL NNWSI Project Department cautions that any information is preliminary and subject to change as further analyses are performed or as an enlarged and perhaps more representative data base is accumulated. These data and interpretations should be used accordingly. Milestones have not been baselined and are included only to show status.

1.2.1.3.1 Site and Engineering Properties Data Base (1561.110)
(C. A. Rautman)

The Site and Engineering Properties Data Base (SEPDB) task will provide a controlled data base that will be used in the design and in the performance assessments needed for licensing a mined geologic disposal system at Yucca Mountain.

PLANNING AND SCHEDULING ACCOUNT STATUS

Data entry and verification work continued.

Work continued on rewriting the work plan for this element.

PLANNED WORK

Data entry and verification of previously received submittals will continue. The work plan will be completed.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
M297	06/01/87	Letter Report to NVO/WMPO summarizing the technical Data Base plan for the Site and Engineering Properties Data Base	Completed 02/15/88
R090	08/20/88	Submit Status Report of Contents and Capabilities of SEPDB to NVO/WMPO	On schedule

1.2.1.3.3 Reference Information Base (1561.160) (J. Schelling)

The Reference Information Base (RIB) task will provide a controlled data base that will serve as a common source for technical information to be used in developmental analyses and Project documents. The objective of the task is to ensure that all investigators within the NNWSI program are using internally consistent technical data in their activities.

PLANNING AND SCHEDULING ACCOUNT STATUS

Six RIB Development Request (RIBDR) packages were essentially completed and will be submitted to the TSAG for approval for submission to the technical baseline. Four other RIBDRs were distributed for review and four are under development.

Seven RIB Change Requests (RIBCRs), used to initiate consideration of changes to the RIB, were prepared for discussion at the June TSAG meeting.

The work plan for this element was rewritten and reviewed. Changes in Quality Assurance Level Assignments from a level of "1" to "None" were proposed for tasks concerned with development, administration, and production of the RIB.

SNL review comments on the draft NNWSI Technical Data and Information Management System (TDIMS) Plan and associated draft Administrative Procedures were compiled and submitted to NVO/WMPO. Due to the number and nature of the comments on the TDIMS Plan, an alternative draft plan was also prepared and submitted for comment to NVO/WMPO.

PLANNED WORK

Efforts will be directed toward completing open RIB Development Requests, establishing necessary elements of the TDIMS, and preparing a RIB update set for controlled distribution.

PROBLEM AREAS

Delays in providing source information and returning RIBCR Evaluations are delaying production of the updated RIB.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
M763	05/15/87	Incorporate NVO/WMPO and TPO comments into annual version of Reference Information Base	Completed 12/18/87
P230	01/06/88	RIB Baselined	Completed 01/30/88
R094	06/15/88	Submit Annual Report on the RIB to NVO/WMPO	On schedule

<u>1.2.1.4.1 Flow and Radionuclide Transport (1561.210)</u> (P. G. Kaplan)

The Flow and Radionuclide Transport task will evaluate the natural hydrologic and geochemical features along flow paths from the prospective mined geologic disposal system at Yucca Mountain to determine their contributions to the performance of the overall system. This task will provide the information necessary to define the appropriate ranges of site conditions to be considered in assessing potential radionuclide releases to the accessible environment.

PLANNING AND SCHEDULING ACCOUNT STATUS

Publication of SAND87-7070, "Hydrologic Modeling of Vertical and Lateral Movement of Partially Unsaturated Fluid Flow Near a Fault Zone at Yucca Mountain," by J. Wang and T. N. Narasimhan (LBL) was delayed while figures were revised.

Draft copies of SAND88-7054, "Processes, Mechanisms, and Parameters Governing Partially Saturated Flow in Soil and Rock Medium," by J. Wang and T. N. Narasimhan (LBL) were held prior to final review until the authors forward missing sections.

Two SAND reports were submitted for peer review: SAND88-0558, "LLUVIA - A One-Dimensional, Steady-State Program for Flow Through Partially Saturated Porous Media," by P. Hopkins and R. Eaton, and SAND88-0580, "Estimating the Probability Density Functions of the Hydraulic Parameters of the Calico Hills Tuff Using the Beta Probability Function," by P. Kaplan and L. Yarrington.

Training of new staff in the application of RS/1 software continued. Factors that contribute to the accuracy of the thermocouple psychrometer were isolated, and staff assembled and checked out the operation of time-lapse video equipment that will be used to record the behavior of unsaturated flow models.

A presentation was made in Albuquerque, NM to the Technical Resource Group (TRG) on capabilities within the NNWSI Project to model flow and radionuclide transport in the unsaturated zone and on possible uses of modeling to support revisions to the EPA regulations for nuclear waste disposal (40 CFR Part 191). The TRG provides technical input to a DOE/HQ Steering Committee that was organized to provide guidance to the EPA. The EPA has been ordered by the courts to reconsider portions of 40 CFR Part 191 because of conflicts between it and EPA regulations promulgated under the Safe Drinking Water Act.

Changes to a preliminary list of alternative conceptual models for fluid flow in the saturated and unsaturated zones at Yucca Mountain were reviewed and proposed in support of SCP Working Group 7.

Final results were sent to the HYDROCOIN Project secretariate for Level 3, Case 7 of the international Hydrologic Code Intercomparison Project (HYDROCOIN). In the analyses for Level 3, Case 7, the accuracy of particle-tracking algorithms for fluid flow through porous media was investigated by comparing calculated results to analytical pathline solutions. The analyses were performed with the finite element code, SAGUARO.

Work on analyses of two-dimensional unsaturated flow for HYDROCOIN, Level 3, Case 2 continued. In this case, methods for sensitivity analysis are investigated for highly nonlinear, computationally intensive, groundwater-flow analyses for nuclear waste repositories.

PLANNED WORK

Efforts to document recent accomplishments will continue; revision of the work plan will also continue.

Psychrometer measurements on tuff samples and other materials will begin.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
M034	09/30/87	Report entitled "Hydrologic Modeling of Vertical and Lateral Movement of Partially Unsaturated Fluid Flow Near a Fault Zone at Yucca Mountain," SAND87-7070	Delayed; estimated completion 07/15/88
M133	01/20/88	Problem Definition Memo for COVE2A Benchmarking Problem for Isothermal Flow	Completed 03/04/88
P650	06/30/88	Report entitled "Processes, Mechanisms, and Parameters Governing Partially Saturated Flow in Soil and Rock Medium," SAND88-7054	On schedule

1.2.4.1.2 Basis for Design (1561.570) (R. R. Hill)

The Basis for Design task will produce the basic criteria and requirements, such as the Repository Design Requirements (RDR) document, for design activities. The RDR will provide a single-point focus to control the requirements and criteria for NNWSI Project designers.

PLANNING AND SCHEDULING ACCOUNT STATUS

Technical editing of the RDR continued. SR and RDR interfaces were resolved. The work plan for this WBS element was developed.

PLANNED WORK

Technical editing of the RDR will be completed prior to submittal for project review.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
P152	08/15/88	Incorporate comments from NVO/WMPO and TPOs into SAND85-0260; precursor to N433	On schedule
N546	09/30/88	Issue Reference Draft of the RDR for ACD	On schedule

1.2.4.2.1.1 Rock Mass Analysis (1561.710) (S. J. Bauer)

This subtask includes evaluation of intact and rock mass thermomechanical properties based on analysis of available laboratory and field experiments and finite element analyses.

PLANNING AND SCHEDULING ACCOUNT STATUS

SAND87-2699, "An Analysis of the G-Tunnel Heated Block Thermal-Mechanical Response Using a Compliant-Joint Rock Mass Model," by L. S. Costin and E. Chen, continued in management review.

Analyses of jointed rock response in the vicinity of flatjacks placed in thin slots cut in the walls or floors of drifts are continuing. Flatjacks may be used to measure in situ and thermal stresses during the proposed Thermal Stress Experiment. Two-dimensional finite element analyses are being run of both plan and elevation views of a flatjack being pressurized in a vertical slot located in the wall of a drift with an imposed horizontal in situ stress. Solutions were obtained using an elastic rock mass model, and solutions using the compliant-joint rock mass model are in progress.

SAND87-1575, "Preliminary Analyses of the Excavation Investigation Experiments Proposed for the Exploratory Shaft at Yucca Mountain, Nevada Test Site," by L. S. Costin and S. J. Bauer, and SAND88-0810, "Preliminary Analyses of the G-Tunnel Mining Evaluations Experiment," by R. Johnson and S. J. Bauer are being revised to incorporate peer review comments.

Work is in progress to revise the analyses used to estimate the dip and frequency of fractures in the rock mass from data obtained from five coreholes at Yucca Mountain, in support of the RIB. Work is also in progress to update the in situ stress portion of the RIB, in support of ES design activities.

Work plans were developed for this WBS element.

PLANNED WORK

Work will continue on the analysis of the flatjack cancellation method of measuring in situ and thermal stresses. Analyses will concentrate on determining the effect of joint stiffness and orientation on the measured stress.

Work to support the ESF is planned, including development of information for the RIB for use with ESF design activities and design performance analyses.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS

No FY88 milestones are defined

1.2.4.2.1.3 Laboratory Properties (1561.730) (F. B. Nimick)

The Laboratory Properties task will determine the bulk, thermal, and mechanical properties of tuff through laboratory measurements. These data are used to support thermal and mechanical analyses, to enhance the capability to predict the response of tuff to excavation of subsurface repository facilities, and to evaluate effects of heat released by the waste.

PLANNING AND SCHEDULING ACCOUNT STATUS

Revision B of EP-0002, entitled "Effects of Variable Environmental Conditions on Compressive Mechanical Properties-High Temperature/Low Strain Rate Experiments," was written and will be submitted for review the first week of June.

Work continued on statistical analysis of data for the ESF design process. The memos on thermal expansion and bulk properties were issued. The memo on mechanical data will be issued before June 10, 1988.

A report on the thermal conductivities of thermal/mechanical units TCw, PTn, TSw3, CHn1v, CHn2v, CHn1z, and CHn2z was written and will be submitted for peer review during the first week of June. Also, a data report on heat-capacity information was written and will be submitted for peer review during the first week of June.

Revision 0 of TP-91, entitled "Unconfined Compression Experiments at 22°C and a Strain Rate of 10^{-9} s^{-1}," was drafted and is being technically reviewed. Revision A of TP-65, entitled "Procedure for Drying Geologic Core Samples to Constant Weight," was approved and issued.

Procedure-development work for eventual QA Level 1 determination of saturated bulk density is approximately 50 percent completed. Nineteen samples of the various lithologies from Yucca Mountain as well as a non-porous material (Pyrex) are used in the work.

A data report summarizing bulk-property data gathered by SNL and its contractors over the last eight years was peer reviewed and is being revised for submittal to management review during the second week of June.

PLANNED WORK

Analysis of data for the ESF design process will be completed and the results will be submitted to the RIB. Study Plans 8.3.1.15.1.2, "Laboratory Thermal Expansion Testing," and 8.3.1.15.1.4, "Laboratory Mechanical Properties of Fractures," will be written.

CANDIDATE INFORMATION FOR THE SITE AND ENGINEERING PROPERTIES DATA BASE

Thermal conductivity data gathered by SNL and its contractors were submitted to the SEPDB.

CANDIDATE INFORMATION FOR THE REFERENCE INFORMATION BASE

Recommended thermal expansion and thermal conductivity values for nine thermal/mechanical units were submitted as a suggested revision to existing values in the RIB.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
P567	04/01/87	Study Plan entitled, "Laboratory Thermal Properties," SP 8.3.1.15.1.1	Completed 03/17/88
P568	04/01/87	Study Plan entitled, "Laboratory Mechanical Properties of Intact Rock," SP 8.3.1.15.1.3	Completed 02/08/88
P570	06/15/88	Study Plan entitled, "Laboratory Mechanical Properties of Fractures," SP 8.3.1.15.1.6	Delayed; estimated completion 09/15/88
P569	07/15/88	Study Plan entitled, "Laboratory Thermal Expansion Testing," SP 8.3.1.15.1.2	Delayed; estimated completion 10/15/88

1.2.4.3.2 Surface Facilities (1561.420) (H. R. MacDougall)

The Surface Facilities task will prepare a conceptual design for the repository surface facilities and coordinate this design activity with the conceptual design of the repository underground facilities and repository-equipment development activities.

PLANNING AND SCHEDULING ACCOUNT STATUS

After discussion with NVO/WMPO staff concerning interaction with transportation, the MRS, and the Waste Package Groups, discontinued work to DIM 36. Rev. 0 instruction was inappropriate due to uncertainties regarding the integration of associated activities. DIM 36 will be revised accordingly.

SLTR 87-7015 "Evaluation of the Impact of the Revised Mission Plan on the Tuff Repository Surface Facilities," SAND87-7082 "Potential Drop of Cask, Container, and Fuel Assembly During Waste-Handling Operations," SAND88-7051 "Probable Maximum Flood (PMF) Control Study," and SLTR 88-7002 "Ventilation System Investigation for the Tuff Repository Surface Facilities" continued to be revised.

Development work continued on the work plan for this element.

PLANNED WORK

Tasks in support of the present repository design are being formulated. These tasks will provide additional design detail for SCP-CDR completion.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILESTONE	DUE DATE	DESCRIPTION	STATUS
		No FY88 milestones are defined	

1.2.4.3.3 Shaft/Ramps (1561.430) (R. E. Stinebaugh)

The Shaft/Ramps task will establish shaft and ramp design criteria using the engineering studies and design guidelines completed to date and will supply input for use in preparing a conceptual design for a Yucca Mountain repository.

PLANNING AND SCHEDULING ACCOUNT STATUS

SAND88-7064, "Study of Alternative Methods to the Proposed Geological Repository in Tuff at Yucca Mountain, Nevada," by B. G. Lawrance (PBQ&D), was completed.

SAND88-7063, "Mined Materials Handling at the Prospective Repository in Tuff," by J. Kendall (PBQ&D), was completed.

Comments on SAND88-7052, "A Concrete Shaft Liner Design Criteria and Methodology Guide," by A. Richardson (PBQ&D) and C. St. John (Principia Mechanica) were resolved and required revisions were made. This report was sent to the non-SNL reviewers (T. Brekke of the University of California, Berkeley, C. St. John, M. Hardy of Agapito & Assoc., and R. Kennedy, Structural Mechanics Consulting) for concurrence.

Preliminary results of the parametric seismic loading analysis on the ESF shafts were completed. Results indicate shaft liners will survive, with only minor damage, a combination of geostatic, thermal, and seismic loading for seismic loads up to 1.0 g.

PLANNED WORK

Publication of SAND88-7064 is planned after editorial review in June.

Work will continue on the parametric seismic loading analysis on the ESF shafts.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
		No FY88 milestones are defined	

1.2.4.3.4 Underground Excavations (1561.440) (R. E. Stinebaugh)

The Underground Excavations task will prepare a conceptual design for the repository subsurface excavations and will coordinate this design activity with other repository conceptual-design activities.

PLANNING AND SCHEDULING ACCOUNT STATUS

Identification of candidate mines for comparison with the proposed underground openings at Yucca Mountain continued. A list of candidate mines is expected to be complete by the end of June. At that time, the owners of the mines selected will be contacted to determine if visits can be arranged.

The potential impact on repository design of the new "picks" for the top of the TSw2 formation was presented by M. Fowler (PBQ&D) and R. E. Stinebaugh (SNL) to the Interface Control Working Group (ICWG) at the May meeting in Las Vegas, NV.

PLANNED WORK

Plans will be developed for early repository construction using ESF mining support facilities and to provide support for continued testing in the ESF after ESF facilities are converted to repository use.

PROBLEM AREAS

To allow better placement of the repository within the candidate horizon (TsW2), additional site geological information is needed. Part of this information could be obtained by reevaluation of the currently available cores.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
		No FY88 milestones are defined.	

Retrievability milestones will be reported when WBS 1.2.4.6.5 is baselined.

1.2.4.3.5 Underground Service System (1561.450) (R. E. Stinebaugh)

The Underground Service System task will establish shop and warehouse designs and locations and will identify utility and general support requirements.

PLANNING AND SCHEDULING ACCOUNT STATUS

The documents needed for certifying the codes used to design the underground ventilation systems are being compiled. This certification package will be sent to SNL within the next month. The codes included are VNETPC and CLIMSIM.

PLANNED WORK

The certification package for ventilation systems design codes will be entered into the certification process as outlined in DOP 3-2.

Certification of computer codes used for underground ventilation design will continue.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
P017	01/30/88	Hoist Selection	Completed 03/17/88

1.2.4.6.1 Repository Performance Code Development/Certification (1561.750)
(S. J. Bauer)

In this subtask, material models which are intended to approximate the rock mass response to thermomechanical loading are developed, verified, validated, and evaluated.

PLANNING AND SCHEDULING ACCOUNT STATUS

Work continued on the Preliminary Benchmark Problem (Problem Definition Memo 71-032). Results from the thermoelastic analysis portion of the exercise have been received from all participants and processed for comparison. The comparisons show good agreement among the results from the three finite element thermal codes. A memo showing a comparison of results was sent to all participants. SAND88-1221, "NNWSI Thermal and Mechanical Codes First Benchmark Exercise, Part I: Thermal Analysis," by L. S. Costin and S. J. Bauer, was prepared to document the results of the thermoelastic analyses and submitted for technical review.

An effort is underway to complete information-gathering forms and collect documentation available for all thermal and mechanical codes to be used for QA level I or II analyses in the near future. These codes will be entered into the configuration management system specified by DOP 3-2. The codes being used in the current benchmark exercise will be entered into the system first.

A preliminary investigation into the use of bench or laboratory scale experiments as a tool for model validation is in progress. A series of analyses is being performed using the compliant-joint rock mass model to simulate the response of jointed blocks of plaster. Data from compression tests on unjointed plaster and tests on jointed blocks with 90-degree and 45-degree joint orientations were used to determine a set of model parameters for the compliant-joint model. Next, the model will be used to predict the results of tests on jointed blocks with 15-degree and 30-degree joint orientations and with different confining pressures. Calculations with 30-degree joints are in progress. At low confining pressure (200 psi), displacement on the joints is large enough to cause problems with solution convergence. Analyses at higher confining pressures (up to 2000 psi) will be run to determine whether the model predictions agree with experimental data and also to determine the conditions under which the code/model fails to converge to a solution.

Work plans were developed for this element.

Analyses in support of the Yucca Mountain Heated Room Experiment, proposed for the Exploratory Shaft Facility, are in progress. Four sets of thermomechanical analyses will be completed. Results from these analyses will be used in completing the design for the proposed experiment.

Outlines for SAND87-7071, "User's Manual for SPECTROM-31," by S. Key and D. Labreche (RE/SPEC), and SAND88-7058, "Description, Verification, and User's Guide of SPECTROM-349: A Three-Dimensional Linear Superpositive, Heat-Conductive Computer Program," by D. Svalstad (RE/SPEC), completed management review.

PLANNED WORK

Results from the jointed rock analysis portion of the benchmark exercise will be processed, and a memo documenting the preliminary results memo will be issued to the participants. After participants review the results, this phase of the benchmark exercise will be documented in a SAND report.

Work will continue on the bench-scale experiment calculations.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
T152	06/30/88	Report entitled "The Joint Empirical Model--An Equivalent Continuum Model for Jointed Rock Masses," SAND87-7072	On schedule
Y052	08/30/88	User's Manual and Guide for the HEFF Code	On schedule

1.2.4.6.2 Design Analysis (1561.760) (B. L. Ehgartner)

The Design Analysis subtask establishes the analytical 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 underground openings, and (3) the establishment of design parameters that are criteria for design of the layout and underground openings.

PLANNING AND SCHEDULING ACCOUNT STATUS

Work plans for this element were written and submitted for review.

"A Synopsis of Past Analyses (1981-87) Performed to Assess the Stability of Underground Excavations for a Repository at Yucca Mountain" (SLTR88-4002) was drafted and submitted for review. This report supports the Title I design of the ESF.

DIMs 133, 147, 148, and 149 were revised and reissued to PBQ&D. The revisions provide explicit traceability to current and future work plans.

To support Task 3 of Contract 57-0881, a new version of the ARRAYF conduction heat transfer code was supplied to RE/SPEC. This new version (NARY) has the ability to allow multiple exponentially decaying heat sources, horizontal and vertical emplacement panel array layouts, and interactive or batch modes for VMS 4.5 or the CTSS operating systems. In addition to supporting Task 3, the NARY code will be used to support several pre-ACD studies.

A draft SLTR, "Three-Dimensional Far-Field Analysis of the ESF," addressing the thermal loads imposed on the design of the ESF by the repository, and a draft SAND report, "Documentation and Verification of STRES3D," a thermoelastic code incorporating point, line, and plate heat sources, were written by Agapito and Associates and submitted for preliminary review.

Thermoelastic analysis of the thermal effects on rock bolts in horizontal and vertical emplacement drifts was completed by Agapito & Associates. The analysis assumed both fully bonded and point anchor bolts installed in the crown and sidewalls of the drifts.

PLANNED WORK

Work on the ESF analyses and related activities, allowable areal power density (APD) study, and report preparation will be emphasized.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
M414	06/01/88	Report entitled "A Thermomechanical Far-Field Model of Yucca Mountain," SAND85-7101	On schedule

1.2.4.6.3 Preclosure Safety Analysis (1561.770) (T. Laub)

The Preclosure Safety Analysis task consists of the analysis and assessment of the radiological safety of the repository and the activities conducted there during the period that begins with the start of construction and ends with the completion of closure and decommissioning. Results obtained and information developed under this task will provide a basis for developing and updating the baseline requirements for the Yucca Mountain Mined Geologic Disposal System; the information will become input to the Safety Analysis Report for the License Application to the NRC.

PLANNING AND SCHEDULING ACCOUNT STATUS

Staff participated in the high priority SCP Completion Working Group 5 task.

SAND88-0292 "Assessment of Radiological Safety for Workers and Surrounding Population of a Geologic Repository Under Normal Conditions" completed peer and line review and was submitted for NVO/WMPO approval.

SAND87-7020C, "Preliminary Preclosure Radiological Safety Analyses for Normal Operations of a Prospective Yucca Mountain Repository" for the SPECTRUM 88 Conference in September completed peer review and entered line review.

A draft work plan for this element was completed and is being reviewed.

Work continued on the Aircraft Crash Consequences Analyses.

PLANNED WORK

The work plan for this element will be completed.

Reviews of SAND88-7061 and PRAM Procedures Guide will begin.

SAND88-0292J will be presented at the ANS Conference and work will continue on DOE/HQ petition for rulemaking.

NETWORK ACTIVITIES/MILESTONE PROGRESS

MILE-STONE	DUE DATE	DESCRIPTION	STATUS
P159	06/30/88	Letter report entitled "Preclosure Radiological Safety Analysis for Normal Conditions of the Yucca Mountain Repository," SLTR87-7013	Completed
P160	06/30/88	Report entitled "Preclosure Radiological Safety Analysis for Accident Conditions of the Yucca Mountain Repository, Phase II"	On schedule

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APPROVALS (Signature and Date)

PI R.E. Stinebaugh 7/21/86
PQA Connie Chavez 7/21/86
Supervisor Joe R Tillerson 7/21/86
TPO Thomas O. Hunter 7/21/86
WMPO (PQM) James Blaylock 7/23/86
WMPO (Tech) [illegible] 7/23/86

Activity: D. General Service Systems

Task Description	QA Level	QA Criteria	Level Justification
D. Same as Activity	II	1-7, 15-18	QA Level II is assigned because determination of general service systems for ACD involves comparative technical analysis of alternatives. (Step

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Activity: C. Underground Instrumentation Systems

Task: C. Same as Activity PI R. E. Stinebaugh

QA Criterion	Applies	Does Not Apply	Comments
1. QA Organization	X		
2. QA Program	X		
3. Design & Scientific Investigation Control	X		Design control and verification 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		

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SNL-QA-00

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Activity: C. Underground Instrumentation Systems

Task Description	QA Level	QA Criteria	Level Justification
C. Same as Activity	II	1-7, 15-18	QA Level II is assigned because design of instrumentation systems for ACD involves comparative technical analysis of alternatives. (Step 1C

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Activity: B. Utility Requirements

Task: B. Same as Activity. PI R. E. Stinebaugh

QA Criterion	Applies	Does Not Apply	Comments
1. QA Organization	X		
2. QA Program	X		
3. Design & Scientific Investigation Control	X		Design control and verification 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		

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QALAS No. 078
Rev. B

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TPO Thomas [signature] 7/21/86

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Activity: B. Utility Requirements

Task Description	QA Level	QA Criteria	Level Justification
B. Same as Activity	II	1-7, 15-18	QA Level II is assigned because determination of utility requirements for ACD involves comparative technical analysis of alternatives. (Step]

QUALITY LEVEL ASSIGNMENT CRITERIA SHEET

WP No. 12435-86 QALAS No. 077
Rev. B Rev. B

Activity: A. Ventilation Systems

Task: A. Same as Activity PI R. E. Stinebaugh

QA Criterion	Applies	Does Not Apply	Comments
1. QA Organization	X		
2. QA Program	X		
3. Design & Scientific Investigation Control	X		Design control and verification 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-0C

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APPROVALS (Signature and Date)

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Activity: A. Ventilation Systems

Task Description	QA Level	QA Criteria	Level Justification
A. Same as Activity	II	1-7, 15-18	QA Level II is assigned because design of ventilation systems for ACD involves comparative technical analysis of alternatives. (Step 10)

Milestone Number	Description and Criteria	Completion Date
P411	Present Underground Ventilation Design Concepts to DOE/NVO	09/01/87
P412	Present Waste Emplacement Support Engineering Concepts to DOE/NVO	03/01/87
R289	Issue Report on the Impact of In-situ Radon on the Design of Repository	09/01/87

12. Cost

Costs are in thousands of expenditure-year dollars.

FY86

SNL Labor Costs: $24 Other Costs: $204

FY87

SNL Labor Costs: $37 Other Costs: $472

FY88

SNL Labor Costs: $38 Other Costs: $233

FY89

SNL Labor Costs: $40 Other Costs: $742

13. Performance Measurements

Percent complete.

FY87

Finalization of the advanced design of the underground support systems. Design will be part of the final conceptual design and will be used as input by the DOE in the selection of a License Application Design A-E. Designs will be supported by detailed analysis.

Establish interactions between the underground support and service systems to the repository performance confirmation plan.

Complete inputs to the ventilation system design.

Complete studies for a report on assessing the impact of in-situ radon on the design of the repository.

FY89

Initiate License Application Design.

FY90

Continue License Application Design.

11. Milestones and Deliverables

Milestone Number	Description and Criteria	Completion Date
R064	Advanced Conceptual Design Review (also shown on 1.2.4.1.1)	09/30/86
R288	Issue Report on the Cooling of Emplacement Drifts to Allow Reentry for Inspection, Repair and Retrieval	09/01/87
P009	SAND Report on Mining and Material Handling Methods	07/31/87
P013	SAND Report on Design and Analysis of a Ventilation System for a Repository in Tuff	07/31/87
P017	Hoist Selection Tradeoff Study	07/31/87

7. Quality Assurance Requirements

A. Quality Assurance Level Assignments

Quality Assurance Level I: None.
Quality Assurance Level II: Tasks A, B, C, & D.
Quality Assurance Level III: None

8. Application of Results

The results of the efforts of this WBS element will become part of the repository advanced conceptual design. Results will be used for system evaluation, cost determination, and operational studies.

9. Schedule

Work on this WBS element will be completed in 1990.

10. Past and Expected Achievements

A. Past Achievements

(1) Preliminary estimates have been made for the quantities of water, electricity, and ventilation needed to support underground operations; (2) support facilities such as shops and warehouses have been designed for the underground; (3) ventilation criteria have been developed; (4) the method for mining and handling of mined material has been selected; (5) basic cost factors have been derived for use in preparing cost estimates for underground construction and operation.

B. Expected Achievements

FY86

Completion of a position paper on fan reversibility.

Establish decommissioning requirements for the underground support facilities.

Definition of the status of the support facilities during the caretaker phase of repository operations.

Generation of criteria for the underground support systems.

Completion of analysis on forced cooling of emplacement drifts for reentry to inspect, maintain, and retrieve.

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

Task B. Utility Requirements

Data Needed - Operating schedule, crew sizes, underground equipment list, and maintenance requirements.
Sources of Data - SDR, equipment vendor data RIB.
Quality of Data - As defined in the Reference Information Base.

Materials Needed - N/A.
Sources of Data - N/A.
Quality of Data - N/A.

Task C. Underground Instrumentation Systems

Data Needed - Ventilation system requirements, safety requirements.
Source of Data - SDR, RIB, MSHA and NRC regulations.
Quality of Data - Quality level will be as assigned to the RIB.

Materials Needed - N/A.
Sources of Data - N/A.
Quality of Data - N/A.

Task D. General Service Systems

Date Needed - Maintenance requirements, crew sizes and schedules, equipment fleet size and type.
Source of Data - SDR, RIB repair and maintenance requirements supplied by equipment vendors.
Quality of Data - As defined in the Reference Information Base.

Materials Needed - N/A.
Sources of Data - N/A.
Quality of Data - N/A.

5. <u>Non-Standard Methods or Techniques</u>

None.

6. <u>Location of Work Performance</u>

Sandia National Laboratories, Albuquerque, NM.

Contractor: Parsons, Brinckerhoff, Quade and Douglas, Inc, San Francisco, CA

f. Documentation of Results: The results of this WBS will result in several letter reports. They will also be incorporated in the ACD.
g. Quality Assurance Level: II
h. Remarks: QA Level II is assigned because this task supports comparative technical analysis of alternatives for ACD.

D. General Service Systems

General service systems will be defined. These systems include underground shops and warehouses, emergency medical facilities, decontamination facilities, sanitation. The mined-material handling system is considered part of the general service systems under this WBS element.

a. Purpose: To determine and do advanced conceptual design on the general service systems.
b. Information Needs: 4.5, 4.9
c. Methods, Techniques, and Equipment: Conventional design and analysis techniques will be utilized.
d. Technique Procedures:
   Available Procedures - Widely accepted industrial standard procedures will be used. They are all in accordance with generally accepted engineering standards.
   Needed Procedures - None.
e. Computer Codes:
   Available Codes - There is little, if any, computer application in this task. There maybe some of such utility packages as Lotus 1-2-3 or industrial available conveyor analysis programs.
   Needed Codes: None.
f. Documentation of Results: The results of this WBS will result in severe letter reports. They will also be incorporated in the ACD.
g. Quality Assurance Level: II
h. Remarks: QA Level II is assigned because this task supports comparative technical analysis of alternatives for ACD.

4. Data and Materials Needed

Task A. Ventilation Systems

Data Needed - Air flow requirements, temperature constraints, heat sources, work temperature, resistors factors, work force levels, equipment lists, and safety requirements.
Source of Data - Reference Information Base (RIB), System Design Requirements (SDR), MSHA regulations, and mining industry standard reference data on ventilation.
Quality of Data - As defined in the Reference Information Base.

B. Utilities Requirements

Utilities necessary to support waste emplacement and construction are part of this task. Utilities include: water, air, electricity, and communications.

a. Purpose: To determine the utility requirements for the underground portions of the repository. To support Advanced Conceptual Design of the utility systems.
b. Information Needs: 4.5, 4.7.1, 4.9.1
c. Methods, Techniques, and Equipment: Conventional design and analysis techniques will be utilized.
d. Technique Procedures:
   Available Procedures - Widely accepted industrial standard procedures will be used. They are all in accordance with generally accepted engineering standards.
   Needed Procedures - None.
e. Computer Codes:
   Available Codes: There are a large number of commercially available computer codes to do design and analysis of water flow, compressed air, electrical, and communication. The exact code(s) have not been determined.
   Needed Codes - None.
f. Documentation of Results: The results of this WBS will result in several letter reports. They will also be incorporated in the ACD.
g. Quality Assurance Level: II
h. Remarks: QA Level II is assigned because this task supports comparative technical analysis of alternatives for ACD.

C. Underground Instrumentation Systems

Included in this task are the following: (1) air quality monitoring systems; (2) safety alarm system transducers; and (3) ventilation system controls.

a. Purpose: To determine and do advanced conceptual design of the instrumentation required for the important underground systems.
b. Information Needs: 4.3.3, 4.5.3, 4.7.3, 4.9
c. Methods, Techniques, and Equipment: Conventional design and analysis techniques will be utilized.
d. Technique Procedures:
   Available Procedures - Widely accepted industrial standard procedures will be used. They are all in accordance with generally accepted engineering standards.
   Needed Procedures - None.
e. Computer Codes:
   Available Codes - There is a wide variety of computer codes available to analyze systems instrumentation requirements. The exact codes are TBD.
   Needed Codes: None.

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 and other work in the project is addressed in the NNWSI System Engineering Plan Configuration Management Plan, Site Definition Report. This work will be incorporated in the Advance Conceptual Design (ACD).

2. <u>Principal Investigator</u>

R. E. Stinebaugh, Sandia National Laboratories (SNL), Albuquerque, NM.

3. <u>Statement of Work</u>

A. Ventilation System

This WBS includes the advanced conceptual design of the ventilation system for supporting underground mining and waste-disposal operations. Design will include the analysis of the system to ensure operator safety and containment. Designs presented will include the system modifications necessary to support caretaking, retrieval, and decommissioning.

a. Purpose: To perform and analyze Advanced Conceptual Design of the ventilation system for the underground portion of the repository.
b. Information Needs: 4.3.3, 4.7.1, 4.7.3, 4.9.1
c. Methods, Techniques, and Equipment: Conventional design and analysis of underground ventilation systems will be used.
d. Technique Procedures:
   Available Procedures - Widely accepted, industrial standard procedures will be used. They are all in accordance with generally accepted engineering standards.
   Needed Procedures - None.
e. Computer Codes:
   Available Codes - There are numerous computer codes available for the analysis of ventilation systems. This includes, but is not limited to, CLIMSIM, Penn State University Codes, Bureau of Mines Codes, and others. The exact code has not been determined at this time.
   Needed Computer Codes - None.
f. Documentation of Results: The results of this WBS will appear in a SAND report, the title of which is TBD. The results will also be incorporated in the advanced conceptual design (WBS 1.2.4.3.4).
g. Quality Assurance Level: II
h. Remarks: QA Level II is assigned because this task supports comparative technical analysis of alternatives for ACD.

WBS 1.2.4.3.5.S UNDERGROUND SERVICE SYSTEMS

1. Objective and Issues Addressed

A. Objective

This task will develop the advanced conceptual design of the various systems required to support the development and operation of the underground facilities of the repository. Systems included are: (1) the ventilation system, (2) the utility distribution system, (3) the operational monitoring system, and (4) the mined-material handling system.

B. Issues Addressed

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

1. This WBS will address the following Information Needs:

Issue 4.3 Are the repository design and operating procedures that ensure worker nonradiological health and safety adequately established to support resolution of the performance issues?
4.3.3 Design measures for avoiding or mitigating hazards to personnel.

Issue 4.5 Are the repository construction, operation, closure and decommissioning technologies adequately established to support resolution of the performance issues?
4.5.3 Potential impacts of surface conditions on design.

Issue 4.7 Do the data collected in order to describe the surface characteristics and conditions provide the information required by the performance and design issues?
4.7.1 Topographic characteristics of potential locations on surface facilities.
4.7.2 Soil and bedrock properties of potential locations of surface facilities
4.7.3 Local meteorological conditions at potential locations of surface facilities.

Issue 4.9 Do the data collected in order to describe the hydrologic characteristics and conditions provide the information required by the performance and design issues?
4.9.1 Flood recurrence intervals and levels at potential locations of surface facilities.
4.9.3 Groundwater conditions within and above the potential host rock.

MODIFIED WORK PLAN TO SUPPORT QUALITY ASSURANCE LEVEL ASSIGNMENTS

for

Sandia National Laboratories

NNWSI WBS ELEMENT 1.2.4.3.5.S

UNDERGROUND SERVICE SYSTEMS

Approvals (signature and date):

PI R.E. Stinebaugh 7/21/86

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Supervisor Jack Tillerson 7/21/86

TPO Thomas O. Hunter 7/21/86

WMPO (PQA) James Blaylock 7/23/86

WMPO (Tech) [illegible] 7/23/86

List of Activities and Tasks

A. Ventilation Systems

B. Utility Requirements

C. Underground Instrumentation Systems

D. General Service Systems

QUALITY LEVEL ASSIGNMENT CRITERIA SHEET

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QALAS No. 076
Rev. B

Activity: E. Design Coordination

Task: E. Same as Activity

PI R. E. Stinebaugh

QA Criterion	Applies	Does Not Apply	Comments
1. QA Organization	X		
2. QA Program	X		
3. Design & Scientific Investigation Control	X		Design control and verification 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-00

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APPROVALS (Signature and Date)

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Supervisor [signature] 7/21/86
TPO [signature] 7/21/86
WMPO (PQM) James Blaylock 7/23/86
WMPO (Tech) [signature] 7/23/86

Activity: E. Design Coordination

Task Description	QA Level	QA Criteria	Level Justification
E. Same as Activity	II	1-7, 15-18	QA Level II is assigned because the task involves comparative technical analysis of the design for underground layout of the repository. (Step 10)

QUALITY LEVEL ASSIGNMENT CRITERIA SHEET

WP No. 12434-86 QALAS No. 075
Rev. B Rev. B

Activity: D. Trade-off Studies

Task: D. Same as Activity PI R. E. Stinebaugh

QA Criterion	Applies	Does Not Apply	Comments
1. QA Organization	X		
2. QA Program	X		
3. Design & Scientific Investigation Control	X		Design control and verification 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-00

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Rev. B

QALAS No. 075
Rev. B
Page 1 of 1

APPROVALS (Signature and Date)

PI R.E. Stinebaugh 7/21/86

PQA Connie Chocas 7/21/86

Supervisor Jack Tillerson 7/21/86

TPO Thomas O. Hunter 7/21/86

WMPO (PQM) James Blaylock 7/23/86

WMPO (Tech) [illegible] 7/23/86

Activity: D. Trade-off Studies

Task Description	QA Level	QA Criteria	Level Justification
D. Same as Activity	II	1-7, 15-18	QA Level II is assigned because the task involves comparative technical analysis of the design for underground layout of the repository. (Step 10)

QUALITY LEVEL ASSIGNMENT CRITERIA SHEET

WP No. 12434-86 QALAS No. 074
Rev. B Rev. B

Activity: C. Flow Diagrams and Operational Studies

Task: C. Same as Activity PI R. E. Stinebaugh

QA Criterion	Applies	Does Not Apply	Comments
1. QA Organization	X		
2. QA Program	X		
3. Design & Scientific Investigation Control	X		Design control and verification 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-00

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QALAS No. 074
Rev. B
Page 1 of 1

APPROVALS (Signature and Date)

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TPO Thomas O. Hunter 7/21/86

WMPO (Tech) [illegible] 7/23/86

Activity: C. Flow Diagrams and Operational Plans

Task Description	QA Level	QA Criteria	Level Justification
C. Same as Activity	II	1-7, 15-18	QA Level II is assigned because the task involves comparative technical analysis of the design for underground layout of the repository. (Step 10)

QUALITY LEVEL ASSIGNMENT CRITERIA SHEET

WP No. 12434-86 QALAS No. 073
Rev. B Rev. B

Activity: B. Analysis of the Underground Layout Design

Task: B. Same as Activity PI R. E. Stinebaugh

QA Criterion	Applies	Does Not Apply	Comments
1. QA Organization	X		
2. QA Program	X		
3. Design & Scientific Investigation Control	X		Design control and verification 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-00:

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Rev. B

QALAS No. 073
Rev. B
Page 1 of 1

APPROVALS (Signature and Date)

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Supervisor [signature] 7/21/86

TPO Thomas O. Hunter 7/21/86

WMPO (PQM) James Blaylock 7/23/86

WMPO (Tech) [signature] 7/23/86

Activity: B. Analysis of the Underground Layout Design

Task Description	QA Level	QA Criteria	Level Justification
B. Same as Activity	II	1-7, 15-18	QA Level II is assigned because the task involves comparative technical analysis of the design for underground layout of the repository. (Step 10)

QUALITY LEVEL ASSIGNMENT CRITERIA SHEET

WP No. 12434-86 QALAS No. 072
Rev. B Rev. B

Activity: A. Design the Underground Layout for the Repository

Task: A. Same as Activity PI R. E. Stinebaugh

QA Criterion	Applies	Does Not Apply	Comments
1. QA Organization	X		
2. QA Program	X		
3. Design & Scientific Investigation Control	X		Design control and verification 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-00:

WP No. 12434-86
Rev. B

QALAS No. 072
Rev. B
Page 1 of 1

APPROVALS (Signature and Date)

PI R. E. Stinebaugh 7/21/86

PQA Connie Chorus

Supervisor Joe R Tillerson 7/21/86

TPO Thomas O. Hunter 7/21/86

WMPO (PQM) James Blaylock 7/23/86

WMPO (Tech) [illegible] 7/23/86

Activity: A. Design the Underground Layout for the Repository

Task Description	QA Level	QA Criteria	Level Justification
A. Same as Activity	II	1-7, 15-18	QA Level II is assigned because the task involves ACD design of the underground repository for technical analysis of alternatives. (Step 10)

R287 Issue underground construction contingency plan report for review 09/01/87

12. Costs

Costs are in thousands of expenditure-year dollars

FY86

SNL Labor Costs: $ 24 Other Costs: $567

FY87

SNL Labor Costs: $ 50 Other Costs: $568

FY88

SNL Labor Costs: $ 64 Other Costs: $447

FY89

SNL Labor Costs: $ 53 Other Costs: $559

13. Performance Measurement

Percent complete.

Establish the margins of safety to be used in the design of the underground facilities.

Develop, as part of a team effort, a performance confirmation plan for the repository. Effort will include the identification of passive and active systems for monitoring and the development of a basis for qualifying results obtained in the performance confirmation effort.

Participate in the development of a retrieval demonstration philosophy. This task will involve working with other program members to develop the rationale for retrieval demonstrations including the development of worst-case mine structural failures to be considered in the development of retrieval plans and demonstrations.

FY88

Issue the repository underground design to be used for guidance and criteria by the License Application A-E.

FY89

Initiate License Application Design

FY90

Continue License Application Design.

11. Milestones and Deliverables

Milestone Number	Description and Criteria	Completion Date
FY86		
R064	Advanced conceptual design review meeting (also shown on 1.2.4.1.1)	09/30/86
P129	Issue report on the welded tuff mining demonstration performed at the "G" tunnel facility on the Nevada Test Site	09/30/86
P130	Publish report on the effect of horizontal borehole length on underground emplacement costs	09/30/86
P008	Issue report on shaft, ramp, and underground openings design and construction methods	07/31/87
M476	Present underground layout and room design concepts to DOE/NVO	03/01/87

SAND83-7445	Subsurface Ventilation Requirements for Horizontal and Vertical Emplacement Methods at Yucca Mountain
SAND83-1261	Recommendation for a Second Access for Yucca Mountain Exploratory Shaft Facility
SAND84-7125	Effect of Variations in the Geologic Data Base on Mining at Yucca Mountain for NNWSI
SAND84-7200	Utilization of the Exploratory Shaft for the Test and Evaluation Facility and the Full Repository for NNWSI
SAND84-7205	Subsurface Repository Boundary Study for a Nuclear Waste Repository in Tuff--Subsurface Facility Conceptual Design
SAND83-7446	Conceptual Operations Report for a Repository at Yucca Mountain

B. Planned Achievements

FY86

Participate in the development of a decommissioning plan for all repositories. Participation will be limited to the underground portion of a repository.

Provide support in the generation of a definition of the facility status during the "caretaker phase" of the repository life.

Review of headquarters documents.

Evaluate design alternatives for the underground elements of the repository (tradeoff studies).

Finalize the underground design to support the Site Characterization Plan, including basis supporting analysis.

FY87

Preparation of a contingency plan for accommodating bad ground that may be encountered in the mining of the repository. Potential bad ground includes: brecchiated zones, faults, zones of excessive porosity.

Prepare report on seismic considerations for underground design of the potential repository at Yucca Mountain.

Prepare an underground operations plan covering the mining of the facility.

7. Quality Assurance Requirements

A. Quality Assurance Level Assignments

Quality Assurance Level I: None
Quality Assurance Level II: Tasks A, B, C, D, E
Quality Assurance Level III: None

8. Application of Results

Completion of the tasks outlined in this WBS will result in an advanced conceptual design for a repository in tuff. The design will be extensively detailed in areas important to safety and repository performance. Designs of items important to safety will be backed by documented analysis. Tradeoff studies will document alternatives chosen for the design. Coordination will assure that performance conformation, sealing, retrieval, and decommissioning are properly integrated in the advanced conceptual design.

9. Schedule

The efforts described under this WBS are phased to coincide with the major Design Phases and comprise a portion of the ACD.

10. Past and Expected Achievements

A. Past Achievements

Numerous designs for the underground layout of the repository have been completed. These designs have been subjected to a number of revisions resulting from changes in program goals. Current layouts reflect a revision to move the Exploratory Shaft Facility to the same horizon as the repository.

A basic ventilation scheme has been developed. This scheme appears workable and meets all the requirements pertaining to ventilation separation between construction and waste emplacement.

Preliminary layouts have been completed for the underground shops and service areas. These layouts also depict the method of dividing ventilation inputs and the means for distributing the underground work force.

A preliminary cost estimate for the underground portion of the repository has been completed. This cost estimate supports the conceptual design developed to support the Site Characterization Plan.

Reports written to this time are:

Source of Data - Reference Information Base (RIB), equipment specification, waste receipt schedules, MSHA and NRC regulations, Subsystem Design Requirements (SDR).
Quality of Data - As defined in the Reference Information Base.
Materials Needed - N/A
Source of Material - N/A
Quality of Material - N/A

Task C. Construct flow diagrams and operational plans.

Data Needed - Delivery schedule of waste, mining and emplacement equipment characteristics, projected equipment availability.
Source of Data - RIB, Published waste receipt schedule, Subsystem Design Requirement (SDR), equipment vendor operational and performance data.
Quality of Data - As defined in the Reference Information Base.
Materials Needed - N/A
Source of Material - N/A
Quality of Material - N/A

Task D Tradeoff studies

Data Needed - Equipment performance; waste delivery schedule; operating costs; repository development schedule
Sources of Data - SDR; RIB equipment performance data from vendors; costs from operating mines and NTS
Quality of Data - As defined in the Reference Information Base.
Materials Needed - N/A
Sources of Material - N/A
Quality of Material - N/A

Task E Design Coordination

Data Needed - Sealing, retrieval, decommissioning, surface facility design, elastic transporter characteristics and performance assessment requirements
Source of Data - SDR, RIB
Quality of Data - As defined in the Reference Information Base
Materials Needed - N/A
Sources of Material - N/A
Quality of Material - N/A

5. <u>Non-Standard Methods or Techniques</u>: None

6. <u>Location of Work Performance</u>

Work will be performed by Sandia National Laboratories with major support provided by the following contractors:

Parsons Brinckerhoff Quade & Douglas, Inc., San Francisco, CA

Los Alamos Technical Associates: Los Alamos, NM

E. Coordinate the design with other interfaces such as preclosure performance assessment, sealing, retrieval, and decommissioning.

a. Purpose: To coordinate with the other activities in the design and to assure that underground design efforts reflect related work being done by others.
b. Information Needs: 1.16, 4.5, 4.6, 4.9, 4.10
c. Methods, Techniques, and Equipment: Engineering coordination techniques will be used. No equipment will be required.
d. Technical Procedures - No technical procedures will be required
e. Computer Codes: - No computer codes, except word processing, will be required for this task
f. Documentation of Results: The results from this effort will be incorporated in reports, studies, and drawings from other WBSs.
g. Quality Assurance Level: II
h. Remarks: QA Level II is assigned because the principle purpose of this activity is to assure that the trade-off studies for the underground design are compatible with those for the surface facilities (and others) and that an appropriate ACD is produced.

4. Data and Materials Needed

Task A. Design the underground layout for the repository.

Data Needed - Characteristics of rock, waste, delivery schedules, mining and waste emplacement equipment characteristics, ventilation requirements, safety regulations.
Source of Data - Reference Information Base (RIB), equipment specification, waste receipt schedules, MSHA and NRC regulations, Subsystem Design Requirements (SDR).
Quality of Data - As defined in the Reference Information Base.
Materials Needed - N/A
Source of Material - N/A
Quality of Material - N/A

Task B. Perform the analysis necessary to support the design of the underground layout.

Data Needed - Characteristics of rock, waste, delivery schedules, mining and waste emplacement equipment characteristics, ventilation requirements, safety regulations.

e. Computer Codes:
   Available Computer Codes - Numerous computer codes are available and widely used, in the design of underground openings. The exact codes have not been determined at this time.
   Needed Computer Codes - None
f. Documentation of Results: A series of engineering drawings, sketches and reports will be created. There will be several letter reports and SAND reports. The exact title of the reports has not been determined at this time.
g. Quality Assurance Level: II
h. Remarks: QA Level II is assigned because the principle purpose of this task is to evaluate design alternatives as part of the ACD.

D. Perform trade-off studies to aid in selection of the most economical methods to perform required tasks.

a. Purpose: To compare practical alternatives in the design process and determine which should be used.
b. Information Needs: 1.16.1, 4.5.2, 4.5.4, 4.5.6, 4.6.2, 4.9.3, 4.10.2, 4.10.3
c. Methods, Techniques, and Equipment: Engineering design and analysis using industry-wide, generally accepted techniques.
d. Technical Procedures:
   Available Procedures - Standard engineering design and analysis procedures
   Needed Procedures - None
e. Computer Codes:
   Available Computer Codes - Numerous computer codes are available and widely used, in the design of underground openings. The exact codes have not been determined at this time.
   Needed Computer Codes - None
f. A series of letter reports, and possibly some SAND reports, will be created. The reports will include a few engineering drawings and sketches. The final titles of the reports have not been determined at this time.
g. Quality Assurance Level: II
h. Remarks: QA Level II is assigned because the principle purpose of this activity is to assure that the trade-off studies for the underground design are compatible with those for the surface facilities (and others) and that an appropriate ACD is produced.

B. Perform the analysis necessary to support the designs generated. Analysis will be directed to verifying feasibility, function, and safety.

a. Purpose: To analyze the underground design for constructability and stability.
b. Information Needs: 1.16.2, 1.16.3, 4.5.2, 4.5.4, 4.5.6, 4.5.11, 4.9.3, 4.10.1, 4.10.2, 4.10.3
c. Methods, Techniques, and Equipment: Engineering design and analysis using industry-wide, generally accepted techniques.
d. Technical Procedures:
   Available Procedures - Standard engineering design and analysis procedures
   Needed Procedures - None
e. Computer Codes:
   Available Computer Codes - Numerous computer codes are available and widely used in the design of underground openings. The exact codes have not been determined at this time.
   Needed Computer Codes - None.
f. Documentation of Results: A series of engineering drawings, sketches, and reports will be created. There will be several letter reports and SAND reports. The exact title of the reports has not been determined at this time.
g. Quality Assurance Level: II
h. Remarks: QA Level II is assigned because the principle purpose of this task is to analyze the design alternatives in support of the ACD.

C. Construct flow diagrams and operational plans to provide basis for sizing the facility, establishing personnel requirements, and setting equipment inventories.

a. Purpose: To determine the flow of waste material from the surface facility to the emplacement location to create operational plans in sufficient detail to allow for scheduling and staffing calculations.
b. Information Needs: 4.5.2, 4.5.4, 4.5.6, 4.6.2, 4.9.1, 4.9.3, 4.10.2, 4.10.3
c. Methods, Techniques, and Equipment: Engineering design and analysis using industry-wide, generally accepted techniques.
d. Technical Procedures:
   Available Procedures - Standard engineering design and analysis procedures
   Needed Procedures - None

C. Regulations and Requirements Addressed

Regulations and requirements addressed by the issues referenced in this WBS are cited in the NNWSI systems requirements document and the Subsystem Design Requirements.

2. Principal Investigator

R. E. Stinebaugh, Sandia National Laboratories (SNL), Albuquerque, NM

3. Statement of Work

A. Design the underground layout for the repository. Design will include all features and will be detailed to the extent necessary to perform functional, safety, and cost analysis.

a. Purpose: To determine a workable, usable, layout for the underground portion of the repository. This will include construction and emplacement development, ventilation, and incorporation of the ESF.

b. Information Needs: 1.16.1, 1.16.2, 1.16.3, 4.5.2, 4.5.4, 4.5.6, 4.5.11, 4.6.2, 4.9.3, 4.10.1, 4.10.2, 4.10.3

c. Methods, Techniques, and Equipment: Engineering design and analysis using industry-wide, generally accepted techniques.

d. Technical Procedures:
   Available Procedures - Standard engineering design and analysis procedures
   Needed Procedures - None

e. Computer Codes:
   Available Computer Codes - Numerous computer codes are available and widely used, in the design of underground openings. The exact codes have not been determined at this time.
   Needed Computer Codes - None

f. Documentation of Results: A series of engineering drawings, sketches and reports will be created. There will be several letter reports and SAND reports. The exact title of the reports has not been determined at this time.

g. Quality Assurance Level: II

h. Remarks: QA Level II is assigned because the principle purpose of this task is to evaluate design alternatives and select the reference design for the ACD.

1.16.3 Spatial distribution of ambient stress and thermal conditions

Issue 4.5 Are the repository construction, operation, closure and decommissioning technologies adequately established to support resolution of the performance issues?

4.5.2 Characteristics and quantities of waste and waste packages needed for design

4.5.4 Potential impacts of rock characteristics on design

4.5.6 Potential impacts of tectonic activity on design

4.5.11 Determination that the seals for shafts, drifts, and boreholes can be emplaced with reasonably available technology

Issue 4.6 Are the waste package and repository costs adequately established to support resolution of the performance issues?

4.6.2 Estimates of the cost of reference and alternative repository designs

Issue 4.9 Do the data collected in order to describe the hydrologic characteristics and conditions provide the information required by the performance and design issues?

4.9.1 Flood recurrence intervals and levels at potential locations of surface facilities

4.9.3 Groundwater conditions within and above the potential host rock

Issue 4.10 Do the data collected in order to describe the expected tectonic phenomena and igneous activity provide the information required by the performance and design issues?

4.10.1 Rates and magnitudes of potential igneous activity that could have an impact on the site

4.10.2 Potential fault movements at the site

4.10.3 Ground-motion at the site from potential man-made or natural seismic events

WBS 1.2.4.3.4.S UNDERGROUND EXCAVATION

1. Objective and Issues Addressed

A. Objective

The objective under this WBS is to develop the advanced conceptual design for the underground portion of the repository. This effort will include, or be a part of the following:

A master plan for the underground portion of the repository. This plan will detail all haulageways, ventilation drifts, and underground support facilities such as shops and warehouses. Plan will include sizes of the various drifts and rooms needed to support the activities required for waste emplacement. The layout of the various drifts required will be keyed to the orientation of the candidate geological horizon so the grades can be determined. Intersections of the shafts and ramps planned for material, personnel, and waste entry to the repository horizon will be designed as part of this task. The advanced conceptual design of the underground portion of the repository will be sufficient to allow construction and operational costs to be estimated.

Analyses to support the advanced conceptual designs presented. An example is analysis of the stability of the openings generated to support waste emplacement.

Material flow diagrams, ventilation flow diagrams, and development diagrams--both construction and waste emplacement.

Operational plans sufficient in detail to establish operational times and equipment needs.

Tradeoff studies on which mining method selection will be based.

B. Issues Addressed

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

Issue 1.16 Do the data collected in order to describe the present and expected rock characteristics provide the information required by the design and performance issues?

1.16.1 Stratigraphy and structure necessary to locate the underground facility .

1.16.2 Spatial distribution of thermal and mechanical properties

MODIFIED WORK PLAN TO SUPPORT

QUALITY ASSURANCE LEVEL ASSIGNMENTS

for

Sandia National Laboratories

NNWSI WBS ELEMENT 1.2.4.3.4.S

UNDERGROUND EXCAVATION

Approvals (signature and date):

PI R. E. Stinebaugh 7/21/86 PQA Connie Chocas 7/21/86

Supervisor Joe R. Tillerson 7/21/86 TPO Thomas O. Hunter 7/21/86

WMPO (PQA) James Blaylock 7/23/86 WMPO (Tech) [illegible] 7/23/86

__List of Activities and Tasks__

A. Design of the Underground Layout for the Repository

B. Analysis of the Underground Layout

C. Construction of Flow Diagrams and Operational Plans

D. Trade-off Studies

E. Design Coordination

12. Costs

Costs are in thousands of expenditure-year dollars.

FY86

SNL Labor Costs: $ 24 Other Costs: $522

FY87

SNL Labor Costs: $ 37 Other Costs: $371

FY88

SNL Labor Costs: $ 38 Other Costs: $342

FY89

SNL Labor Costs: $ 40 Other Costs: $342

13. Performance Measurement

Percent complete.

12. Costs

Costs are in thousands of expenditure-year dollars.

FY86

SNL Labor Costs: $ 24 Other Costs: $522

FY87

SNL Labor Costs: $ 37 Other Costs: $371

FY88

SNL Labor Costs: $ 38 Other Costs: $342

FY89

SNL Labor Costs: $ 40 Other Costs: $342

13. Performance Measurement

Percent complete.

FY87

Generate an operations plan for the repository underground. Plan will identify all system elements, operations, and capacities for the purpose of establishing staff requirements, equipment requirements, task times, operator exposures, and other items important to the operation of the repository.

Develop inputs to the report on "Seismic Considerations for Underground Construction at Yucca Mountain." Inputs by the WBS will concentrate on shafts and ramps.

FY88

Issue shaft and ramp designs to be used for guidance and criteria by the License Application Design A-E.

FY89

Initiate License Application Design.

FY90

Continue License Application Design.

11. Milestones and Deliverables

Milestone Number	Description and Criteria	Completion Date
FY86		
R064	Advanced conceptual design review meeting (also shown on 1.2.4.1.1)	09/30/86
FY87		
P008	SAND report on shaft, ramp, and underground openings design and construction methods (also shown on 1.2.4.3.4)	07/31/87
P410	Present waste ramp and ground support design concepts to DOE/NVO	03/01/87

9. Schedule

This work will be phased to match the design phases, ACD, LAD and FP&CD. This definition only covers the ACD phase.

10. Past and Expected Achievements

A. Past Achievements

The location and size of the access ramps and shaft have been determined. The following reports have been published or are in the final stages of review for publication:

SAND83-7068	Lining Considerations for a Circular Vertical Shaft in Generic Tuff
SAND83-7069	Preliminary Stability Analysis for the Exploratory Shaft at Yucca Mountain, Nevada
SAND83-7448	Repository Surface to Underground Access
SAND84-1261	Recommendation for a Second Access for the Yucca Mountain Exploratory Shaft Facility
SAND84-7123	The Effect of Variation in the Geologic Data Base on Mining at Yucca Mountain for NNWSI
SAND84-7200	The Utilization of the Exploratory Shaft for the Test and Evaluation Facility and the Full Repository for NNWSI

B. Expected Achievements

FY86

Refinement of the design analysis to support design presented in the Conceptual Design to support the Site Characterization Plan (SCP/CDR).

Finalize the shaft and ramp designs to be used in the SCP/CDR.

Participate in the development of a decommissioning plan. This WBS will concentrate on the decommissioning of shafts and ramps.

Develop position on the status of shafts and ramps during the caretaker phase of repository operations.

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. Tradeoff Studies

Data Needed - Repository design, equipment characteristics, economic constraints, operating costs, staffing levels, production rates, and emplacement schedule.

Source of Data - Subsystem Design Requirements, Reference Information Base, emplacement schedule studies, cost studies, equipment characteristics.

Quality of Data - As defined in the Reference Information Base.

5. Non-Standard Methods or Techniques

None

6. Location of Work Performance

Sandia National Laboratories, Albuquerque, NM

Contractor: Parsons Brinckerhoff Quade & Douglas, Inc., San Francisco, CA

7. Quality Assurance Levels

Quality Assurance Level Assignment

All tasks in this WBS have been assigned Quality Assurance Level II.

8. Application of Results

The conceptual design provided by this WBS element will be used by (1) subsurface excavation (WBS 2.4.3.4) to ensure that the access method selected is adequate to support the mining plan and the waste emplacement schedule, (2) underground service system (WBS 2.4.3.5) to ensure adequate allowance for the various utility and support systems, and (3) surface design (WBS 2.4.3.2) to ensure compatibility with the surface structures.

d. Technical Procedures:
   Available - N/A
   Needed - N/A

e. Computer Codes:
   Available Computer Codes - Standard industry computer codes are being used for opening analysis, hoisting capacity determination, and financial analysis.
   Needed Computer Codes - None

f. Documentation of Results: The results of this task will be documented in letter reports.

g. Quality Assurance Level: II

h. Remarks: QA Level II is assigned because this task supports comparative technical analysis of alternatives for ACD.

4. <u>Data and Materials Needed</u>

Task A. Access Design

Data Needed - Rock characteristics, waste emplacement schedules, equipment specification, safety requirements, and operating requirements.

Source of Data - Subsystem Design Requirements, Reference Information Base, emplacement schedule studies, equipment specification from vendors and, MSHA Regulations (30 CFR 60) and 10 CFR 60.

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. Analysis

Data Needed - Rock characteristics, waste emplacement schedules, equipment specification, safety requirements, and operating requirements.

Source of Data - Subsystem Design Requirements, Reference Information Base, emplacement schedule studies, equipment specification from vendors and, MSHA Regulations (30 CFR 60) and 10 CFR 60.

g. Quality Assurance Level: II

h. Remarks: QA Level II is assigned because this task supports comparative technical analysis of alternatives for ACD

B. Analysis

Design analysis will be performed on the ACD to verify that the access designs are safe and meet the long-term stability requirements imposed by retrieval.

a. Purpose: To analyze the access designs for the underground portion of the repository. This would include safety, stability, operational, and ventilation analysis.
b. Information Needs: 1.16.2, 1.16.3, 4.5.3, 4.5.4, 4.9.1, 4.9.3, 4.10.3
c. Methods, Techniques, and Equipment: Engineering analysis, design, review of existing operations, and trade off studies will be utilized.
d. Technical Procedures:
   Available - N/A
   Needed - N/A
e. Computer Codes:
   Available Computer Codes - Standard industry computer codes are being used for opening analysis, hoisting capacity determination, and financial analysis.
   Needed Computer Codes - None
f. Documentation of Results: The results from this WBS will be incorporated in various letter reports and SAND documents.
g. Quality Assurance Level: II
h. Remarks: QA Level II is assigned because this task supports comparative technical analysis of alternatives for ACD.

C. ACD Tradeoff Studies

Tradeoff studies will be performed to select various components and designs. Tradeoff studies will assess, evaluate, and compare functional capabilities, safety, and costs for the purpose of selecting the system to be used in the repository design.

a. Purpose: To evaluate the practical design alternatives which are available, and make appropriate recommendations.
b. Information Needs: 1.16.2, 4.5.3, 4.5.4, 4.6.2, 4.9.3, 4.10.3
c. Methods, Techniques, and Equipment: Engineering analysis, design, review of existing operations, and trade off studies will be utilized.

Issue 4.10 — Do the data collected in order to describe the expected tectonic phenomena and igneous activity provide the information required by the performance and design issues?

4.10.3 — Ground motion at the site from potential or natural seismic events

C. Regulations and Requirements Addressed

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

2. Principal Investigator

R. E. Stinebaugh, Sandia National Laboratories (SNL), Albuquerque, NM

3. Statement of Work

A. Access Design for the ACD

The advanced conceptual design of the means of access from the surface to the underground portion of the repository will be developed. Accesses include: access for waste, operations personnel, general support hardware, ventilation, and mined material removal. This work will be phased into the design phases ACD, LAD and FP&CD. This definition only covers the ACD phase.

a. Purpose: To determine practical methods of access to the underground portion of the repository. This will include verification of surface location of the access, type of access, dimensions, and support requirements.

b. Information Needs: 1.16.3, 4.5.3, 4.5.4, 4.5.11, 4.6.2, 4.9.1, 4.9.3, 4.10.3

c. Methods, Techniques, and Equipment: Engineering analysis, design, review of existing operations, and trade off studies will be utilized.

d. Technical Procedures:
Available - N/A
Needed - N/A

e. Computer Codes:
Available Computer Codes - Standard industry computer codes are being used for opening analysis and hoisting capacity determination.
Needed Computer Codes - None

f. Documentation of Results: A series of engineering drawings and reports will be created. There will also be several letter reports and at least one SAND report. The exact title of the reports has not been determined at this time. A portion of the data may be entered in the Reference Information Base.

WBS 1.2.4.3.3.S SHAFTS AND RAMPS

1. Objective and Issues Addressed

A. Objective

The objective of this task is to the design the shafts and ramps used for personnel, material, and waste entrance leading to and exiting from the repository underground facilities. Design task includes the analysis necessary to verify compliance with functional and safety requirements.

B. Issues Addressed

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

Issue 1.16 — Do the data collected in order to describe the present and expected rock characteristics provide the information required by the design and performance issues?

- 1.16.2 Spatial distribution of thermal and mechanical properties
- 1.16.3 Spatial distribution of ambient stress and thermal conditions

Issue 4.5 — Are the repository construction, operation, closure and decommissioning technologies adequately established to support resolution of the performance issues?

- 4.5.3 Potential impacts of surface conditions of design
- 4.5.4 Potential impacts of rock characteristics on design
- 4.5.11 Determination that the seals for shafts, drifts, and boreholes can be emplaced with reasonably available technology

Issue 4.6 — Are the waste package and repository costs adequately established to support resolution of the performance issues?

- 4.6.2 Estimates of the cost of reference and alternative designs

Issue 4.9 — Do the data collected in order to describe the hydrologic characteristics and conditions provide the information required by the performance and design issues?

- 4.9.1 Flood recurrence intervals and levels at potential locations of surface facilities
- 4.9.3 Groundwater conditions within and above the potential host rock

MODIFIED WORK PLAN TO SUPPORT

QUALITY ASSURANCE LEVEL ASSIGNMENTS

for

Sandia National Laboratories

NNWSI WBS ELEMENT 1.2.4.3.3.S

SHAFTS AND RAMPS

Approvals (signature and date):

PI R.E. Stinebaugh 7/21/86 PQA Connie Chocas 7/21/86

Supervisor Joel Tillerson 7/21/86 TPO Thomas O. Hunter 7/21/86

WMPO (PQA) James Blaylock 7/23/86 WMPO (Tech) Dustin R. ... 7/23/86

List of Activities and Tasks

A. Access Design

B. Analysis

C. ACD Tradeoff Studies

QUALITY LEVEL ASSIGNMENT CRITERIA SHEET

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Rev. B

QALAS No. 083
Rev. B

Activity: C. ACD Trade-off Studies

Task: C. Same as Activity

PI R. E. Stinebaugh

QA Criterion	Applies	Does Not Apply	Comments
1. QA Organization	X		
2. QA Program	X		
3. Design & Scientific Investigation Control	X		Design control and verification 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

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Rev. B

QALAS No. 083
Rev. C
Page 1 of 1

APPROVALS (Signature and Date)

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PQA Connie Chorover 7/21/86
Supervisor Joe R. Tillerson 7/21/86
TPO Thomas O. Hunter 7/21/86
WMPO (PQM) James Blaylock 7/23/86
WMPO (Tech) [signature] 7/23/86

Activity: C. ACD Trade-off Studies

Task Description	QA Level	QA Criteria	Level Justification
C. Same as Activity	II	1-7, 15-18	QA Level II is assigned because ACD trade-off studies are for comparative technical analysis of alternatives. (Step 10)

QUALITY LEVEL ASSIGNMENT CRITERIA SHEET

WP No. 12433-86 QALAS No. 082
Rev. B Rev. B

Activity: B. Analysis

Task: B. Same as Activity PI R. E. Stinebaugh

QA Criterion	Applies	Does Not Apply	Comments
1. QA Organization	X		
2. QA Program	X		
3. Design & Scientific Investigation Control	X		Design control and verification 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

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QALAS No. 082
Rev. B
Page 1 of 1

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WMPO (Tech) [illegible] 7/23/86

Activity: B. Analysis

Task Description	QA Level	QA Criteria	Level Justification
B. Same as Activity	II	1-7, 15-18	QA Level II is assigned because analysis of ACD for shafts and ramp access to subsurface portion of the repository is to support technical comparison of alternatives. (Step 10)

QUALITY LEVEL ASSIGNMENT CRITERIA SHEET

WP No. 12433-86 QALAS No. 081
Rev. B Rev. B

Activity: A. Access Design

Task: A. Same as Activity PI R. E. Stinebaugh

QA Criterion	Applies	Does Not Apply	Comments
1. QA Organization	X		
2. QA Program	X		
3. Design & Scientific Investigation Control	X		Design control and verification 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-00:

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QALAS No. 081
Rev. B
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APPROVALS (Signature and Date)

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Supervisor Joe Tillerson 7/21/86

TPO Thomas O. Hunter 7/21/86

WMPO (PQM) James Blaylock 7/23/86

WMPO (Tech) [illegible] 7/23/86

Activity: A. Access Design

Task Description	QA Level	QA Criteria	Level Justification
A. Same as Activity	II	1-7, 15-18	QA Level II is assigned because ACD of access and egress to the underground portion of the repository is to support comparative technical analysis of alternatives. (Step 10)

QUALITY LEVEL ASSIGNMENT CRITERIA SHEET

WP No. 12412-86 QALAS No. 044
Rev. C Rev. A

Activity: D. Prediction of Seismic Hazard at the Site from UNE Tests at NTS and from Natural Earthquakes

Task: D.2 Development of sseismic hazard and design basis to support the ACD PI C. V. Subramanian

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		Applies to surveillance only.
11. Test and Experiment/ Research Control	X		
12. Control of Measuring and Test Equipment	X		
13. Handling, Shipping, and Storage	X		
14. Inspection, Test, and Operating Status	X		
15. Control of Nonconformances	X		
16. Corrective Action	X		
17. QA Records	X		
18. QA Audits	X		

QUALITY LEVEL ASSIGNMENT CRITERIA SHEET

? No. 12412-86 QALAS No. 044
..ev. C Rev. A

Activity: D. Prediction of Seismic Hazard at the Site from UNE Tests at NTS and from Natural Earthquakes

Task: D.1 Measurement of ground motions to support development of the design basis PI C. V. Subramanian

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		Applies to surveillance only.
11. Test and Experiment/ Research Control	X		
12. Control of Measuring and Test Equipment	X		
13. Handling, Shipping, and Storage	X		
14. Inspection, Test, and Operating Status	X		
15. Control of Nonconformances	X		
5. Corrective Action	X		
17. QA Records	X		
13. QA Audits	X		

NNWSI QUALITY ASSURANCE LEVEL ASSIGNMENT

SNL-QA-0(

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Rev. A
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PQA Connie Chocas 9/18/86

Supervisor Vernon W. Burgham 9/18/86

TPO Monroe S. Lester 9/18/86

WMPO (PQM) James Blaylock 9/19/86

WMPO (Tech) Lester P. Dixon 9/19/86

Activity: D. Prediction of Seismic Hazard at the Site from Underground Nuclear Expolositon Tests at NTS and from Natural Earthquakes

Task Description	QA Level	QA Criteria	Level Justification
D.1 Measurement of ground motions to support development of the design basis	I	1-7, 10-18	QA Level I is assigned because ground motion data associated with the UNE tests are not repeatable (step 5).
D.2 Development of seismic hazard and design basis to support the Advanced Conceptual Design	II	1-7, 10-18	QA Level II is assigned because the design basis will be used to support the ACD and will be revised based on site characterization data before LAD (step 10).

QUALITY LEVEL ASSIGNMENT CRITERIA SHEET

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Rev. B

QALAS No. 119
Rev. B

Activity: C. Engineering Design Data Studies

Task: C. Same as Activity

PI R. E. Stinebaugh

QA Criterion	Applies	Does Not Apply	Comments
1. QA Organization	X		
2. QA Program	X		
3. Design & Scientific Investigation Control	X		Design control and verification 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		

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APPROVALS (Signature and Date)

PI Roger R. Hill 7/22/86
Supervisor Leo W. Scully 7/23/86
WMPO (PQM) James Blaylock 7/23/86

PQA Connie Chorez 7/22/86
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WMPO (Tech) [illegible] 7/23/86

Activity: C. Engineering Design Data Studies

Task Description	QA Level	QA Criteria	Level Justification
C. Same as Activity	TBD	1-7, 15-18	The QA Level is to be determined before the task begins.

QUALITY LEVEL ASSIGNMENT CRITERIA SHEET

WP No. 12412-86 QALAS No. 118
Rev. B Rev. B

Activity: B. Change Control Studies

Task: B. Same as Activity PI R. E. Stinebaugh

QA Criterion	Applies	Does Not Apply	Comments
1. QA Organization	X		
2. QA Program	X		
3. Design & Scientific Investigation Control	X		Design control and verification 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-Q

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APPROVALS (Signature and Date)

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WMPO (PQM) James Blaylock 7/23/86

PQA Connie Chavez 7/22/86
TPO Thomas O. Hunter 7/22/86
WMPO (Tech) [illegible] 7/23/86

Activity: B. Change Control Studies

Task Description	QA Level	QA Criteria	Level Justification
B. Same as Activity	II	1-7, 15-18	QA Level II is assigned because the change control processes involves comparative technical analysis and will cont modifications to the S... throughout the ACD (Step 10).

QUALITY LEVEL ASSIGNMENT CRITERIA SHEET

WP No. 12412-86 QALAS No. 058
Rev. B Rev. B

Activity: A. Subsystem Design Requirements (SDR)

Task: A. Same as Activity PI R. E. Stinebaugh

QA Criterion	Applies	Does Not Apply	Comments
1. QA Organization	X		
2. QA Program	X		
3. Design & Scientific Investigation Control	X		Design control and verification 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-Q[illegible]

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Page 1 of 1

APPROVALS (Signature and Date)

PI Roger L. Hill 7/22/86
Supervisor Leo W Scully 7/22/86
WMPO (PQM) James Blaylock 7/23/86

PQA Connie Chavez 7/22/86
TPO Thomas O. Hunter 7/22/86
WMPO (Tech) [illegible] 7/23/86

Activity: A. Subsystem Design Requirements (SDR)

Task Description	QA Level	QA Criteria	Level Justification
A. Same as Activity	II	1-7, 15-18	QA Level II is assigned because Subsystem Design Requirements will be identified to provide guidance for ACD activities and involve comparative technical analys. (Step 10).

Milestone Number	Description and Criteria	Completion Date
M042	Update SDR with Initial ACD Changes A copy of the SDR will be submitted Deliverable: SAND Report	06/30/88
Level 2 R059	Prepare SAND Report containing prediction equations developed using the test data from UNEs at NTS	12/17/85
N491	Update Subsystems Design Requirements A copy of the SDR will be submitted Deliverable: SAND Report	

12. Costs

Costs are in thousands of expenditure-year dollars.

FY86

SNL Labor Costs: $309   Other Costs: $544

FY87

SNL Labor Costs: $ 87   Other Costs: $483

FY88

SNL Labor Costs: $243   Other Costs: $717

FY89

SNL Labor Costs: $199   Other Costs: $561

13. Performance Measurement

Level of Effort

Perform change control studies as necessary to update the SDR.

Perform engineering design data studies as necessary to provide Basis of Design information including prediction equations developed using test data from Underground Nuclear Events at NTS and preparation of Seismic Design Basis.

FY87

Update Subsystem Design Requirements.

Perform change control studies as necessary to update the SDR.

Perform engineering design data studies as necessary to provide Basis-of-Design information.

Update predictive equations for ground motions due to UNEs at the Yucca Mountain site based on data collected during FY86 and FY87. Develop a relationship between UNEs and earthquakes at the site.

FY88

Update SDR and complete License Application Design criteria.

Perform change control studies as necessary to update the SDR.

Perform engineering design data studies as necessary to provide Base-of-Design information.

FY89

Perform change control studies as necessary to update the SDR.

11. Milestones and Deliverables

Milestone Number	Description and Criteria	Completion Date
Level 1		
N433	Initial Subsystem Design Requirements	02/24/86
	A copy of the SDR will be submitted Deliverable: SAND Report	
M456	Complete Final Subsystem Design Requirements for ACD	11/30/87
	A copy of the SDR will be submitted Deliverable: SAND Report	

1.2.4.2 Development and Testing

1.2.4.3 Facilities

1.2.4.4 Operations and Maintenance

1.2.4.5 Decommissioning

1.2.4.6 Performance Assessment

The data from the tests under the Activity D will be used in WBS 1.2.4.3 to develop the design basis for ground motion due to UNEs and natural earthquakes at the surface facilities and underground facilities for use in the ACD phase of design.

9. Schedule

Starting Date: 1987

Activities for "Design Basis" will continue through ACD.

Activity D is ongoing and will continue through FY87.

10. Past and Expected Achievements

A. Past Achievements

Milestone N433	Preparation of the Initial Draft of the Subsystem Design Requirements
Milestone N446	Preparation of Seismic Design Basis
Milestone R059	Preparation of prediction equations developed using test data from Underground Nuclear Events at the Nevada Test Site
SAND85-1605	"Ground Motion Produced at Yucca Mountain from Pahute Mesa Underground Nuclear Explosions," February 1986.
SAND85-7104	"Ground Motion Evaluations at Yucca Mountain, Nevada, with Applications to Repository Conceptual Design and Siting."

B. Expected Achievements

FY86

Complete preparation of initial Subsystem Design Requirements (SDR) document.

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

Task D.2 Development of seismic hazard and design basis to support the Advanced Conceptual Design

Data Needed: Ground motion measurements and historical earthquake data base of the region.
Source of Data: Ground motion measurements due to UNEs will be obtained from Task D.1 and from previously gathered SNL Weapons Test seismic data. The historical earthquake data base will be obtained from the USGS.
Quality of Data: Data from Task D.1 will be QA Level I. The quality of the Weapons Test seismic data and the historical earthquake data base has not been established.

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

5. <u>Non-Standard Methods or Techniques</u>

None.

6. <u>Location of Work Performance</u>

Sandia National Laboratories, Albuquerque, NM

Yucca Mountain, NNWSI Site

Contractors: Bechtel National, Inc.
San Francisco, CA

Parsons Brinckerhoff Quade & Douglas, Inc.
San Francisco, CA

URS/John A. Blume, Engineers
San Francisco, CA

Department 7100, Sandia National Laboratories, Albuquerque, NM

7. <u>Quality Assurance Requirements</u>

Quality Assurance Level Assignments

Quality Assurance Level I: Task D.1
Quality Assurance Level II: Activity A, Activity B, Task D.2
To be Determined: Activity C

8. <u>Application of Results</u>

The information developed by Activities A, B and C will be utilized in the management and by the designs of the following WBS elements.

4. Data and Materials Needed

Activity A. Subsystem Design Requirements

Data Needed: The type of information required consists of technical and design requirements traceable to DOE Orders, Federal regulations and laws, national and state codes and standards and the Yucca Mountain Mined Geologic Disposal System Requirements (SAND84-1882). In addition, requirements and/or special considerations based on subjective engineering judgment may be included in the SDR.

Source of Date: As stated above.
Quality of the Data: N/A.

Materials Needed: N/A.
Source of Materials: N/A.
Quality of Materials: N/A.

Activity B. Change Control Studies

Data Needed: Only that data necessary to justify the proposed change.
Source of Data: TBD.
Quality of the Data: TBD.

Materials Needed: N/A.
Source of Materials: N/A.
Quality of Materials: N/A.

Activity C. Engineering Design Data Studies

Data Needed: TBD.
Source of Data: TBD.
Quality of the Data: TBD.

Materials Needed: TBD.
Source of Materials: TBD.
Quality of Materials: TBD.

Activity D. Prediction of Seismic Hazard at the Site from UNE Tests at NTS and Natural Earthquakes

Task D.1 Measurements of ground motion to support development of the design basis

Data Needed: Location, date and size of underground nuclear explosion tests; geologic map of site showing geologic features, including line faults and their characteristics.
Source of Data: DOE for location, date, and size of underground nuclear explosion tests; USGS for geologic maps with geologic features
Quality of Data: N/A

c. Methods, Techniques, and Equipment: Conventional methods and equipment for field data collection and evaluation due to ground motion.

d. Technical Procedures:
Available Procedures - NNWSI Weapons Test Seismic Investigation Quality Plan
Needed Procedures - Sequence of Activities in the Weapons Test Seismic Investigations.

e. Computer Codes:
Available Computer Codes - Standard codes for manipulating ground motion data.
Needed Computer Codes - N/A

f. Documentation of Results: Results will be documented in SAND reports. Data will be stored at SNL but will not be entered into the Tuff Data Base because portions of the data are classified.

g. Quality Assurance Level: I

h. Remarks: QA Level I is assigned because ground motion data associated with UNE tests are not repeatable.

D.2. Development of seismic hazard and design basis to support the Advanced Conceptual Design

a. Purpose: The purpose of this task is to predict seismic hazard, ground motion due to natural earthquakes and UNE, and surface displacement due to natural earthquakes. This will include generating seismic hazard for both ground motion and surface hazard models and considering parameter effects due to rupture length, slip-rate, rupture-magnitude relationships, etc. Design basis will be developed for both ground motions and surface rupture for use in the Advanced Conceptual Design.

b. Information Needs: 4.2.1, 4.2.2, 4.2.3, 4.5.1, 4.5.6, 4.5.9, 4.5.10, 4.5.11, 4.5.12, 4.10.3, 4.10.4

c. Methods, Techniques, and Equipment: Conventional analytical procedures that are commonly used in seismology.

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

e. Computer Codes:
Available Computer Codes - Standard seismology codes for predicting ground motions and surface displacements
Needed Computer Codes - N/A

f. Documentation of Results: Results will be documented in SAND reports.

g. Quality Assurance Level: II

h. Remarks: Design basis development is assigned Level II because of its use in ACD and will be reviewed during licensing application design (LAD) and revised based on data from site characterization.

C. Engineering Design Data Studies

Activities to be accomplished under this element are the preparation, collection, derivation, and review of site-specific geological, geotechnical, natural conditions, topography, weather conditions/climate, and seismic activity data. These studies may directly support design and cross different WBS elements.

a. Purpose: The purpose of Engineering Design Data Studies is to fully analyze specific aspects of the design and related information needs in order to provide the data necessary with which to proceed with in design.
b. Information Needs: 4.5.6 and other information needs as they are identified by future design data studies.
c. Methods, Techniques, and Equipment: Unknown until studies are identified and determined
d. Technical Procedures:
   Available Procedures - None
   Needed Procedures - None
e. Computer Codes:
   Available Computer Codes: N/A.
   Needed Computer Codes: Unknown until studies are determined.
f. Documentation of Results: SAND Reports and/or criteria changes.
g. Quality Assurance Level: TBD (Previously Approved - QALAS 119, Rev. B)
h. Remarks: The QA Level is to be determined before tasks begins.

D. Prediction of Seismic Hazard at the Site from Underground Nuclear Explosion (UNE) Tests at NTS and from Natural Earthquakes.

Activities to be accomplished under this element are experiment design, design and development of test and data acquisition methods, field and laboratory calibration of equipment, field data collection, data reduction and analysis, and the development of seismic hazard and design basis to support the Advanced Conceptual Design (ACD).

D.1. Measurements of ground motion to support development of the design basis

a. Purpose: The purpose of this task is to define the ground motion at the Yucca Mountain due to UNE tests at the NTS. Data from surface and downhole measurements will be used to revise approaches to predicting vibratory ground motion for surface and underground facilities.
b. Information Needs: 4.2.1, 4.2.2, 4.2.3, 4.5.1, 4.5.6, 4.5.9, 4.5.10, 4.5.11, 4.5.12, 4.10.3, 4.10.4

d. Technical Procedures:
   Available Procedures - None
   Needed Procedures - None
e. Computer Codes:
   Available Computer Codes - N/A
   Needed Computer Codes - N/A
f. Documentation of Results: SAND85-0260, Subsystem Design Requirements to Support the Advanced Conceptual Design Studies for the Yucca Mountain Mined Geologic Disposal System, 2/24/86. This report will be updated, revised, and reissued on 3/15/87, 11/30/87, and 6/30/88.
g. Quality Assurance Level: II (Previously Approved - QALAS 058, Rev. B)
h. Remarks: Initial report written, Interface Control Drawings will be added to the SDR at the start of the ACD. The SDR will be updated periodically to maintain currency to the design and will be put under change control (see item B below). QA Level II is assigned because the SDR will provide guidance for Advanced Conceptual Design activities which involves comparative technical analyses.

B. Change Control Studies

Activities to be accomplished under this element are those necessary to implement changes to the SDR and other approved baselined documents including the preparation, justification, review and evaluation, authorization, and distribution of the change.

a. Purpose: The purpose of the change control studies is to provide the means to effect changes to baselined documents. These baselined documents provide a control point from which all future changes require a deliberate evaluation prior to implementation.
b. Information Needs: Self defined per topic under proposed change
c. Methods, Techniques, and Equipment: N/A
d. Technical Procedures:
   Available Procedures - None
   Needed Procedures - None
e. Computer Codes:
   Available Computer Codes - N/A
   Needed Computer Codes - N/A
f. Documentation of Results: Engineering change directives will be issued in accordance with approved Quality Assurance Procedures
g. Quality Assurance Level: II (Previously Approved - QALAS 118, Rev. B)
h. Remarks: QA Level II is assigned because change control studies involves comparative technical analyses and will be used to modify the SDR throughout the ACD.

Issue 4.4 Are the waste package production technologies adequately established to support resolution of the performance issues?

Issue 4.5 Are the repository construction, operating, closure and decommissioning technologies adequately established to support resolution of the performance issues?

Issue 4.6 Are the waste package and repository costs adequately established to support resolution of the performance issues?

Issue 4.10 Do the data collected in order to describe the expected tectonic phenomena and igneous activity provide the information required by the performance and design issues?

2. Principal Investigator

R. R. Hill, Sandia National Laboratories, Albuquerque, NM (Activities A, B and C)

C. V. Subramanian, Sandia National Laboratories, Albuquerque, NM (Activity D)

3. Statement of Work

The following project management and integration activities have been assigned to this WBS element.

A. Subsystem Design Requirements (SDR)

Activities to be accomplished under this element are the preparation, collection, derivation, and review of site-specific information to be used as design criteria for the advanced conceptual design of the repository facilities. The SDR document will consolidate legal and functional requirements, site information, definitions of project scope design parameters, and applicable codes, standards, and regulations to govern the efforts of the repository designers.

a. Purpose: The purpose of the SDR is to provide criteria for design of the repository. The SDR will act as the technical base for any further design after the criteria are developed.
b. Information Needs: 3.6.1, 3.6.2, 3.6.3, 3.6.4, 3.6.5, 3.6.6, 3.6.7, 3.6.8, 3.6.9, 3.6.10, 3.6.11, 3.6.12, 3.7.1, 3.7.2, 3.8.1, 3.8.3, 3.8.4, 3.8.5, 4.3.1, 4.3.2, 4.3.3, 4.4.1, 4.5.1, 4.5.2, 4.5.3, 4.5.4, 4.5.5, 4.5.6, 4.5.7, 4.5.8, 4.5.9, 4.5.10, 4.5.11, 4.5.12
c. Methods, techniques, and equipment design process and design criteria development will proceed as discussed in DOE Orders 6410.1 and 6430.1

WBS 1.2.4.1.2.S DESIGN BASIS

1. Objective and Issues Addressesd

A. Objectives

Activities to be accomplished under this WBS element are the preparation, collection, derivation, and review of site-specific design bases information and documentation; and the performance of engineering studies which directly support design of more than one "Repository" WBS activity element.

B. Issues Addressed

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

1. This WBS element will both address and contribute to the resolution of the following Issues and Information Needs:

Issue 3.6 Have the characteristics of the mined geologic disposal system and its operating procedures and activities been established adequately to assess environmental impacts and risks to the public health and safety?

Issue 3.7 Have the characteristics of the mined geologic disposal system and its operating procedures and activities been established adequately to determine if such characteristics, procedures, and activities could induce social and economic impacts in communities and surrounding regions?

Issue 3.8 Have the characteristics of the transportation system and its operating procedures and activities been established adequately to assess impacts and risks to public health and safety in the affected area?

Issue 4.2 Can the higher level findings required by 10 CFR Part 960 be made for the qualifying condition on the preclosure system guideline and the disqualifying and qualifying conditions on the technical guidelines for surface characteristics, rock characteristics, hydrology and tectonics?

Issue 4.3 Are the repository design and operating procedures that ensure worker nonradiological health and safety adequately established to support resolution of the performance issues?

MODIFIED WORK PLAN TO SUPPORT QUALITY ASSURANCE LEVEL ASSIGNMENTS for Sandia National Laboratories NNWSI WBS ELEMENT 1.2.4.1.2.S DESIGN BASIS

Approvals (signature and date):

PI Roger R. Hill 9/16/86 PQA Connie Chocan 9/16/86

Supervisor 9/16/86 TPO Thomas C. Hunter 9/16/86

WMPO (PQA) James Blaylock 9/19/86 WMPO (Tech) 9/19/86

List of Activities and Tasks

A. Subsystem Design Requirements

B. Change Control Studies

C. Engineering Design Data Studies

D. Prediction of Seismic Hazard at the Site from Underground Nuclear Explosion (UNE) Tests at NTS and from Natural Earthquakes

- D.1 Measurement of ground motions to support development of the design basis
- D.2 Development of seismic hazard and design basis to support the Advanced Conceptual Design

QUALITY LEVEL ASSIGNMENT CRITERIA SHEET

? No. 12141-86 QALAS No. 065
Rev. B Rev. B

Activity: C. Verification and Validation

Task: C.2 Final verification of codes and validation of models used in flow and transport analyses

PI Y. T. Lin

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 or experiments involved.
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
FOR SNL USE ONLY

P No. 12141-86 QALAS No. 065
Rev. B Rev. B

Activity: C. Verification and Validation

Task: C.1 Preliminary verification of codes and validation of models used in flow and transport analyses PI Y. T. Lin

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 or experiments involved.
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

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Rev. B

QALAS No. 065
Rev. B
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APPROVALS (Signature and Date)

PI [illegible] 9/17/86
Supervisor [illegible] 9/17/86
WMPO (PQM) [illegible] 9/19/86
PQA [illegible] 9/17/86
TPO [illegible] 9/17/86
WMPO (Tech) [illegible] 9-19-86

Activity: C. Verification and Validation

Task Description	QA Level	QA Criteria	Level Justification
C.1 Preliminary verification of codes and validation of models used in flow and transport analyses	III	* 1-7, 15-18	QA Level III is assigned because this task involves scoping studies of models and codes to be used in flow and transport analyses. (Steps 1-11 do not apply)
C.2 Final verification of codes and validation of models used in flow and transport analyses	I	1-7, 15-18	QA Level I is assigned because the codes and models selected for final verification and validation will be used to support the DEIS, FEIS, SAR, and the license application. (Step 4)

* QA LEVEL III CRITERIA FOR SNL USE ONLY

QUALITY LEVEL ASSIGNMENT CRITERIA SHEET

? No. 12141-86 QALAS No. 064
..ev. B Rev. B

Activity: B. Flow and Transport Analyses

Task: B.2 Final analyses of groundwater flow and radionuclide transport PI Y. T. Lin

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 or experiments involved.
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		
7. QA Records	X		
18. QA Audits	X		

QUALITY LEVEL ASSIGNMENT CRITERIA SHEET
FOR SNL USE ONLY

P No. 12141-86
Rev. B

QALAS No. 064
Rev. B

Activity: B. Flow and Transport Analyses

Task: B.1 Preliminary analyses of groundwater flow and radionuclide transport

PI Y. T. Lin

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 or experiments involved.
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

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Rev. B

QALAS No. 064
Rev. B
Page 1 of 1

APPROVALS (Signature and Date)

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PQA Connie Chase 9/17/86
Supervisor [signature] 9/17/86
TPO Thomas O. Hunter 9/17/86
WMPO (PQM) James Blaylock 9/19/86
WMPO (Tech) Maxwell Blanchard 9-19-86

Activity: B. Flow and Transport Analyses

Task Description	QA Level	QA Criteria	Level Justification
B.1 Preliminary analyses of groundwater flow and radionuclide transport	III	* 1-7, 15-18	QA Level III is assigned because this task involves scoping studies of flow and transport. (Steps 1-11 do not apply)
B.2 Final analyses of groundwater flow and radionuclide transport	I	1-7, 15-18	QA Level I is assigned because these analyses will support the DEIS, FEIS, and SAR and may be used to support the license application. (Step 4)

QA LEVEL III CRITERIA FOR SNL USE ONLY

QUALITY LEVEL ASSIGNMENT CRITERIA SHEET
FOR SNL USE ONLY

WP No. 12141-86 QALAS No. 063
Rev. B Rev. B

Activity: A. Model Development for Fluid Flow and Radionuclide Transport

Task: A. Same as Activity PI Y. T. Lin

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 or experiments involved.
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

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QALAS No. 063
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Page 1 of 1

APPROVALS (Signature and Date)

PI G. T. Lin 9/17/86
PQA Connie Chavez 9/17/86
Supervisor [signature] 9/17/86
TPO [signature] 9/17/86
WMPO (PQM) [signature] 9/19/86
WMPO (Tech) Maxwell Blanchard 9-16-86

Activity: A. Model Development for Fluid Flow and Radionuclide Transport

Task Description	QA Level	QA Criteria	Level Justification
A. Same as Activity	III	* 1-7, 15-18	QA Level III is assigned because this activity involves scoping studies and interative development of preliminary fluid flow and transport models. (Steps 1-11 do not apply

QA LEVEL III CRITERIA FOR SNL USE ONLY

12. Costs

Costs are in thousands of expenditure-year dollars.

FY86

SNL Labor Costs: $574 Other Costs: $486

FY87

SNL Labor Costs: $843 Other Costs: $593

FY88

SNL Labor Costs: $704 Other Costs: $661

FY89

SNL Labor Costs: $731 Other Costs: $721

13. Performance Measurement

Level of Effort

Milestone Number	Description and Criteria	Completion Date
	This deliverable will be a draft report submitted to WMPO/NVO describing potential ranges of behavior of the flow system at Yucca Mountain with respect to 1000-year flow time requirements of the NRC. The milestone will also include providing to the task of the Performance Assessment Division responsible for predicting radionuclide releases at the accessible environment estimates of the appropriate ranges of site behavior to consider in probabilistic assessments of compliance with EPA standards.	
M133	Definition of COVE 2 Benchmarking Problem	06/30/87
	This deliverable will be met by submitting a SAND report to WMPO/NVO. The report will contain a complete definition of the COVE 2 benchmarking activity which will test the performance of flow and radionuclide transport codes on one- and two-dimensional cases typical of conditions at Yucca Mountain.	
M035	Results of COVE 2 Benchmarking Calculation	12/20/87
	This deliverable will be met by submitting a SAND report to WMPO/NVO. The report will contain results of calculations made for the COVE 2 benchmarking exercise defined in M133. Results from several different flow and transport codes will be analyzed and compared; difficulties encountered when Yucca Mountain problems are expanded from one to two dimensions will be explored.	
M183	Modification of Ranges of Potential Site Behavior	08/31/89
	This milestone will be met by considering the early results of tests in the Exploratory Shaft Facilities and modifying as necessary, the appropriate ranges of site behavior to us in predicting the degree of compliance with the probabilistic requirements of regulatory agencies. If the modifications are significant enough, a letter report or formal draft report may be prepared.	

Milestone Number	Description and Criteria	Completion Date
	This deliverable will be a draft report submitted to WMPO/NVO describing the effects of stratigraphic interfaces on flow through the partially saturated rocks at Yucca Mountain. Flow will be addressed as concentrated pulses caused by pulses of recharge as well as steady-state infiltration. Also included will be an attempt to establish the critical values of flux necessary for initiating and sustaining fracture flow within and between various stratigraphic units.	
R082	Preliminary Estimates of Groundwater Travel Time and Radionuclide Transport at the Yucca Mountain Repository Site	05/15/86
	This deliverable will be a report submitted to WMPO/NVO describing the assumptions, methods, and data used to obtain pre-waste emplacement groundwater travel time distributions and total radionuclide releases to the accessible environment for the final NNWSI EA.	
M180	Preliminary Analysis of Flow and Transport From the Repository to the Accessible Environment	12/15/86
	This deliverable will be a draft report submitted to WMPO/NVO describing the results of modeling saturated flow from repository area to accessible environment.	
M034	Concepts of Radionuclide Transport in Tuff	03/30/87
	This deliverable will be a report submitted to WMPO/NVO describing the results of modeling flow and transport through the partially saturated tuff at Yucca Mountain.	
M181	Draft Report Establishing Preliminary Ranges of Potential Site Behavior for Use in Licensing and Environmental Analyses	04/30/88

Modify the models to account for the uncertainty associated with the scenarios and the validation.

Continue model validation analysis using early results from laboratory, surface-based, and exploratory shaft tests.

FY89

Modify projected ranges of potential site behavior, as necessary, based on test data from the Exploratory Shaft Facilities, surface-based testing and USGS tectonic and geologic models.

Establish which codes need to be verified for licensing assessments of flow and transport; and initiate the final verification of the codes.

Continue model validation analyses, using results of exploration shaft tests.

Establish ranges of potential site behavior for use in licensing and environmental analysis.

FY90 through FY92

Verify codes and validate models for flow and transport.

Modify projected ranges of potential site behavior, as necessary, based on test data and underground observations being obtained as part of the ongoing site characterization program.

Participate in the performance assessment activities required for the draft Environmental Impact Statement.

11. Milestones and Deliverables

Milestone Number	Description and Criteria	Completion Date
Level 2		
N117	Draft Report Updating the Concepts of Flow in Fractured, Unsaturated Tuff	06/04/86

A three-dimensional model of reference thermal/mechanical and hydrological stratigraphy at Yucca Mountain has been established. The reference stratigraphy defining units with distinct thermal, physical, mechanical, and hydrological properties is documented in a technical report, SAND84-1076.

Analyses of the infiltration of water through alternating layers of welded and nonwelded units at Yucca Mountain has been performed. The parametric results of analyses are documented in a technical report, SAND84-7114, prepared by LBL.

Probabilistic approach to calculate the pre-waste-emplacement groundwater travel-time distribution and cumulative radionuclide releases to the water table for the NNWSI EA was documented. The analyses are described in technical report, SAND85-2701.

B. Expected Achievements.

FY86

Establish a preliminary model of the saturated zone in the region surrounding Yucca Mountain.

Establish a preliminary conceptual approach to modeling the flow and transport systems in unsaturated zones at Yucca Mountain.

Execute performance allocation on groundwater travel time issue for SCP.

FY87

Establish a more firmly founded concept of the behavior of fluid flow in fractured, unsaturated tuff media.

Preliminary estimate of potential site behavior of groundwater flow and radionuclide transport.

Initiate analysis leading to validation of flow and transport models.

FY88

Evaluate preliminary ranges of potential site behavior for use in licensing and environmental analyses.

Quality Assurance Level I: Tasks B.2 and C.2
Quality Assurance Level III: Activity A and Tasks B.1, and C.1

8. Application of Results

The analyses performed under this task will be used by SNL as input to WBS 1.2.1.4.4, Radionuclide Release from Total System, to define the appropriate range of site behavior to consider in assessing compliance with regulatory standards for probabilistic assessments of radionuclide releases to the accessible environment. This task will also provide the analyses necessary to judge whether the Yucca Mountain site complies with the NRC requirement for a 1000-year flow time from the disturbed zone to the accessible environment. Finally this task will provide estimates of the amount and character of water flow into the repository for use by SNL as input to WBS 1.2.1.4.2, Radionuclide Source Term, in analyzing the effects of near-field conditions (heat and excavations) on repository behavior.

9. Schedule

Starting date: 1982; expected ending date: 1992

10 Past and Expected Achievements

A. Past Achievements

Establishment of an interim conceptual flow model through the fractured tuffs of the unsaturated zone, documented in a Sandia technical report, SAND84-1492, and a Sandia contractor report, SAND84-7202, prepared by LBL.

Preliminary calculations of the expected behavior of the Yucca Mountain flow and transport systems under the conditions dictated by the interim conceptual model. These calculations projected the abilities of the site to comply with regulatory requirements in the absence of engineered barriers and without quantitatively considering the effects of heat or excavation on repository behavior. Results of the calculations are documented in a Sandia technical report, SAND84-1492.

Confirmation of hydraulic conductivity and storativity was estimated from well-test data at well USW H-1. Results of this accomplishment are documented in a Sandia technical report, SAND84-0637.

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

Task C.2. Final verification of codes and validation of models used in flow and transport analyses.

Data Needed: Design and Site Characterization data.
Source of Data: Project Data Bases.
Quality of Data: QA Level I.

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

5. Non-Standard Methods or Techniques

Quantitative projection of the groundwater travel times and radionuclide transport for 10,000 years with accommodation of spatial variability and temporal variability in repository site analyses will be undertaken. This undertaking represents an unprecedented request for information from the scientific community made by regulatory and other decision-making institutions.

To analyze the fluid flow and radionuclide transport at the Yucca Mountain site, this WBS element will develop new mathematical models and their associated computer codes. Because of the field scale of repository sites (several kilometers) and long time periods (tens of thousands of years) required for predicting repository performance, it will involve validation tests to the extent feasible, comparisons between the model predictions and combination of data from laboratory and field experiments from the NNWSI project and from the existing literature and data from natural and man-made analogues.

6. Location of Work Performance

Sandia National Laboratories, Albuquerque, NM

Contractors: Lawrence Berkeley Laboratory, Berkeley, CA (Activity A)

7. Quality Assurance Requirements

Quality Assurance Level Assignments

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

Data Needed: Design and Site Characterization data.
Source of Data: Project Data Bases, Project Technical Reports, and open literature.
Quality of Data - This Task will use data of Quality Level I, II, III, and data for which Quality Levels have not been determined.

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

Activity B.

Task B.1. Preliminary analyses of groundwater flow and radionuclide transport.

Data Needed: Design and Site Characterization data.
Source of Data: Project Data Bases, Project Technical Reports, and open literature.
Quality of Data: This Task will use data of Quality Level I, II, III, and data for which Quality Levels have not been determined.

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

Task B.2. Final analyses of groundwater flow and radionuclide transport.

Data Needed: Design and Site Characterization data.
Source of Data: Project Data Bases.
Quality of Data: QA Level I.

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

Activity C.

Task C.1. Preliminary verification of codes and validation of models used in flow and transport analyses.

Data Needed: Design and Site Characterization data.
Source of Data: Project Data Bases, Project Technical Reports, and open literature.
Quality of Data: This task will use data of QA Level I, II, and III, and data for which QA Levels have not been determined.

g. Quality Assurance Level: III

h. Remarks: Quality Assurance Level III is assigned because this task involves scoping studies of models and codes used in flow and transport analyses.

C.2 Final verification of codes and validation of models used in flow and transport analyses.

a. Purpose: Perform final verification of those codes used to generate predictions of flow and transport and validation of those models used for flow and transport analyses used in support of the DEIS, FEIS, SAR and license application.

b. Information Needs: 1.1.3, 1.1.4, 1.1.5, 1.1.6,.1.2, 1.3, 1.6.2, 1.6.3, 1.6.4, 1.7.1, 1.7.3, 1.9.2, 1.9.3, 1.10.1, 1.10.2, 1.10.3, 1.11.1.

c. Methods, Techniques, and Equipment: Benchmarking, comparing numerical solutions to analytical solutions, comparing model predictions to data from laboratory experiments and field tests and to natural analogues. High-speed digital computers and associated support equipment will be used.

d. Technical Procedures:
Available Procedures: None
Needed Procedures: To be determined.

e. Computer Codes:
Available Computer Codes: None
Needed Computer Codes: Computer codes selected for final verification.

f. Documentation of Results: SAND Reports will be written to document final verification and validation of flow and transport codes used to support a license application.

g. Quality Assurance Level: I

h. Remarks: QA Level I is assigned because codes and models which are selected for final verification and validation will be used to support the DEIS, FEIS, SAR and the license application.

4. <u>Data and Materials Needed</u>

Activity A. Development of models for fluid flow and radionuclide transport.

Task C.1 will be done in conjunction with WBS 1.2.1.4.2 and WBS 1.2.1.4.4. The first preliminary code verification exercise (COVE 1), under WBS 1.2.1.4.3, is completed and a report written. COVE 2 (isothermal flow), under WBS 1.2.1.4.4 and this WBS, and COVE 3 (heat-driven flow), under WBS 1.2.1.4.2, are in progress. Additional preliminary cases may be defined to test other aspects of the performance of existing and new codes.

Computer codes used for analyses for the DEIS, FEIS, SAR and license application will be verified under Task C.2 on cases representative of conditions at Yucca Mountain using Quality Level I data. If validation and verification done under C.1 is used to support models or codes used for DEIS, FEIS, SAR, or the license application, then those validations and verifications will be regenerated under Quality Assurance Level I controls as part of Task C.2.

C.1 Preliminary verification of codes and validation of models used in flow and transport analyses.

a. Purpose: Develop a strategy for code verification and model validation. Perform scoping studies for defining the proper approach for verification of the codes and validation of the models. Perform preliminary verification of codes and validation of models developed in Task B.1.

b. Information Needs: 1.1.1, 1.1.3, 1.1.4, 1.1.5, 1.1.6, 1.6.1, 1.6.2, 1.6.3, 1.6.4, 1.7.1, 1.7.3.

c. Methods, Techniques, and Equipment: Benchmarking and analytical solutions using high-speed digital computers and associated support equipment.

d. Technical Procedures:

Available Procedures: None

Needed Procedures: To be determined.

e. Computer Codes:

Available Computer Codes: Computer codes that are available to use in this WBS include SPARTAN, SAGUARO, NORIA, FEMTRAN, TOSPAC, TRUST, TRUMP, CHAMP, TRACR3D, ISOQUAD, HDOC, UNSAT2, FEMWATER, and SEGOL.

Needed Computer Codes: Those codes developed in Task B.1.

f. Documentation of Results: SAND Report will be written on COVE 2 Benchmarking Problem for Isothermal Flow. Reports will be written for any additional preliminary verification problems defined under this Task.

a. Purpose: Perform the analyses and calculations required for the NNWSI Draft Environmental Impact Statement (DEIS), the NNWSI Final Environmental Impact Statement (FEIS), the NNWSI Safety Analysis Report (SAR) and the license application.

b. Information Needs: 1.1.1, 1.1.4, 1.1.5, 1.1.6, 1.2, 1.3, 1.6.2, 1.6.3, 1.6.4, 1.7.1, 1.7.3, 1.9.2, 1.9.3, 1.10.1, 1.10.2, 1.10.3, 1.11.1.

c. Methods, Techniques, and Equipment: Numerical simulation of deterministic and stochastic models of flow and transport using high-speed digital computers and associated support equipment.

d. Technical Procedures:
   Available Procedures: None
   Needed Procedures: To be determined.

e. Computer Codes:
   Available Computer Codes: Computer codes that are available to complete this task include SPARTAN, SAGUARO, NORIA, TOSPAC, TRUST, TRACR3D, ISOQUAD, FEMWATER, FEMTRAN, CHAMP, HDOC, UNSAT2, SEGOL, and codes yet to be developed. These codes may be used to investigate flow and transport phenomenology. Verification and validation of the codes used in support of the DEIS, FEIS, SAR and license application will be done under Task C.2.
   Needed Computer Codes: To be determined.

f. Documentation of Results: SAND reports will be written. Results will be reported in the DEIS, FEIS, and SAR.

g. Quality Assurance Level: I

h. Remarks: QA Level I is assigned because these analyses will be used to support the DEIS, FEIS, SAR and the license application.

C. Verification and Validation

The codes used to analyze the flow and transport must be verified and validated. The numerical accuracy of the flow and transport codes to solve the pertinent mathematical equations will be verified by verification tests involving comparisons to analytical solutions, and by benchmarking against other codes. The adequacy of theoretical and mathematical models in the simulation of flow and transport phenomena will be demonstrated by model validation. The validation tests will involve comparisons to laboratory experiments and field data or benchmarking against other models already validated, to assure the models represent the process or system for which they are intended.

B.1 Preliminary analyses of groundwater flow and radionuclide transport.

a. Purpose: Update and modify the ranges of potential site behavior. Perform scoping studies to support planning and preparation of DEIS, FEIS, and SAR. Code assessment and modification used to support analyses will continue as additional data becomes available. If any flow or transport predictions obtained under Task B.1 are chosen for inclusion in the DEIS, FEIS and SAR, then those results will be regenerated under Quality Assurance Level I controls as part of Task B.2.

b. Information Needs: 1.1.1, 1.1.4, 1.1.5, 1.1.6, 1.2, 1.3, 1.6.1, 1.6.2, 1.6.3, 1.6.4, 1.7.1, 1.7.3.

c. Methods, Techniques, and Equipment: Numerical simulation of deterministic and stochastic models of flow and transport using high-speed digital computers and associated support equipment.

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

e. Computer Codes:
   Available Computer Codes: Computer codes that are available to complete this task include SPARTAN, SAGUARO, NORIA, TOSPAC, TRUST, TRACR3D, ISOQUAD, FEMWATER, FEMTRAN, CHAMP, HDOC, etc. These codes may be used to investigate flow transport phenomenology in the partially saturated and saturated zones.
   Needed Computer Codes: To be determined.

f. Documentation of Results: SAND reports have been written to satisfy Milestones R082 and 408. Additional reports will be written to satisfy Milestones M180, M181, and M183.

g. Quality Assurance Level: III

h. Remarks: Quality Assurance Level III is assigned because this task involves scoping studies. Refinement of the analyses will be necessary as conceptual understanding of flow in unsaturated fractured, porous tuff and additional data are acquired from Yucca Mountain site.

B.2 Final analyses of groundwater flow and radionuclide transport.

b. Information Needs: 1.1.1, 1.1.4, 1.1.5, 1.1.6, 1.2, 1.3, 1.6.1, 1.6.2, 1.6.3, 1.6.4, 1.7.1, 1.7.3.

c. Methods, Techniques, and Equipment: Update conceptualization of the physical process to be modeled at Yucca Mountain. Refine theoretical framework for mathematically describing the physical process and hydrologic parameters controlling the water movement in the fractured, tuffaceous rock at the site. Formulate the equations that describe the groundwater flow and radionuclide transport.

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

e. Computer Codes:
   Available Computer Codes: None
   Needed Computer Codes: None (this task develops mathematical or physical models).

f. Documentation of Results: SAND reports have been written to satisfy Milestones 103 and N117. Additional reports will be written to further model development.

g. Quality Assurance Level: III

h. Remarks: Quality Assurance Level III is assigned because this activity involves scoping studies and iterative development of preliminary fluid flow and tranpsort models.

B. Flow and Transport Analyses

This activity will determine likely ranges of behavior for the hydrologic and radionuclide transport systems at Yucca Mountain. It will use the geometrical framework established in WBS 1.2.1.3.2, data established in WBS 1.2.1.3.3, simplified radionuclide source term formulated in WBS 1.2.1.4.2, and theoretical frameworks developed in activity A, above. Selected codes will be assessed and modified as necessary to satisfy requirements for analysis of the movement of water and radionuclide transport through Yucca Mountain. Fluid flow and radionuclide transport analyses for the saturated and partially saturated zones will be performed to support the NNWSI Draft Environmental Impact Statement (DEIS), NNWSI Final Environmental Impact Statement (FEIS) and NNWSI Safety Analysis Report (SAR). These analyses will be done with finalized models and codes that have been verified and validated under Task C.2. Uncertainty will be addressed by providing a distribution of potential flow and transport times and estimates of their likelihoods.

particular regulations address by this WBS element are 10CFR60.113(a)(2), 10CFR60.112 and the DOE guidelines 10CFR960.4.

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 8 (Section 8.3.5.7).

2. <u>Principal Investigator</u>

Y. T. Lin, Sandia National Laboratories (SNL), Albuquerque, NM

3. <u>Statement of Work</u>

A. Model Development for Fluid Flow and Radionuclide Transport

This activity will entail development and documentation of models of the fluid flow and radionuclide transport features at Yucca Mountain for use in analyses of groundwater and radionuclide movement from a repository. Modeling of unsaturated flow through fractured, porous rock is rapidly developing but not completed. Additional models are being developed under WBS 1.2.3.3 at the USGS. Models will be assessed and refined as additional data become available. Work under this task is done in conjunction with code development and analyses of flow and radionuclide transport (Tasks B.1), and preliminary verification of codes and validation of models (Task C.1). This work will provide the basis to select the models for final analyses of flow and transport (Task B.2) and final verification and validation (Tasks C.2).

a. Purpose: The theoretical frameworks for mathematically representing hydrologic mechanisms governing fluid flow and radionuclide transport through the particular conditions occurring at Yucca Mountain will be derived by adopting the current state of knowledge about groundwater flow and contaminant transport with special attention given to fractured unsaturated zone environments.

1.1.6 Probabalistic estimates of the radionuclide releases to the accessible environment considering anticipated and unanticipated scenarios.

Issue 1.2 Will the mined geologic disposal system meet the requirements for doses to individuals in the accessible environment as required by 40 CFR 191.15?

Issue 1.3 Will the mined geologic disposal system meet the requirements for the protection of special sources of ground water as required by 40 CFR 191.16?

Issue 1.7
1.7.1 Site information and design concepts needed to assess the effects of the repository on site characteristics.
1.7.3 Boundaries of the disturbed zone.

Issue 1.9
1.9.2 Identification of favorable and potentially adverse conditions at the site that may influence postclosure repository performance.
1.9.3 Potential effects of favorable and potentially adverse conditions on postclosure repository performance.

Issue 1.10
1.10.1 Determination that the site is not disqualified and is not likely to be disqualified for each of the disqualifying conditions.
1.10.2 Determination that the site meets the qualifying conditions of the technical guidelines and is likely to continue to meet the qualifying conditions.
1.10.3 Determination that the site meets the qualifying condition of the system guideline and is likely to continue to meet the qualifying condition.

Issue 1.11
1.11.1 Definition of the near field environment of the waste packages following emplacement.

C. Regulations and Requirements Addressed

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

WBS 1.2.1.4.1.S FLOW AND RADIONUCLIDE TRANSPORT

1. Objectives and Issues Addressed

A. Objectives

The objective of the Flow and Radionuclide Transport WBS is to evaluate the hydrologic and geochemical features along flow paths from the repository to the accessible environment to determine their contributions to the performance of the overall repository system.

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 1.6

1.6.1	Site information and design concepts needed to identify the fastest path of likely radionuclide travel and to calculate the groundwater travel time along that path.
1.6.2	Calculational models to predict groundwater travel times in the unsaturated and saturated zones.
1.6.3	Description of paths from the disturbed zone to the accessible environment.
1.6.4	Determination of the pre-waste-emplacement groundwater travel time along the fastest path of likely radionuclide travel from the disturbed zone to the accessible environment.

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.
1.1.3	Representative release scenarios that address both anticipated and unanticipated conditions.
1.1.4	Calculational models to predict radionuclide releases to the accessible environment.
1.1.5	Determination of the radionuclide releases to the accessible environment associated with representative scenarios.

MODIFIED WORK PLAN TO SUPPORT

QUALITY ASSURANCE LEVEL ASSIGNMENTS

for

Sandia National Laboratories

NNWSI WBS ELEMENT 1.2.1.4.1.S

FLOW AND RADIONUCLIDE TRANSPORT

Approvals (signature and date):

PI	Y. T. Lin 9/17/86	PQA	Connie Chocas 9/17/86
Supervisor	Scott Sinnock 9/17/86	TPO	Thomas Hunter 9/17/86
WMPO (PQA)	James Blaylock 9/19/86	WMPO (Tech)	Maxwell Blanchard 9-19-86

List of Activities and Tasks

A. Model Development for Fluid Flow and Radionuclide Transport

B. Flow and Transport Analyses

- B.1. Preliminary analyses of groundwater flow and radionuclide transport.
- B.2. Final analyses of groundwater flow and radionuclide transport.

C. Verification and Validation

- C.1. Preliminary verification of codes and validation of models used in flow and transport analyses.
- C.2. Final verification of codes and validation of models used in flow and transport analyses.

QUALITY LEVEL ASSIGNMENT CRITERIA SHEET

WP No. 12133-86
Rev. B

QALAS No. 117
Rev. B

Activity: C. Product Management

Task: C. Same as Activity

PI D. H. Zeuch

QA Criterion	Applies	Does Not Apply	Comments
1. QA Organization	X		
2. QA Program	X		
3. Design & Scientific Investigation Control	X		
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	Task only involves publishing RIB information.
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, hard-ward 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. 12133-86
Rev. B

QALAS No. 117
Rev. B
Page 1 of 1

APPROVALS (Signature and Date)

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Supervisor Scott Sinnock 8/5/86
WMPO (PQM) James Blaylock 8/8/86

PQA Connie Chorney 8/5/86
TPO Thomas O. Hunter 8/5/86
WMPO (Tech) Maxwell Blanchard 8-7-86

Activity: C. Product Management

Task Description	QA Level	QA Criteria	Level Justification
C. Same as Activity	I	1-7, 15-18	QA Level I is assigned because thew RIB publication contains information which will be used to support analyses needed for a licnese application (Step 4).

QUALITY LEVEL ASSIGNMENT CRITERIA SHEET

WP No. 12133-86 QALAS No. 116
Rev. B Rev. B

Activity: B. Reference Information Base Development and Administration

Task: B. Same as Activity PI D. H. Zeuch

QA Criterion	Applies	Does Not Apply	Comments
1. QA Organization	X		
2. QA Program	X		
3. Design & Scientific Investigation Control	X		
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 identification and control of data.
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, hard-ward 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-(

WP No. 12133-86
Rev. B

QALAS No. 116
Rev. B
Page 1 of 1

APPROVALS (Signature and Date)

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Supervisor Tom Tinnin 8/5/86
WMPO (PQM) James Blaylock 8/5/86
PQA Connie Chavez 8/5/86
TPO Thomas O. Hunter 8/5/86
WMPO (Tech) Maxwell Blanchard 7-7-76

Activity: B. Reference Information Base Development and Administration

Task Description	QA Level	QA Criteria	Level Justification
B. Same as Activity	I	1-3, 5, 6, 8, 15-18	QA Level I is assigned because development and administration activities affect the continued integrity of information which may be used to support a license application (Step 4).

NNWSI QUALITY ASSURANCE LEVEL ASSIGNMENT SNL-QA-001

WP No. 12133-86
Rev. B

QALAS No. 115
Rev. B
Page 1 of 1

APPROVALS (Signature and Date)

PI David H Zeuch 8-5-86

PQA Connie Chocas 8/5/86

Supervisor [illegible] 8/5/86

TPO Thomas O. Hunter 8/5/86

WMPO (PQM) James Blaylock 8/8/86

WMPO (Tech) Maxwell Blanchard 8-8-86

Activity: A. Design of Data Management System

Task Description	QA Level	QA Criteria	Level Justification
A. Same as activity	N/A	N/A	A QA Level assignment is not applicable because establishing the scope and content of the RIB is a management function.

12. Costs

Costs are in thousands of expenditure-year dollars.

FY86

SNL Labor Costs: $202 Other Costs: $ 31

FY87

SNL Labor Costs: $372 Other Costs: $ 91

FY88

SNL Labor Costs: $384 Other Costs: $103

FY89

SNL Labor Costs: $399 Other Costs: $116

13. Performance Measurement

Percent complete

Based upon the results of a systems analysis that is currently underway, suitable means of managing and controlling the wide variety of data to be included in the RIB will be developed.

FY87

The RIB contents will continue to be refined and expanded as necessary. The second annual report on the RIB contents will be published.

11. Milestones and Deliverables

Milestone Number	Description and Criteria	Completion Date
R081	Annual Report on the NNWSI Reference Information Base The deliverable will be the first annual report to WMPO that will catalog the current organization and content of the NNWSI Reference Information Base. The report shall contain descriptions and listings (tabulations) of the NNWSI reference data. Secondary sources for reference information not readily contained within the report format shall be listed. The report will be issued and fully distributed only on an annual basis, but the Reference Information Base will be updated throughout the year. Listings of Reference Information more current than that contained in the annual report can be obtained directly from the Reference Information Base project leader at SNLA.	03-15-86
R092	Annual Report on the NNWSI Reference Information Base	03-15-87
R094	Annual Report on the NNWSI Reference Information Base	03-15-88
R096	Annual Report on the NNWSI Reference Information Base	03-15-89
R098	Annual Report on the NNWSI Reference Information Base	03-15-90
M155	Licensing RIB established	11-30-90

8. Application of Results

The primary product of the Reference Information Base activity will be a common source of professionally interpreted information intended for Project-wide use in design and performance assessment analyses, and in licensing activities. At any point in time, the RIB will represent the best project understanding of the technical characteristics of the relevant portions of the site/repository system. As such, the RIB will progressively evolve, culminating in a site description, licensing design, and performance assessment of the site/repository system to be used in a license application. It will effectively contain the interpreted technical basis for the license application and will point to the source data upon which the technically interpreted information is based.

9. Schedule

Starting date: 1985 Anticipated ending date: 1992

10. Past and Expected Achievements

Past Achievements

A preliminary draft of an outline for the contents of the RIB has been prepared and circulated for comments. Currently, the outline is organized to correspond to the Issues Hierarchy; thus, the data and analytical results that will be contained therein will necessarily be restricted only to those which address one or more Issues.

An initial effort has been made to identify data for inclusion in the RIB per the RIB outline. A tentative publication format has been decided upon, the data correspondingly organized, and a draft version of the RIB document has been printed.

Expected Achievements

FY86

The mechanisms for authorization of data for inclusion in the RIB will be determined.

A report will be prepared describing the current contents and capabilities of the TUFF Data Base and Graphics Data Base, which together comprise the largest single source of information which will be used to develop input to the RIB.

The preliminary draft of the Reference Information Base will be revised, expanded, finalized and published.

4. Data and Materials Needed

Activity A: Design of Reference Information Base

Data Needed: Performance Allocation information which identifies scientific and engineering information needed by the NNWSI Project.

Source of Data: Project participants responsible for Performance Allocation.

Quality of Data: N/A

Materials Needed: N/A
Source of Material: N/A
Quality of Materials: N/A

Actvity B: Reference Information Base Development and Adminstration

Data Needed: Information authorized for input into the RIB.

Source of Data: Scientific, engineering, and management reviews by NNWSI Project participants of technical information will provide a basis for appropriate judgement about the proper scope and content of the RIB.

Quality of Data: Data of any QA Level can be used to derive Reference Information. The Reference Information must be approved prior to Project use in accordance with NNWSI Project procedure.

Activity C: Product Management

Data Needed: Information authorized for input into the RIB.

Source of Data: As defined by NNWSI Project procedures

Quality of Data: N/A

5. Non-Standard Methods or Techniques: N/A

6. Location of Work Performance

SNL, Albuquerque, NM

7. Quality Assurance Requirements

Quality Assurance Level Assignments

Quality Assurance Level I: Activities B and C
Quality Assurance Level II: None
Quality Assurance Level III: None
Quality Assurance Level Not Applicable: Activity A

b. Information Needs: N/A

c. Methods, Techniques and Equipment: Established information base implementation methods.

d. Technical Procedures:
Available Procedures: None
Needed Procedures: Reference Information Base input and update procedures.

e. Computer Codes:
Available Codes: N/A
Needed Codes: N/A

f. Documentation of Results: The screening of inputs, updates backups and archiving will be documented in accordance with NNWSI Project procedures.

g. Quality Assurance Level: I

h. Remarks: The preliminary draft of te RIB (SLTR 86-5005) has been distributed for review and comment. QA Level I is assigned because Reference Information development and adminstration activities affect continued integrity of information which may be used to support a license application.

C. Product Management

a. Purpose: The RIB will be published annually and disseminated in hardcopy. Distribution of the published versions and dissemination of the updates will be controlled according to written procedures.

b. Information Needs: N/A

c. Methods, Techniques and Equipment: Established information base management methods.

d. Technical Procedures:
Available Procedures: None
Needed Procedures: Procedures for control of publication and dissemination updates.

e. Computer Codes:
Available Codes: N/A
Needed Codes: N/A

f. Documentation of Results: Annual updates of the RIB will be published (Milestones R092, R094, R096, R098, M155).

g. Quality Assurance Level: I

h. Remarks: The preliminary draft of the RIB (SLTR 86-5005) has been distributed for review and comment. The outline and format will be finalized following comments. QA Level I is assigned because the RIB publication contains information which will be used to support analyses needed for license application.

3. Statement of Work

A. Design of Reference Information Base

a. Purpose: The purpose of this activity is to design a data and information management system capable of supporting the RIB WBS element at a level consistent wih NNWSI Project needs and requirements. The first steps in this multiphase design process are: (1) completion of a comprehensive survey of the information categories and relationships that will eventually comprise the RIB, and (2) a detailed evaluation of the geotechnical and institutional applications to which the information and data management system will be put in support to the NNWSI Project mission.

b. Information Needs: N/A

c. Methods, Techniques and Equipment: Established information base design methods.

d. Technical Procedures:
Available Procedures: N/A
Needed Procedures: N/A

e. Computer Codes:
Available Codes: N/A
Needed Codes: N/A

f. Documentation of Results: The results of the development of a design for the RIB are contained in the RIB published for comment in SLTR # 86-5005, (Milestone R081). Annual updates of the RIB will document results of this activity (Milestones R092, R094, R096, R098, M155).

g. Quality Assurance Level: N/A

h. Remarks: A QA Level assignment is not applicable because establishing the scope and content of the RIB is a management function.

B. Reference Information Base Development and Administration

a. Purpose: The objective of this activity is to define and routinely execute the management procedures necessary for the successful development and maintenance of the RIB for use in support of QA Level I activities. Included in this activity are the development, performance, and associated documentation of procedures for: (1) screening of incoming information for proper authorizations prior to input, (2) updating and (3) post-update verification. This WBS element does <u>not</u> originate information. Information is recommended by the NNWSI System Engineering Integration Group for project baselining by the NNWSI Change Control Board or its designated representatives.

WBS 1.2.1.3.3.S Reference Information Base

1. Objectives and Issues Addressed

A. Objectives

The objective of the Reference Information Base (RIB) activity is to establish professionally interpreted information that constitutes the reference description of: (1) the Yucca Mountain site and associated properties; (2) the repository design; and (3) performance assessment analyses. Prior to license application, the RIB will serve as a common source of project controlled information for use in interim design and performance assessment activities.
At the time of licensing application, the RIB will constitute the professionally interpreted, technical basis for demonstration of the suitability of the Yucca Mountain Mined Geologic Disposal System.

B. Issues Addressed

The RIB WBS element does not address directly any of the Issues or Information Needs listed in the NNWSI Issues Hierarchy. However, the RIB will contain, and make accessible, interpreted data which will be used in activities that address many, if not most, of the Issues listed in the NNWSI Issues Hierarchy. Thus, although the Reference Information Base task will not directly satisfy any of the Information Needs of the Issues Hierarchy, it will serve as a centralized and common source for controlled, professionally interpreted data which will be used Project-wide to resolve many issues.

C. Regulations and Requirements Addressed

Because this WBS element does not directly address any Issues or Information Needs, it also does not directly address any regulations or requirements. Rather, it provides information which will be used in support of demonstration of compliance with many, if not all, regulations and requirements.

D. Related Project Plans

The RIB is referenced by the NNWSI Site Characterization Plan (SCP) as a technical baseline document supporting license application. The necessary controls for the flow of information into the RIB are outlined in the NNWSI Systems Engineering Management Plan (SEMP).

2. Principal Investigator

D. H. Zeuch, Sandia National Laboratories (SNL), Albuquerque, NM.

MODIFIED WORK PLAN TO SUPPORT

QUALITY ASSURANCE LEVEL ASSIGNMENTS

for

Sandia National Laboratories

NNWSI WBS ELEMENT 1.2.1.3.3.S

REFERENCE INFORMATION BASE

Approvals (signature and date):

PI	David H. Zimmerman 8-5-86	PQA	Connie Chavez 8/5/86
Supervisor	Scott Sinnock 8/5/86	TPO	Thomas Hunter 8/5/86
WMPO (PQA)	James Blaylock 8/8/86	WMPO (Tech)	Maxwell Blanchard 8-8-86

List of Activities and Tasks

A. Design of Reference Information Base Management System

B. Reference Information Base Development and Administration

C. Product Management

QUALITY LEVEL ASSIGNMENT CRITERIA SHEET

WP No. 12432-86 QALAS No. 068
Rev. B Rev. B

Activity: B. Develop Reference Configuration for ACD

Task: B. Same as Activity PI C. V. Subramanian

QA Criterion	Applies	Does Not Apply	Comments
1. QA Organization	X		
2. QA Program	X		
3. Design & Scientific Investigation Control	X		Design control and verification 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		

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APPROVALS (Signature and Date)

PI [signature]
Supervisor [signature] 7/21/86
WMPO (PQM) [signature] 7/23/86

PQA [signature] 7/21/86
TPO [signature] 7/21/86
WMPO (Tech) [signature] 7/23/86

Activity: B. Develop Reference Configuration for ACD

Task Description	QA Level	QA Criteria	Level Justification
B. Same as Activity	II	1-7 15-18	This development is based on the RCD/SC design modified by the results of the special studies. The output from this will be prepared as an Advanced Conceptual Design (ACD) report which will be used to initiate the LAD. QA Level II is assigned based on satisfying Step 10 of the logic diagram.

QUALITY LEVEL ASSIGNMENT CRITERIA SHEET

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Activity: A. Special Studies for ACD

Task: A.2. Miscellaneous Studies PI C. V. Subramanian

QA Criterion	Applies	Does Not Apply	Comments
1. QA Organization	X		
2. QA Program	X		
3. Design & Scientific Investigation Control	X		Design control and verification 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

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Activity: A. Special Studies for ACD

Task: A.1. Option Studies PI C. V. Subramanian

QA Criterion	Applies	Does Not Apply	Comments
1. QA Organization	X		
2. QA Program	X		
3. Design & Scientific Investigation Control	X		Design control and verification 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		

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Rev. B
Page 1 of 1

APPROVALS (Signature and Date)

PI [signature] 7/21/86
PQA Connie Chocas 7/21/86
Supervisor Leo W Scully 7/21/86
TPO Thomas O. Hunter 7/21/86
WMPO (PQM) James Blaylock 7/23/86
WMPO (Tech) [signature] 7/23/86

Activity: A. Special Studies for ACD

Task Description	QA Level	QA Criteria	Level Justification
A.1. Option Studies	II	1-7, 15-18	These studies are a set of comparative technical design evaluations of alternatives to determine which alternative is preferred for the next stage of design. QA Level II i. assigned based on satisfying Step 10 of the logic diagram.
A.2. Miscellaneous Studies	II	1-7, 15-18	These involve design evaluation of the conceptual design phase (RCD/SC)(i) to identify potential problems and develop first cut design concepts to mitigate the problems, (ii) to determine quantities of parameters for use in the next page of design (ACD) and iii) to develop design concepts of systems and components for use in the ACD Phase. QA Level II is assigned based on satisfying Step 10 of the logic diagram.

Milestone Number	Description and Criteria	Completion Date
P007	Complete Advanced Conceptual Design of Surface Waste-Handling Facilities	05/31/87
N428	Waste-Handling Facilities Design Concepts Design concepts shall be generated which provide the facilities, equipment, systems, and utilities required for accepting, unloading, storing, consolidating, packaging, and transferring radioactive waste to the underground portion of the repository. These operations shall be effected in a safe and efficient manner with exposure of the worker, the public, or the environment limited to levels less than those specified by 10 CFR 20 and 10 CFR 60.	03/01/87

12. Costs

Costs are in thousands of expenditure-year dollars.

FY86

SNL Labor Costs: $238 Other Costs: $1,165

FY87

SNL Labor Costs: $310 Other Costs: $ 767

FY88

SNL Labor Costs: $320 Other Costs: $ 493

FY89

SNL Labor Costs: $332 Other Costs: $1,339

Total Projected Cost: $4,218

13. Performance Measurement

Level of Effort

Develop a reference configuration for LAD based on the results of the special studies listed in 3 and the SCP/CDR design.

FY88

Provide support for updating the subsystems design requirements for LAD in preparation for starting the LAD.

FY89

Initiate LAD.

FY90

Continue LAD.

Initiate preclosure performance confirmation studies.

11. Milestones and Deliverables

Milestone Number	Description and Criteria	Completion Date
P409	Site-Generated Waste Disposal System Design Concepts Design concepts shall be generated which provide the facilities and systems required to safely and efficiently treat on-site generated solid and liquid radioactive wastes for disposal in a low-activity, underground waste disposal area. Treatment of gaseous radioactive waste effluents will be addressed, if required, by future safety analysis.	03/01/87
P408	Exhaust Filter Building Design Concepts Design concepts shall be generated which provide the facilities and systems required to maintain optimum environments in the underground waste emplacement spaces with the following conditions: 1) maintain ventilation during normal repository operations, or 2) automatically assure exhaust and effective effluent air filtration should a release accident occur.	03/01/87

"Preliminary Reference Waste Descriptions for a Repository at Yucca Mountain" (SAND83-1805).

"Two-Stage Repository Development at Yucca Mountain: An Engineering Feasibility Study" (SAND84-1351).

"A Project Plan for the Advanced Conceptual Design of Surface Facilities for a Proposed Nuclear Waste Repository," by BNI, November 1985.

"Integrated MRS/Repository Waste Management System Study Repository in Tuff" (SAND85-7112).

"Suitability of Natural Soils for Foundations for Surface Facilities at the Prospective Yucca Mountain Nuclear Waste Repository" (SAND85-7107).

B. Expected Achievements

FY86

Provide site preparation information to support Chapter 6 of the Site Characterization Plan.

Provide support for the site-specific repository design concepts.

Provide information and support for the subsystems design requirements document.

Provide information and support for the preparation of RCD/SC.

Complete the Repository Options Study.

Develop design margin philosophy for NNWSI.

Determine PMF and develop flood protection barrier concepts.

FY87

Prepare an Operations Plan for the NNWSI facilities.

Prepare a report on site-generated waste.

Provide support for selecting LAD contractor.

Provide support for updating the subsystems design requirements document.

8. Application of Results

Completion of the work outlined under this WBS will result in a reference configuration for LAD of the work-handling facilities and an overall operating plan at the prospective repository in tuff at Yucca Mountain.

9. Schedule

Starting date: 1984; expected ending date: 1987

10. Past and Expected Achievements

A. Past Achievements

The following reports have been prepared:

"Area 25, Nevada Test Site," Holmes & Narver.

"Meteorological Design Parameters for the Candidate Site of a Radioactive Waste Repository at Yucca Mountain, Nevada" (SAND84-0440/2).

"Conceptual Design Plan for a Tuff Repository at the Nevada Test Site" (SAND83-1839).

"Recommendations for Physical Protection Levels for a Prospective Nuclear Waste Repository at the NTS" (SAND83-2011).

Final Draft, "Conceptual Design Guidelines for a Repository at Yucca Mountain" (SAND83-1820).

"Review of Seismic Studies for Proposed Nuclear Waste Repository" (SAND82-7458).

"Meteorological Tower Data for NNWSI - Quarterly Report" (SAND84-1327).

"Conceptual Design of a Facility for Receiving and Unloading Contact-Handled TRU Waste From Commercial Sources" (SAND84-7131) (in review).

"Fuel Consolidation Equipment" (SAND84-7130) (in policy review).

"NNWSI Repository Operational Procedures for Receiving, Packaging, Emplacing, and Retrieving High-Level and Transuranic Waste" (SAND83-1166).

a. Purpose: The purpose of this task is to modify the existing conceptual design of the surface facilities (RCD/SC) using the results of the special studies in (A). Then the modified configuration developed will be used to prepare an ACD report and cost and schedule estimates of the repository.

b. Information Needs: 4.2.1, 4.2.2, 4.2.3, 4.5.1, 4.5.3, 4.5.6, 4.5.8, 4.5.9, 4.7.1, 4.7.2, 4.7.3, 4.7.4, 4.9.1, 4.9.2, 4.10.4

c. Methods, Techniques, and Equipment: Conventional design methods will be used.

d. Technical Procedures: Standard civil, mechanical, and nuclear engineering procedures used in the nuclear industry will be used.

e. Computer Codes:
Available Computer Codes - SAP ANSYS, STARDYNE, FLUSH, CLASSI, etc., which are standard structural analysis computer codes used in the nuclear power plant industry. These are public domain codes which are extensively verified and documented.
Needed Computer Codes - N/A

f. Documentation of Results: The reference configuration will be documented as an ACD SAND report. Title and number are not available at this time. It will also be filed in the project file at the contractor's office and at SNL (File No. 21/000/52-9817/REP/QII and 60/12413/1.1/QII).

g. Quality Assurance Level: II

h. Remarks: The product will be the ACD report, which documents the results of all option studies, therefore QA Level II is assigned to this task.

4. Data and Materials Needed

Tasks A.1 and A.3: Data and design criteria requirements are obtained from the RIB and the SDR. The quality of the data is defined in the RIB.

5. Non-Standard Methods or Techniques: None

6. Location of Work Performance

Sandia National Laboratories, Albuquerque, NM

Contractors: Bechtel National, Incorporated, San Francisco, CA

7. Quality Assurance Requirements

The Quality Assurance Level II has been assigned to the Tasks A.1, A.2, and B under this WBS.

- Overall arrangement and layout of surface facilities.
- Reconfiguration and modifications to the RCD/SC design based on the results of the special studies listed under item 2.
- Offsite and onsite systems, utilities and site services.
- Operations and support services and conceptual design requirements for waste receipt, handling, and transfer to the underground disposal area.
- Exhaust shaft filteration facility.
- Surface ventilation and filtration systems for waste handling facilities.
- Waste handling and packaging equipment.
- Waste processing and packaging of both on-site generated radioactive and non-radioactive wastes.
- Repository operating plan.
- Operational monitoring and control data.
- Safety-related elements associated with the balance of plant facilities. Engineering judgment and past experience will be used where necessary.

The effort involved under this task will mainly consist of:

- Compile the documents including the drawings developed for the Maintenance of Reference Configuration.
- Incorporate changes to these documents based on the results of special study tasks in (A).
- Check the documents.
- Review the documents for completeness of contents as an engineering package.
- Issue the documents as an engineering package of the Reference Configuration to be prepared as an Advanced Conceptual Design (ACD) report for initiating LAD and to develop the cost and schedule data as required.

a. Purpose: The studies listed under this task are primarily for scoping out design requirements of the different aspects of the design data and concepts so that they can be used to support the Advanced Conceptual Design of the repository surface facilities.

b. Information Needs: 4.2.1, 4.2.2, 4.2.3, 4.5.1, 4.5.3, 4.5.8, 4.5.9, 4.7.1, 4.7.4, 4.9.1, 4.9.2.

c. Methods, Techniques, and Equipment: Design data available from RIB and SDR, and standard methods will be used to quantify items and develop design concepts.

d. Technical Procedures: Standard civil, mechanical and nuclear engineering procedures used in the nuclear industry will be used.

e. Computer Codes:
Available Computer Codes - N/A
Needed Computer Codes - N/A

f. Documentation of Results: The results of these studies will be documented either in a SAND report or in an SLTR. Title and number are not known at this time. They will also be filed in the project file at the contractor's office and at SNL (File No. 21/000/52-9817/REP/QII and 60/12432/1.1 (or 1.4)/QII.

g. Quality Assurance Level: II

h. Remarks: The studies listed under this involve the comparative technical analysis of alternative designs to support the ACD phase and hence QA Level II is assigned.

B. Develop Reference Configuration

The objective of this item is to prepare a reference surface facility configuration to be used as the base for preparing an Advanced Conceptual Design (ACD) report which will be used in initiating the Licensing Application Design (LAD) phase. The contractor will use the design information from RCD/SC and modify the same using the conclusions from all the special studies tasks in (A) to develop this configuration. The effort under this task will concentrate on the repository system elements that affect radiation safety, both on and off-sites. Level of details will be sufficient to assure the identification of all system elements important to safety and to justify the absence of other candidate elements. Non-safety related system elements will be treated in a schematic fashion to the level of detail necessary to establish conceptual level cost and construction schedule data. As indicated earlier, this design will be consistent with SAND85-0260 (SDR), SAND84-1880 (SR) and the RIB. Items to be included are:

c. Methods, Techniques, and Equipment: Comparative evaluation of the designs will be made based on the different options for the different factors (cost, schedule, operations, etc.).

d. Technical Procedures:
Available Procedures - Standard engineering evaluation procedures used in the nuclear industry and which were used in the MRS evaluation report and the two-stage report (SAND84-1351) will be used.
Needed Procedures - None

e. Computer Codes:
Available Computer Codes - N/A
Needed Computer Codes - N/A

f. Documentation of Results: The results of the study will be documented in a Sandia Letter Technical Report (SLTR). Title and number are not known at this time. It will also be filed in the project file at the contractor's office and at SNL (File No. 21/000/52-9817/REP/QII).

g. Quality Assurance Level: II

h. Remarks: QA Level II is assigned to this task because its principal purpose is to conduct a comparative technical analysis of alternatives.

A.2. Miscellaneous Studies - These include: (i) Development of an operations plan for the repository to scope staffing requirements and operating schedule, identify major equipment items for waste handling, scope mining and ventilation needs, estimate of repository operations costs, provide a first-cut basis for the calculation of operator radiological exposures, provide an approximate basis for identifying credible accidents which involve radiological and non-radiological materials, scope out a life-of-repository ventilation plan and identify logistical support requirements; (ii) Site-generated waste study to make a scoping quantification of site generated waste, develop concepts for the method of processing and disposal of the waste; (iii) Determine probable maximum flood (PMF) and develop design concepts for flood protection barriers; (iv) Develop a first-cut electrical design basis for the repository; (v) Make a scoping assessment of the potential for criticality within the operational and storage areas of the surface facilities; (vi) Develop a basis and estimate of the quantity of water requirements for all phases of repository operations; (viii) Develop a design margin philosophy for use with the repository facilities design; (viii) Support preparation of SCP and SCP/CDR; (ix) Support updating and revising SDR; (x) Support in developing seismic design philosophy and criteria for the repository.

Issue 4.10

4.10.4 Information about the expected tectonic phenomena and igneous activity that is required to support preclosure higher level findings for the ease and cost of siting, construction, operation, and closure.

C. Regulations and Requirements Addressed

Regulations and requirements addressed by the issues referenced in this WBS are cited in the NNWSI Systems Requirements Document SAND84-1880.

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 6.2.4 and 6.3.7) and Chapter 8 (Section 8.3.1.10, 8.3.1.12, 8.3.2.9, and 8.3.5.9). The data and reference values to be used under this WBS will be controlled by the SNL Tuff Repository Reference Information Base (RIB) and the Subsystems Design Requirements (SDR), SAND85-0260.

2. Principal Investigator

C. V. Subramanian, Sandia National Laboratories (SNL), Albuquerque, NM

3. Statement of Work

A. Special Studies for Advanced Conceptual Design (ACD)

Under this activity, there are two major categories of studies that need to be performed. These are: (i) options studies and (ii) miscellaneous studies including quantification of design parameters, supporting preparation of SCP, SCP/CDR, cost estimates, SDR, seismic design basis methodology, etc. These are described below:

A.1. Option Studies - Includes one stage vs. two stage, consolidation vs. no consolidation, and emplacement option.

a. Purpose: To evalute the more important design options possible for use in the design of the repository surface facilities from the point of operational consideration, cost, construction schedule; and their impact on the scheduled date of completion of the repository construction; and to select the most advantageous options to support the ACD phase consistent with INS 4.5.9.

b. Information Needs: 2.2, 2.3, 4.2.1, 4.2.2, 4.2.3, 4.5.8, 4.5.9

WBS 1.2.4.3.2.S SURFACE FACILITIES

1. Objectives and Issues Addressed

A. Objectives

The objectives are (i) to evaluate the different options that are possible for use in the design of the repository facilities from the point of operational considerations, cost, construction schedule, and their impact on the 1998 scheduled date of completion of repository construction, and to select the most advantageous options, and (ii) to develop the reference configuration of the surface facilities for the repository for use in the Advanced Conceptual Design (ACD). The designs are to ensure that the construction, operations, and closure of the repository will be timely, safe, economic, and environmentally acceptable.

B. Issues Addressed

Issue 4.5

4.5.3 Potential impacts of surface conditions on design.

4.5.6 Potential impacts of tectonic activity on design.

4.5.8 Reference preclosure repository design.

4.5.9 Determination that the surface facilities can be constructed, operated, closed, and decommissioned with reasonably available technology.

Issue 4.7

4.7.1 Topographic characteristics of potential locations of surface facilities.

4.7.2 Soil and bedrock properties of potential locations of surface facilities.

4.7.3 Local meteorological conditions at potential locations of surface facilities.

4.7.4 Information about the surface characteristics and conditions that is required to support the preclosure higher level findings for the ease and cost of siting, construction, operation, and closure.

Issue 4.9

4.9.1 Flood recurrence intervals and levels at potential locations of surface facilities.

4.9.2 Location of adequate water supplies.

MODIFIED WORK PLAN TO SUPPORT
QUALITY ASSURANCE LEVEL ASSIGNMENTS

FOR

SANDIA NATIONAL LABORATORIES
NNWSI WBS ELEMENT 1.2.4.3.2.S
SURFACE FACILITIES

Approvals (Signature & Date):

PI	[signature] 7/21/86	PQA	Connie Chavez 7/21/86
Supervisor	Leo W. Scully 7/21/86	TPO	Thomas O. Hunter 7/21/86
WMPO (PQA)	James Blaylock 7/23/86	WMPO (Tech)	[signature] 7/23/86

List of Activities and Tasks

A. Special Studies for ACD

A.1 Option Studies

A.2 Miscellaneous Studies

B. Develop Reference Configuration for ACD

QUALITY LEVEL ASSIGNMENT CRITERIA SHEET
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Activity: C. Product Management

Task: C.2. QA Level III Product Management

PI D. H. Zeuch

QA Criterion	Applies	Does Not Apply	Comments
1. QA Organization	X		
2. QA Program	X		
3. Design & Scientific Investigation Control	X		
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 identification and control of data.
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, hard-ward 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		

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Activity: C. Product Management

Task: C.1. QA Level I Product Management

PI D. H. Zeuch

QA Criterion	Applies	Does Not Apply	Comments
1. QA Organization	X		
2. QA Program	X		
3. Design & Scientific Investigation Control	X		
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 identification and control of data.
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, hard-ward 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

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PQA Connie Chorse 8/5/86

TPO Thomas O. Hunter 8/5/86

WMPO (Tech) Maxwell Blanchard 8-8-86

Activity: C. Product Management

Task Description	QA Level	QA Criteria	Level Justification
C.1 QA Level I Product Management	I	1-3, 5, 6, 8, 15-18	QA Level I is assigned because this task provides data base products which may be used to support a license application (Step 4).
C.2 QA Level III Product Management	III	* 1-3, 5, 6, 8, 15-18	QA Level III is assigned because this task provides data base products used for scoping activities. (Steps 1-11 do not apply).

* QA LEVEL III CRITERIA FOR SNL USE ONLY

QUALITY LEVEL ASSIGNMENT CRITERIA SHEET

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Activity: B. Data Base Development and Administration

Task: B. Same as Activity PI D. H. Zeuch

QA Criterion	Applies	Does Not Apply	Comments
1. QA Organization	X		
2. QA Program	X		
3. Design & Scientific Investigation Control	X		
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 identification and control of data.
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		

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Activity: B. Data Base Development and Administration

Task Description	QA Level	QA Criteria	Level Justification
B. Same as Activity	I	1-8 15-18	QA Level I is assigned because data base development and administration activities affect the continued integrity of data which may be used to support a license application (Step 4).

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APPROVALS (Signature and Date)

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PQA Connie Chocas 8/5/86
TPO Thomas O. Hunter 8/5/86
WMPO (Tech) Maxwell Blanchard 8-8-86

Activity: A. Design of Data Management System

Task Description	QA Level	QA Criteria	Level Justification
A. Same as Activity	N/A	N/A	A QA Level assignment is not applicable because establishing the scope and content of the data base management system is a management function.

12. Costs

Costs are in thousands of expenditure-year dollars.

FY86

SNL Labors Costs: $134 Other Costs: $376

FY87

SNL Labors Costs: $248 Other Costs: $392

FY88

SNL Labors Costs: $448 Other Costs: $ 44

FY89

SNL Labors Costs: $598 Other Costs: $ 45

13. Performance Measurement

Percent complete

Milestone Number	Description and Criteria	Completion Date
R077	Plans and Procedures for the Tuff Data Base Operations The deliverable will be a letter report to NVO/WMPO describing the procedures used in the operation and maintenance of the Reference Information Base and the Tuff Data Base at SNL. The report will also discuss the procedures used for data selection and entry into the data bases. This information will also be put in the form of a presentation at the TPO meeting in May.	05/15/86
R080	Status Report on the NNWSI Data-Base Capabilities. The deliverable will meet by submitting a letter report to NVO/WMPO summarizing the current contents and capabilities of the Tuff and Graphics Data Base. The report shall also list and briefly describe significant data-base products prepared for use by NNWSI Project participants or other organizations.	09/20/86
R089	Description of the Organizational Structure for the Tuff Base The deliverable will be a letter report to NVO/WMPO describing the organization structure of the System 2000 data base. The description will emphasize how the data structure allows retrieval of different types and combinations of site data. If the existing structure is difficult to use in a manner that satisfies requests for data tabulations, recommendations will be made for changing the data-base structure and/or data-base system.	07/10/86
R090	Summary Report of Data-Base Interactions among NNWSI Participants	08/20/87
R093	Summary Reports of Data Base Interactions among NNWSI Participants	08/20/88
R095	Summary Reports of Data Base Interactions among NNWSI Participants	08/20/89
R097	Summary Reports of Data Base Interactions among NNWSI Participants	08/20/90

Expected Achievements

FY86

"Version II of the User's Manual for the Tuff Data Base Interface" will be published.

A design review and systems analysis of the current form of the Tuff Data Base will be initiated, and if the findings so indicate, restructuring the data base will commence in order to better serve Project needs.

FY87

Content and scope of data base will continue to be expanded. Two data base audits will be performed.

11. Milestones and Deliverables

Milestone Number	Description and Criteria	Completion Date
R075	Preliminary Geometrical and Statistical Synthesis of Data from Yucca Mountain The deliverable will be met by submitting a letter report to WMPO summarizing progress in statistical analysis of site property data contained in the Tuff Data Base. If appropriate, the statistical analysis shall include consideration of geometrical variability of site properties. Analyses will be performed on available hydrological, geochemical and thermal/mechanical properties for additional definition of statistical characteristics and spatial distribution of site properties.	09/05/86
R076	Summary Report of Data Base Interactions Among NNWSI Participants The deliverable will be a letter report to NVO/WMPO summarizing interactions between SNL data-base personnel and other NNWSI Project personnel. Recommendations for changes or additions to the data base shall be noted. Estimates of quantities of additional information that are likely to be obtained in the future will be made to approximate the current completeness of the segment of the data base in question.	08/20/86

7. Quality Assurance Requirements

Quality Assurance Level Assignments:

Quality Assurance Level I: Tasks B, C.1
Quality Assurance Level II: None
Quality Assurance Level III: Task C.2
Not Applicable: Task A

8. Application of Results

The results of this WBS element are products (tabulations of scientific and engineering data, organized in formats specified by requestors) which will be used in subsequent project analysis and design activities. A principal use for these products will be in the creation of NNWSI Reference Information.

9. Schedule

Begin: 1982. End: 1992

10. Past and Expected Achievements

Past Achievements

The present structure of the Tuff Data Base was defined in 1983 after a first attempt proved unsatisfactory. The first "user-friendly" software interface, PRIMER, was completed in 1983, and an informal user's manual was circulated to Project representatives holding valid passwords. This interface allowed the user to directly access the data base from remote sites. The first version of a more flexible, interactive type of interface, the Tuff Data Base INTERFACE, was completed and the user's manual published, in April, 1985. The documentation for an enhanced package, "Version II of the User's Manual for the Tuff Data Base INTERFACE" (SAND84-1643/Rev. 1), completed policy review in January 1985 and is being readied for printing. The INTERFACE allows the user to choose many different sets of data for display, or for inclusion in computer files.

Eleven Quarterly Tuff Data Base Documents were produced and distributed to Project participants in 1983-1985. A preliminary draft of a manual describing all procedures used in updating the Tuff Data Base was completed in 1984, and a second draft was completed in June 1985.

The data base staff have now prepared and released three products in response to direct requests for data from Project participants. Two of the products were used to prepare an Environmental Assessment reference report on estimates of preemplacement groundwater travel times at Yucca Mountain.

Task B Data Base Development and Administration.

Data Needed: Data authorized for input into the Tuff Data Base.
Source of Data: Those Project Participants responsible for collection of the data.
Quality of Data: As defined by the Project Participants.

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

Task C.1 QA Level I Product Management

Data Needed: As requested by the user
Source of Data: Tuff Data Base
Quality of Data: As defined by NNWSI Project procedures

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

Task C.2 QA Level III Product Management

Data Needed: As requested by the user
Source of Data: Tuff Data Base
Quality of Data: N/A

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

5. Non-Standard Methods or Techniques

Task A: None
Task B: None
Task C.1: None
Task C.2: None

6. Location at Work Performance

Sandia National Laboratories, Albuquerque, NM

Contractors: Applied Methods, Inc.
Albuquerque, NM

Spectra Research Institute
Albuquerque, NM

h) Remarks: QA Level I is assigned because this task provides data base products which may be used to support a license application.

C.2 QA Level III Product Management

a) Purpose: The purpose of this task is to satisfy data requests, the product for which will be used in QA Level III analysis and design activities (Preliminary, scoping retrievals). This task may also include generation of products for scoping the development of new applications for the Tuff Data Base, or to anticipate Project needs for new products.

b) Information Needs: N/A

c) Methods, Techniques and Equipment: Standard data base management system query techniques.

d) Technical Procedures:
Available Procedures: None
Needed Procedures: Data Base Product Management Procedure.

e) Computer Codes:
Available Computer Codes: N/A
Needed Computer Codes: N/A

f) Documentation of Results: QA Level III Tuff Data Base Products distributed to users.

g) Quality Assurance Level: III

h) Remarks: QA Level III is assigned because this task provides data base products used for scoping activities in support of design and Performance Assessment.

4. <u>Data and Materials Needed</u>

Task A Design of Data Base Management System.

Data Needed: Performance Allocation Information which identifies scientific and engineering data categories to be collected by the NNWSI Project.
Source of Data: Project participants responsible for Performance Allocation.
Quality of Data: N/A

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

f) Documentation of Results: Schema and data dictionary. The screening of inputs, updates, backups and archiving will be documented in accordance with NNWSI Project procedures.

g) QA Level: I

h) Remarks: QA Level I is assigned because data base development and activities affect the continued integrity of data which may be used to support a license application.

C. Product Management

The purpose of this activity is to make the information contained in the site and engineering properties data base available to project participants and authorized non-participants. The data base staff will retrieve and report data in response to authorized requests, using procedures designed to ensure compete traceability, where necessary, of any product to its source data base version and ultimately to the original (authorized) reference(s) from which the data derive.

C.1 QA Level I Product Management

a) Purpose: The purpose of this task is to satisfy data requests, the product for which will be used in support of Advanced Conceptual Design or a license application. This task may also include generation of products in an effort to develop new applications for the Tuff Data Base, or to anticipate the Project need for new products.

b) Information Needs: N/A

c) Methods, Techniques and Equipment: Standard data base management system query techniques.

d) Technical Procedures:
Available Procedures: None
Needed Procedures: Data Base Product Management Procedure.

e) Computer Codes
Available Computer Codes: N/A
Needed Computer Codes: N/A

f) Documentation of Results: QA Level I or QA Level II Tuff Data Base Products distributed to users.

g) Quality Assurance Level: I

B. Data Base Development and Administration

a. Purpose: The objective of this activity is to define and routinely execute the management procedures necessary for the successful development and maintenance of the Tuff Data Base for use in support of other QA Level I activities. Included in this activity are the development, performance, and associated documentation of procedures for: (1) screening of incoming data for proper authorization prior to input; (2) standardization of data (e.g., unit conversions); (3) data base updating (data input) and (4) post-update verification. The purpose of those procedures are to guarantee (1) the accurate transcription of data into the data management system, and (2) the complete traceability of data to their source(s). Additional procedures are necessary for execution of data base backups and archiving following updating, which ensure (1) the continued physical security of the data base, and (2) traceability of any product to its particular data base version an thence to its authorizations and sources. Internal audits will also be performed to ensure the continued integrity of the data base. Access to the system will be controlled by a multi-tiered password mechanism which will partition access into "read-only" and "control" classes, and exclude unauthorized intrusion. Procedures must be developed to control schema and data-dictionary updates, so as to ensure that each data base version has its contents rigorously defined at any instant in the history of the project and no data definitions are lost or become ambiguous. Finally, utility software change control procedures must be established.

b) Information Needs: N/A

c) Methods, Techniques and Equipment: Conventional data base management techniques and procedures.

d) Technical Procedures:
Available Procedures: None
Needed Procedures: Procedures for (1) input of data to the data base; (2) Data Base Management and internal auditing.

e) Computer Codes:
Computer Codes Available: N/A
Computer Codes Needed: N/A

with NNWSI Project needs and requirements. The first steps in this multiphase design process are: (1) completion of a comprehensive survey of the data categories and relationships that must be managed, and (2) a detailed evaluation of the geotechnical applications to which the information and date base management system will be put in support of the NNWSI mission. It is anticipated that the outcome of the Performance Allocation process will provide the information necessary to satisfy the first step listed above. Associated with this first step is the development of a data dictionary, which is a comprehensive catalog that rigorously describes the content of the data base system and the relationships stored therein.

b. Information Needs: N/A

c. Methods, Techniques and Equipment: Established data base design methods (e.g. CODATA-Committee on Data for Science and Technology, ANSI/SPARC Committee or data bases)

d. Technical Procedures:
Available: N/A
Needed: N/A

e. Computer Codes:
Available: N/A
Needed: N/A

f. Documentation of Results: Milestone R089 will support this activity.

g. Quality Assurance Level: N/A

h. Remarks: A QA Level assignment is not applicable because establishing the scope and content of the data base management systems is a management function.

WBS 1.2.1.3.1.S TUFF DATA BASE

1. Objective and Issues Addressed

A. Objectives

The objective of the data base management task is to develop a reliable data base for site and engineering properties from which selected categories of scientific and engineering information acquired by the NNWSI Project can be readily retrieved in an organized manner and in a form amenable to further analysis. Information contained in the Tuff Data Base will be a major source of data used to create the Reference Information Base (WBS 1.2.1.3.3).

B. Issues Addressed

The site and engineering properties data base will contain, and make accessible, data which will be used in activities that address many, if not most, of the Issues listed in the NNWSI Issues Hierarchy. Thus, although the data base management task will directly satisfy none of the Issues, it will serve as a centralized up-to-date clearinghouse for the data (and associated information about the data), which can be used with confidence to resolve many Issues.

C. Regulations and Requirements Addressed

Because this activity does not directly address any Issues or Information Needs, it also does not directly address any regulations or requirements. Rather, it provides the data which will be used in support of demonstration of compliance for many, if not all, regulations and requirements.

D. Related Project Plans

The data managed under this WBS are a part of the NNWSI Technical Baseline and will be controlled as specified in the NNWSI Systems Engineering Management Plan (SEMP).

2. Principal Investigator

D. H. Zeuch, Sandia National Laboratories (SNL), Albuquerque, NM.

3. Statement of Work

A. Design of Data Management System

a. Purpose: The purpose of this activity is to design a data management system capable of handling scientific and engineering information of designated quality levels in a manner consistent

MODIFIED WORK PLAN TO SUPPORT QUALITY ASSURANCE LEVEL ASSIGNMENTS

for

Sandia National Laboratories

NNWSI WBS ELEMENT 1.2.1.3.1.S

TUFF DATA BASE

Approvals (signature and date):

PI	David H. [illegible] 8-5-86	PQA	Connie Chocas 8/5/86
Supervisor	Scott Sinnock 8/5/86	TPO	Thomas O. Hunter 8/5/86
WMPO (PQA)	James Blaylock 8/8/86	WMPO (Tech)	Maxwell Blanchard 8-8-86

List of Activities and Tasks

A. Design of Data Management System

B. Data Base Development and Administration

C. Product Management

- C.1 QA Level I Product Management
- C.2 QA Level III Product Management

QUALITY LEVEL ASSIGNMENT CRITERIA SHEET

IP No. 12435-86 QALAS No. 080
Rev. B Rev. B

Activity: D. General Service Systems

Task: D. Same as Activity PI R. E. Stinebaugh

QA Criterion	Applies	Does Not Apply	Comments
1. QA Organization	X		
2. QA Program	X		
3. Design & Scientific Investigation Control	X		Design control and verification 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		
7. QA Records	X		
18. QA Audits	X		

MODIFIED WORK PLAN TO SUPPORT QUALITY ASSURANCE LEVEL ASSIGNMENTS

for

Sandia National Laboratories

NNWSI WBS ELEMENT 1.2.4.6.1.S

REPOSITORY PERFORMANCE CODE
DEVELOPMENT/CERTIFICATION

Approvals (signature and date):

PI Stephen J Bauer 7/25/86 PQA Connie Chocas 7/25/86

Supervisor Joe R Tillerson 7/25/86 TPO Thomas O Hunter 7/25/86

WMPO (PQA) James Blaylock 7/29/86 WMPO (Tech) [illegible] 7/29/86

List of Activities and Tasks

A. Model/Code Development and Assessment

B. Verification
- B.1 Preliminary Verification
- B.2 Final Verification

C. Benchmarking and Parametric Studies
- C.1 Preliminary Benchmarking
- C.2 Parametric Studies
- C.3 Final Benchmarking

D. Validation

WBS 1.2.4.6.1 REPOSITORY PERFORMANCE CODE DEVELOPMENT/CERTIFICATION

1. Objectives and Issues Addressed

A. Objectives

Analysis methods, computer codes, and material models (constitutive models embodied in computer codes) will be developed, verified, benchmarked, and validated. These methods, codes, and models are being developed for application to the Exploratory Shaft Facility, the Advanced Conceptual Design, and the License Application Design activities.

B. Issues Addressed

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

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

Issue 1.7
- 1.7.3 Boundaries for the disturbed zone.

Issue 1.12
- 1.12.6 Predicted thermal and chemical response of the host rock, surrounding strata, and groundwater system.

Issue 4.3
- 4.3.3 Design measures for avoiding or mitigating hazards to personnel.

Issue 4.5
- 4.5.4 Potential impacts of rock characteristics on design.
- 4.5.6 Potential impacts of tectonic activity on design.
- 4.5.8 Reference preclosure repository design.

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

Issue 1.12
- 1.12.1 Site characterization information needed for design.
- 1.12.7 Reference postclosure underground facility designs.

Issue 1.20
- 1.20.2 Nature and rates of tectonic processes, including faulting, folding, uplift and subsidence, and seismic activity.
- 1.20.5 Potential effects of igneous and tectonic activity on rock characteristics.

Issue 2.6

2.6.3 Identification and description of safety-related items, radiation zones, and normal and accident conditions, including disruptive events.

Issue 4.10

4.10.2 Potential fault movements at the site.

4.10.3 Ground motion at the site from potential man-made or natural seismic events.

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 8 (Section 8.3.2.4). Testing related to code validation is discussed in the NNWSI Exploratory Shaft Test Plan (ESTP) and is presented in the Work Plan under WBS 1.2.6.9.2.3.S (Exploratory Shaft Geomechanical Test) and WBS 1.2.4.2.1.3.S (Laboratory Properties). 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

S. J. Bauer, Division 6314, Sandia National Laboratories (SNL), Albuquerque, NM.

3. Statement of Work

A. Model/Code Development and Assessment

At least three classes of material models (linear elastic/elastic-plastic; compliant joint; discrete discontinuities) are recommended for mechanical/structural calculations. Linear and nonlinear, steady and transient heat conduction codes are recommended for thermal calculations. A review of existing material models/codes will be performed in order to assess their applicability to repository performance, repository design, and site evaluation calculations. Selected material models and codes will be modified as necessary to satisfy requirements for analysis of repository performance and design.

a. Purpose: Material models necessary for the mechanical, thermal, and thermomechanical analysis of repository performance and design will be selected and/or developed to meet anticipated analytical needs for the NNWSI Project activities. Scoping or preliminary calculations will be performed using these analytical tools to

assess their adequacy and completeness prior to allowing their use in design or performance assessment analyses. Because tuff is a jointed rock, the effect of joints and fractures must be taken into account in the analysis. Thus, a compliant joint model must be developed for the mechanical and thermomechanical analysis. The remainder of the analysis capability necessary will be obtained by selecting and modifying existing material and thermal models.

b. Information Needs: 1.7.3, 1.12.6, 4.3.3, 4.5.4, 4.5.6, 4.5.8

c. Methods, Techniques, and Equipment: Finite element methods with both implicit and explicit integration. Boundary element method for linear elastic calculations.

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

e. Computer Codes:
   Available Computer Codes - SANCHO, JAC2D, JAC3D, ABACUS, COYOTE, SPECTROM-31, SAGUARO, VISCOT, and HEFF for code assessment.
   Needed Computer Codes - None.

f. Documentation of Results: SAND reports will be written as required by milestones M491 and M432.

g. Quality Assurance Level: III

h. Remarks: Compliant joint material models have been developed separately at SNL and RE/SPEC, Inc. The SNL compliant joint material model was upgraded by modifications to the joint shear response and the addition of an orthogonal joint set. Documentation of this work is being prepared. QA Level III is assigned because the analyses done under this activity are of a scoping nature.

B. Verification

Computer codes developed for engineering analysis will be verified to ensure that they correctly perform the operations specified in the numerical model. Verification will be accomplished by testing numerical computations against closed form analytic solutions. Part of the verification procedure for finite element codes will be comparison of solutions with previously fully documented boundary element codes.

B.1 Preliminary Verification

a. Purpose: In order to satisfy the requirements of SOP-03-02, the correctness of the software must be verified. Preliminary verification of materials models will be accomplished by testing numerical computations against closed form analytic solutions to help identify problems in the ability of the code to perform operation specified in the numerical model.

b. Information Needs: 1.7.3, 1.12.6, 4.3.3, 4.5.4, 4.5.6, 4.5.8

c. Methods, Techniques, and Equipment: Finite element methods with both implicit and explicit integration. Boundary element method for linear elastic calculations.

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

e. Computer Codes:
Available Computer Codes - SANCHO, JAC2D, JAC3D, ABACUS, COYOTE, SPECTROM-31, SAGUARO, VISCOT, and HEFF for code verification.
Needed Computer Codes - None.

f. Documentation of Results: Results will be documented in SAND reports.

g. Quality Assurance Level: II.

h. Remarks: Preliminary verification of compliant joint models has been completed. QA Level II has been assigned because the task involves comparison of alternative codes.

B.2 Final Verification

a. Purpose: In order to satisfy the requirements of SOP-03-02, the correctness of the software must be verified. Final verification is intended to satisfy the requirements of SOP-03-02 and to provide the necessary documentation for software used for license application (QA Level I) analyses.

b. Information Needs: 1.7.3, 1.12.6, 4.3.3, 4.5.4, 4.5.6, 4.5.8

c. Methods, Techniques, and Equipment: Finite element methods with both implicit and explicit integration. Boundary element method for linear elastic calculations.

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

e. Computer Codes:
Available Computer Codes - SANCHO, JAC2D, JAC3D, ABACUS, COYOTE, SPECTROM-31, SAGUARO, VISCOT, and HEFF for code verification.
Needed Computer Codes - None.

f. Documentation of Results: Results will be documented in SAND reports.

g. Quality Assurance Level: I

h. Remarks: QA Level I is assigned because this verification must be performed prior to submittal of license application.

C. Benchmarking and Parametric Studies

Benchmarking is the comparison of the results on one item of software with the results of another item of software designed to solve a comparable problem to show that they produce similar results. Material models/codes will be benchmarked by cross-checking the numerical solutions to a series of well-defined thermal, mechanical, and thermomechanical boundary value problems. At least one benchmarking analysis will be run for each model for each problem scale to be encountered in repository design. Material properties, in-situ conditions, boundary conditions and loading conditions for

these problems will be representative of those expected of the repository. The material models will be further evaluated through parametric studies in which input parameters are systematically varied to determine the relative significance of a parameter and to ensure that the variations impart the correct sense of change in material behavior.

C.1 Preliminary Benchmarking

a. Purpose: Benchmarking is the comparison of the results on one item of software with the results of another item of software designed to solve a comparable problem to show that they produce similar results. Benchmarking will assist both the verification and validation requirements of SOP-03-02 to provide the necessary documentation for software quality assurance. Preliminary benchmarking is intended also to assist in the model development phase as a tool for identifying potential problems with the software before validation is undertaken.
b. Information Needs: 1.7.3, 1.12.6, 4.3.3, 4.5.4, 4.5.6, 4.5.8
c. Methods, Techniques, and Equipment: Finite element methods with both implicit and explicit integration. Boundary element method for linear elastic calculations.
d. Technical Procedures:
   Available Procedures - None.
   Needed Procedures - None.
e. Computer Codes:
   Available Computer Codes - SANCHO, JAC2D, JAC3D, ABACUS, COYOTE, SPECTROM-31, SAGUARO, VISCOT, and HEFF for code Benchmarking.
   Needed Computer Codes - None.
f. Documentation of Results: Results will be documented in SAND reports.
g. Quality Assurance Level: II
h. Remarks: Preliminary benchmarking is performed in parallel with code development and verification and is intended to help identify any problems with the models before conducting final benchmarking and validation studies. QA Level II is assigned because the task involves comparison of alternatives codes.

C.2 Parametric Studies

a. Purpose: Parametric studies are required to determine the sensitivity of material models to variations in input material parameters. This is an important step in evaluating the model and determining how well material data must be known for the model to accurately represent the desired material behavior. The results of these studies will be used in support of ACD and related work in the development of design specifications.
b. Information Needs: 1.7.3, 1.12.6, 4.3.3, 4.5.4, 4.5.6, 4.5.8
c. Methods, Techniques, and Equipment: Finite element methods with both implicit and explicit integration. Boundary element method for linear elastic calculations.
d. Technical Procedures:

   Available Procedures - None.
   Needed Procedures - None.

e. Computer Codes:
   Available Computer Codes - SANCHO, JAC2D, JAC3D, ABACUS, COYOTE, SPECTROM-31, SAGUARO, VISCOT, and HEFF for thermomechanical studies.
   Needed Computer Codes - None.
f. Documentation of Results: Results will be documented in SAND reports.
g. Quality Assurance Level: II
h. Remarks: Parametric studies are performed in parallel with code development and verification and are intended to help identify any problems with the mathematical models being used or their numerical implementation before conducting the final benchmarking and validation studies. QA Level II is assigned because the results of the parametric studies will support ACD.

C.3 Final Benchmarking

a. Purpose: Benchmarking is the comparison of the results on one item of software with the results of another item of software designed to solve a comparable problem to show that they produce similar results. Benchmarking will assist both the verification and validation requirements of SOP-03-02 to provide the necessary documentation for software quality assurance. Final benchmarking is intended to satisfy portions of the requirements for both verification and validation to produce the documentation needed to certify software for license application (QA Level I) analyses.
b. Information Needs: 1.7.3, 1.12.6, 4.3.3, 4.5.4, 4.5.6, 4.5.8
c. Methods, Techniques, and Equipment: Finite element methods with both implicit and explicit integration. Boundary element method for linear elastic calculations.
d. Technical Procedures:
   Available Procedures - None.
   Needed Procedures - None.
e. Computer Codes:
   Available Computer Codes - SANCHO, JAC2D, JAC3D, ABACUS, COYOTE, SPECTROM-31, SAGUARO, VISCOT, and HEFF for code Benchmarking.
   Needed Computer Codes - None.
f. Documentation of Results: Results will be documented in SAND reports.
g. Quality Assurance Level: I
h. Remarks: Benchmarking is a significant software quality assurance activity. Software must be accepted as QA Level I before use in LAD activities.

D. Validation

Validation is assurance that the physical model as embodied in software is a correct representation of the intended physical system or process. Validation will be accomplished by comparing the results of numerical computations with the results of field-, bench- and laboratory-scale experiments. Certain G-Tunnel (WBS 1.2.4.2.1.2.S),

Exploratory Shaft (WBS 1.2.6.9.2.3.S), and Laboratory (WBS 1.2.4.2.1.3.S) experiments were developed for this purpose. The purpose of these physical models is to test the physics embodied in the material models. Analog material tests may be appropriate for this purpose. Validation analysis may also be conducted by comparing calculated results to experimental results available in the open literature. In general, the validation process will be conducted using the following series of steps: (1) Experiment design analysis is performed in order to develop the experiment concept into a design which will address the phenomena of interest, (2) site specific data and material properties are collected for model calculations, (3) a pretest analysis is performed, (4) the experiment is conducted, (5) the pretest analysis is reevaluated in light of the actual experimental procedure, and (6) a post-test comparison of experiment and analysis is conducted by a peer review panel.

a. Purpose: Model validation is required by SOP-03-02 as one step in the process of software certification for use in QA Level I analyses. Validation calculations also provide assistance in documenting the applicability of the model to the geologic repository, including any extrapolations, restrictions and the effects of unusual or extreme conditions peculiar to the repository.
b. Information Needs: 1.7.3, 1.12.6, 4.3.3, 4.5.4, 4.5.6, 4.5.8
c. Methods, Techniques, and Equipment: Finite element methods with both implicit and explicit integration. Boundary element method for linear elastic calculations.
d. Technical Procedures:
   Available Procedures - None.
   Needed Procedures - None.
e. Computer Codes:
   Available Computer Codes - SANCHO, JAC2D, JAC3D, ABACUS, COYOTE, SPECTROM-31, SAGUARO, VISCOT, and HEFF for code validation.
   Needed Computer Codes - None.
f. Documentation of Results: Results will be documented in SAND reports.
g. Quality Assurance Level: I
h. Remarks: Model validation is required by SOP-03-02 as one step in the process of software certification for use in QA Level I analyses such as those in support of LAD. A preliminary validation study for the compliant joint models, in which thermally fractured granite was used as a physical model, has been completed and the results published.

4. Data and Materials Needed

Activity/Task A. Model/Code Development and Assessment

Date Needed - Joint properties for development and evaluation of material models.
Source of Data - Reference Information Base (RIB) or Tuff Data Base.
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 Verification and Task B.2 Final Verification

Data Needed - Analytic solutions to specific boundary value problems. Some solutions may require modification in order to capture the effect of a coupled thermal and mechanical response.
Source of Data - Peer reviewed open literature or the RIB.
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 Benchmarking

Data Needed - Tuff material properties data for numerical models.
Source of Data - Reference Information Base or peer reviewed open literature.
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. Parametric Studies

Data Needed - Tuff material properties data for numerical models.
Source of Data - Reference Information Base.
Quality of Data - As defined in Reference Information Base.

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

Task C.3. Final Benchmarking

Data Needed - Tuff material properties data for numerical models.
Source of Data - Reference Information Base or other sources as appropriate.

Quality of Data - Because benchmarking is a comparison of software using the same model and input data, the quality level of the data is not a significant factor as long as it falls within the range of reasonably expected values. However, every effort will be made to use data of highest quality available.

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

Activity/Task D. Validation

Data Needed - Site specific and experiment specific material properties data for numerical models. Experimental data collected during validation experiments (WBS 1.2.6.9.2.3.S and WBS 1.2.4.2.1.2.S).
Source of Data - Tuff Data Base.
Quality of Data - The quality of the data will vary depending on the particular experiment to be modeled.

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

5. <u>Non-Standard Methods or Techniques</u>

Activity/Task A. Model/Code Development and Assessment

The compliant joint model is a relatively new material model that has not been rigorously tested. A substantial effort will be required to complete the tasks supporting it; however, the model's conceptual promise warrants such an effort.

6. <u>Location of Work Performance</u>

Sandia National Laboratories, Albuquerque, NM.

Contractors: RE/SPEC, Inc., Albuquerque, NM
Technadyne, Albuquerque, NM

7. <u>Quality Assurance Requirements</u>

Quality Assurance Level Assignments

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

Quality Assurance Level I: Task B.2, C.3 and D.
Quality Assurance Level II: Tasks B.1, C.1 and C.2.
Quality Assurance Level III: Activity/Task A.

8. Application of Results

The necessary documentation of material models/computer codes for mechanical, thermal, and thermomechanical analyses provides direct support for Design Analysis (2.4.6.2), Field Test (2.4.2.1.2), Rock-Mass Analysis (2.4.2.1.1), and indirect support for Subsurface Excavations (2.4.3.4) and Sealing (2.4.2.3).

9. Schedule

Starting Date: 1984
Expected Ending Date: 1991

10. Past and Expected Achievements

A. Past Achievements

Compliant joint material models, developed separately at SNL and RE/SPEC, have completed some very basic verification steps.

A validation study for the compliant joint models, in which thermally fractured granite is the physical model, has been completed and the results have been published.

The compliant joint model was upgraded by modifications to the joint shear response and the addition of an orthogonal joint. Documentation of this work will be published shortly.

B. Expected Achievements

FY86

Perform finite element calculations to support material model qualification: preliminary verification of compliant joint models.

Evaluate modeling efforts in support of field experiments and field measurements in order to assess the status of the codes/material models.

FY87

Perform and report on pre- and post-test compliant joint model validation analysis in support of benchscale large block laboratory test.

Begin compliant joint model benchmarking and parametric studies calculations.

Perform compliant joint model validation analysis of G-Tunnel Mining Experiment.

FY88

Continue and report on compliant joint model benchmarking and parametric studies calculations.

Report on compliant joint model validation analysis of G-Tunnel Mining Experiment.

Evaluation modeling efforts in support of field experiments and field measurements in order to assess the status of the codes/material models.

FY89

Perform and report on validation analyses for plate-loading experiments.

Perform and report on validation analyses for small-scale heater experiments.

Perform pre-test validation analysis of Sequential Drift Mining Evaluations.

Perform pre-test validation analysis of Canister-Scale Heater Experiment.

Perform post-test validation analysis of Sequential Drift Mining Evaluations.

Perform post-test validation analysis of Canister-Scale Heater Experiment.

FY91

Complete report on post-test validation analysis of Sequential Drift Mining Evaluations.

Complete report on post-test validation analysis of Yucca Mountain Heated Block Experiment.

Complete report on post-test validation analysis of Canister-Scale Heater Experiment.

Complete summary report on thermal, mechanical, and thermomechanical material models/codes for license application design.

11. Milestones and Deliverables

Milestone Number	Description and Criteria	Completion Date
Level 2		
M491	Summary Report on Geomechanical Analyses as Reference to the SCP This deliverable is a SAND report submitted for policy review on the status of thermomechanical models/analyses for use as an SCP reference.	06/30/86 (estimated)
M432	Report on Rock-Mass Constitutive Model The deliverable will be a SAND report which recommends and details a constitutive model with which rock-mass response to thermal, mechanical, and thermomechanical loads can be calculated.	10/30/86
P089	Report on compliant joint model validation analysis of G-tunnel mining experiment.	09/30/88
P081	Report on validation analyses for plate-loading experiments.	09/28/90
P082	Summary report on compliant joint model benchmarking activities.	07/31/90
P083	Report PM validation analysis for small-scale heater experiments.	09/28/90
P090	Report on post-test validation analysis of sequential drift mining evaluations.	04/30/91
P091	Report on post-test validation analysis of Yucca Mountain heated-block experiment.	06/28/91
P092	Report on post-test validation analysis of canister-scale heater experiment.	06/28/91
P094	Summary report on thermal-mechanical and thermo-mechanical material models/codes for license application design.	09/30/91

12. Costs

Costs are in thousands of expenditure-year dollars.

FY86

SNL Labor Costs: $119 Other Costs: $210

FY87

SNL Labor Costs: $211 Other Costs: $463

FY88

SNL Labor Costs: $282 Other Costs: $677

FY89

SNL Labor Costs: $359 Other Costs: $804

13. Performance Measurement

Level of Effort.

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APPROVALS (Signature and Date)

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TPO Thomas O. Hunter 7/25/86

WMPO (PQM) James Blaylock 7/29/86

WMPO (Tech) [illegible] 7/29/86

Activity: A. Model/Code Development and Assessment

Task Description	QA Level	QA Criteria	Level Justification
A. Same as Activity	III	* 1-7, 15-18	Compliant joint model will be developed and other material models will be assessed to determine applicability to repository performance and design. This task is assigned QA Level III as Steps 1 through 11 of the logic diagram do not apply.

* QA LEVEL III CRITERIA FOR SNL USE ONLY

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FOR SNL USE ONLY

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Activity: A. Model/Code Development and Assessment

Task: A. Same as Activity PI S. J. Bauer

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		Control of contractor services applies.
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		

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Activity: B. Verification

Task Description	QA Level	QA Criteria	Level Justification
B.1. Preliminary Verification	II	1-7, 15-18	QA Level II is assigned because preliminary verification involves comparison of alternative codes. (Step 10)
B.2. Final Verification	I	1-7, 15-18	QA Level I is assigned because final verification is performed for codes used in support of license application analyses. (Step 6)

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Activity: B. Verification

Task: B.1. Preliminary Verification PI S. J. Bauer

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		Control of contract services applies.
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		

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Activity: B. Verification

Task: B.2. Final Verification PI S. J. Bauer

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		Control of contractor services applies.
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		

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WMPO (Tech) [illegible] 7/29/86

Activity: C. Benchmarking and Parametric Studies

Task Description	QA Level	QA Criteria	Level Justification
C.1 Preliminary Benchmarking	II	1-7, 15-18	QA Level II is assigned because preliminary benchmarking involves comparison of alternative codes. (Step 10)
C.2 Parametric Studies	II	1-7, 15-18	QA Level II is assigned because the parameteric studies will be used to support ACD. (Step 10)
C.3 Final Benchmarking	I	1-7, 15-18	QA Level I is assigned because final benchmarking is performed to certify code for support of licnese application analyses. (Step 6)

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Activity: C. Benchmarking and Parametric Studies

Task: C.1. Preliminary Benchmarking PI S. J. Bauer

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		Control of contractor services applies.
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		

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Activity: C. Benchmarking and Parametric Studies

Task: C.2. Parametric Studies PI S. J. Bauer

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		Control of contrac services applies.
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		

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Activity: C. Benchmarking and Parametric Studies

Task: C.3. Final Benchmarking PI S. J. Bauer

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		Control of contractor services applies.
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		

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WMPO (PQM) James Blaylock 7/29/86
WMPO (Tech) [illegible] 7/29/86

Activity: D. Validation

Task Description	QA Level	QA Criteria	Level Justification
D. Same as Activity	I	1-7, 15-18	QA Level I is assigned validation is performed to certify code for support of license application analyses. (Step 6)

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Activity: D. Validation

Task: D. Same as Activity

PI S. J. Bauer

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		Control of contractor services applies.
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		

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):

PI	Arthur Mansure 10/9/86	PQA	Connie Chase 10/9/86
Supervisor	Leo W Scully 10/9/86	TPO	Thomas O. Hunter 10/9/86
WMPO (PQA)	[illegible] 10/10/86	WMPO (Tech)	[illegible] 10/[illegible]

<u>List of Activities and Tasks</u>

A. Design Parameter Evaluations

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

B. Far-Field Thermomechanical Evaluation

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

C. Excavation Stability Analysis

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

D. Layout Analysis

D.1. Preliminary Determination of Area Needed for the Underground Facility.
D.2. Preliminary Comparison of Layout to the 3-D Model of Yucca Mountain.
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.

F. Scoping Studies for Establishing the Design Analysis Approach.

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. <u>Principal Investigator</u>

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

3. <u>Statement of Work</u>

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 (Previously Approved - QALAS 109, Rev. B)

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 (Previously Approved - QALAS 109, Rev. B)

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 (Previously Approved - QALAS 109, Rev. B)

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 (Previously Approved - QALAS 109, Rev. B)

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 thermomechanical 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 (Previously Approved - QALAS 110, Rev. B)

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 thermomechanical 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 (Previously Approved - QALAS 110, Rev. B)

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 (Previously Approved - QALAS 110, Rev. B)
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 (Previously Approved - QALAS 110, Rev. B)
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 (Previously Approved - QALAS 111, Rev. B)
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 (Previously Approved - QALAS 111, Rev. B)
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 8.3.2.5.

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 (Previously Approved - QALAS 124, Rev. B)

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 (Previously Approved - QALAS 124, Rev. B)

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 (Previously Approved - QALAS 124, Rev. B)

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 (Previously Approved - QALAS 125, Rev. B)
h. Remarks: This task involves a performance tradeoff study for horizontal versus vertical emplacement.

F. Scoping Studies for Establishing the Design Analysis Approach.

a. Purpose: In order to determine the best approach for confirming the design meets constraints or for choosing between design alternatives, it is necessary to do calculations to evaluate various calculational procedures. Also in order to prepare inputs to the RIB and SCP, it is necessary to do scoping studies.
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: Finite element methods, boundary element methods, and engineering work station with standard CAD software capable of three-dimensional display of the geology and design.
d. Technical Procedures:
   Available Procedures - None.
   Needed Procedures - None.
e. Computer Codes:
   Available Computer Codes - COYOTE, SPECTROM, ARRAYF, SIM, JAC, ADINA, HEFF, STRESS3D, BMINES, LINED, BELP, VISCOT, and DOT.
   Needed Computer Codes - None.
f. Documentation of Results: Memos, the Rib, and the SCP will be used to document this work.
g. Quality Assurance Level: III
h. Remarks: Work done under this activity will be for scoping purposes and will not support the ACD or LAD.

4. <u>Data and Materials Needed</u>

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

Task F. Scoping Studies for Establishing the Design Analysis Approach.

Data Needed - Material properties and reference designs.
Source of Data - Tuff Data Base and SCP-CDR.
Quality of Data - As defined in the Tuff Data Base.

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

5. <u>Non-Standard Methods or Techniques</u>

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. <u>Location of Work Performance</u>

Sandia National Laboratories, Albuquerque, NM.

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

7. <u>Quality Assurance Requirements</u>

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: Activity F.

8. <u>Application of Results</u>

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 57 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
N414	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)

Milestone Number	Description and Criteria	Completion Date
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
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

Milestone Number	Description and Criteria	Completion Date
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
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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.

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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		

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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		

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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		

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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-Q

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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 Lev II because Step 10 of t 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.

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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		

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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		

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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		

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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		

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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.

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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		

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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		

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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.

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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		

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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		

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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		

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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.

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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		

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Activity: F. Scoping Studies for Establishing the Design Analysis Approach

Task Description	QA Level	QA Criteria	Level Justification
F. Same as Activity	III	* 1-7 15-18	QA Level III is assign because this activity is for scoping purposes and will not be used to support ACD or LAD. (Steps 1-11 do not app

* QA LEVEL III CRITERIA FOR SNL USE ONLY

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Activity: F. Scoping Studies for Establishing the Design Analysis Approach

Task: F. 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		
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		

MODIFIED WORK PLAN TO SUPPORT QUALITY ASSURANCE LEVEL ASSIGNMENTS

for

Sandia National Laboratories

NNWSI WBS ELEMENT 1.2.4.6.3.S

PRECLOSURE SAFETY ANALYSES

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<u>List of Activities and Tasks</u>

A. Radiation Protection Design and Performance Criteria and Design Options

A.1. Design and Performance Criteria Development and Design Evaluation

B. Radiation Exposures Under Normal Conditions

B.1. ACD Normal Conditions Predicted Exposures
B.2. LAD Normal Conditions Predicted Exposures

C. Radiation Exposures Under Accident Conditions

C.1. Conceptual Design Accident Conditions Predicted Exposures
C.2. ACD Accident Conditions Predicted Exposures
C.3. LAD Accident Conditions Predicted Exposures

D. Preclosure Criticality Assessment

D.1. ACD Preclosure Criticality Assessment
D.2. LAD Preclosure Criticality Assessment

E. Retrievability Assessment

E.1. ACD Retrievability Assessment
E.2. LAD Retrievability Assessment

WBS 1.2.4.6.3.S PRECLOSURE SAFETY ANALYSES

1. Objectives and Issues Addressed

A. Objectives

The objective is to assess the compliance of the Yucca Mountain Mined Geologic Disposal System (MGDS) design with the radiation protection, criticality, and retrievability regulations. Assessments are performed during each phase of the repository desic and provide feedback in the design process to ensure that the final design of the Yucca Mountain MGDS will comply with all applicable regulations.

B. Issues Addressed

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

1. This WBS element will address the following Issues:

Issue 2.1 During repository operation and closure, (a) will the expected average radiation dose to members of the p' within any highly populated area be less than a sma. fraction of the allowable limits, and (b) will the expected radiation dose received by any member of the public in an unrestricted area be less than the allowabl limits as required by 10 CFR 60.111, 40 CFR 191 Part A, and 10 CFR Part 20?

Issue 2.2 Can the repository be designed, constructed, and operate in a manner that ensures the radiological safety of workers under normal operations as required by 10 CFR 60.111 and 10 CFR Part 20?

Issue 2.3 Can the repository be designed, constructed, and operate so that credible accidents do not result in projected radiological exposures of the general public at the nearest boundary of the unrestricted area, or workers in the restricted area, in excess of applicable values?

Issue 2.6 Have the characteristics and configurations of the repository been adequately established to (a) show compliance with the preclosure design criteria of 10 CFR 60.131 through 60.133, and (b) provide information to support resolution of the performance issues?

Issue 4.1 Will the repository preserve the option of waste retrieval as required by 10 CFR 60.111 using reasonabl available technology?

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

Issue 3.6

3.6.8 A detailed description of all sources of radioactivity associated with normal operations and projected operational occurrences.

Issue 4.5

4.5.7 Development and demonstration of required equipment.

4.5.8 Reference preclosure repository design.

4.5.9 Determination that the surface facilities can be constructed, operated, closed, and decommissioned with reasonably available technology.

4.5.10 Determination that the underground facilities can be constructed, operated, closed, and decommissioned with reasonably available technology.

4.5.12 Determination that the repository will meet the requirements for permanent closure.

C. Regulations and Requirements Addressed

The Issues and Information Needs addressed under this WBS address the following regulations: 10 CFR Part 20; 10 CFR 60.111; 10 CFR 60.131 through 10 CFR 60.133; and 40 CFR Part 191, Subpart A. Other 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 work performed under this WBS element and other work in the project is partially addressed in the NNWSI Site Characterization Plan (SCP), Chapter 6 (Sections 6.4.4 and 6.4.5), and Chapter 8 (Sections 8.3.2.7, 8.3.5.2.1, 8.3.5.2.2, 8.3.5.2.3, and 8.3.5.3). The relationship will be discussed in detail in the Repository Design Plan (RDP).

2. Principal Investigators

T. W. Laub, Sandia National Laboratories (SNL), Albuquerque, NM, Principal Investigator for activities A, B, C, and D,

R. J. Flores, Sandia National Laboratories, Albuquerque, NM, Principal Investigator for activity E.

3. Statement of Work

A. Radiation Protection Design and Performance Criteria and Design Options

The preclosure radiological safety, criticality, and waste retrievability analyses described in activities B, C, D, and E below will provide the information that will be used in this activity. This activity will develop design and performance criteria to be used by designers to ensure the radiological safety of the workers and the public and to ensure the preservation of the retrieval option. During each stage of the repository design, information from activities B, C, D, and E will also include recommended design

modifications or design options to improve the radiological safety of the repository and the retrievability of the waste.

A.1. Design and Performance Criteria Development and Design Evaluation

a. Purpose: The purpose of this task is to develop and maintain the design and performance criteria for radiological safety and retrievability. Additionally, the design will be evaluated for compliance with the criteria and recommendations developed for new criteria and/or design changes to improve radiological safety and/or retrievability.
b. Issues and Information Needs: 2.1.1, 2.6.1, 2.6.4, 2.6.5, 2.6.6, 2.6.7, 2.6.8, 4.1.1, 4.5.1, 4.5.7, 4.5.8, 4.5.9, 4.5.10, and 4.5.12.
c. Methods, Techniques, and Equipment: Systems engineering techniques along with design and performance reviews will be used to perform this task. These are standard engineering methods and techniques.
d. Technical Procedures:
   Available Procedures - none.
   Needed Procedures - none.
e. Computer Codes:
   Available Computer Codes - none.
   Needed Computer Codes - none.
f. Documentation of Results: Criteria will be incorporated into the Subsystems Design Requirements document. Design evaluations will be documented as a part of design reports.
g. Quality Assurance Level: II
h. Remarks: This task supports the comparative technical analysis of ACD alternative design concepts. A Quality Assurance Level II assignment is therefore required.

B. Radiation Exposures Under Normal Conditions

For normal conditions of MGDS construction, operation, closure and decommissioning, public and worker radiation exposures will be calculated as part of the radiological safety assessment of the repository. Two iterations of this assessment will be performed. The first assessment will be performed during the Advanced Conceptual Design Studies (ACDS) and will contribute to the basis for the License Application Design (LAD). The second assessment will be performed during the LAD and will provide input to the License Application.

B.1. ACD Normal Conditions Predicted Exposures

a. Purpose: This task is the first iteration of this activity. This task will assess the radiological safety of the repository for normal operating conditions. The analysis detail will be consistent with the detail available in the current design. The scope of this task includes exposures of both workers and the public. Scoping analyses have been performed for the Repository

Conceptual Design in support of site characterization. The results of this task will contribute to the basis for LAD.

b. Issues and Information Needs: 2.1.3, 2.1.4, 2.1.5, and 3.6.8.
c. Methods, Techniques, and Equipment: standard engineering and risk assessment techniques.
d. Technical Procedures:
   Available Procedures - none.
   Needed Procedures - none.
e. Computer Codes:
   Available Computer Codes - A list of typical computer codes available to perform this task may be found in NUREG/CR-3209. Other computer codes may be used when necessary.
   Needed Computer Codes - Part of this task will be to select appropriate computer codes for this analysis and assess the verification/validation requirements of these codes.
f. Documentation of Results: The results of this task will be documented in SLTR86-1006.
g. Quality Assurance Level: II
h. Remarks: This task involves the continuing development of models and analytical methods for radiological safety analysis of the repository. A Quality Assurance Level II assignment is therefore required.

B.2. LAD Normal Conditions Predicted Exposures

a. Purpose: This task is the final iteration of this activity. The purpose of this task is to perform analyses to resolve preclosure public health and safety issues. This task will assess the repository design to ascertain compliance with radiological safety regulations as a part of the Safety Analysis Report and the License Application. The scope of this task includes exposures of both workers and the public.
b. Issues and Information Needs: 2.1.3, 2.1.4, 2.1.5, and 3.6.8.
c. Methods, Techniques, and Equipment: standard engineering and risk assessment techniques.
d. Technical Procedures:
   Available Procedures - none.
   Needed Procedures - none.
e. Computer Codes:
   Available Computer Codes - Computer codes will be selected in task B.1.
   Needed Computer Codes - none.
f. Documentation of Results: The results of this task will be documented in a SAND report whose title and number are still to be determined.
g. Quality Assurance Level: I
h. Remarks: Again, the purpose of this task is to perform analyses to resolve preclosure public health and safety issues. A Quality Assurance Level I assignment is therefore required.

C. Radiation Exposures Under Accident Conditions

Public and worker radiation exposures will be calculated for accident conditions during operation and decommissioning of the repository. Accident scenarios used in this analysis will be developed using risk assessment methodologies. These will include analyses such as Failure Modes and Effects, Common-Cause Failures, Human Reliability, Fault Trees, and Event Trees. Three iterations of this assessment will be performed. The first assessment will be used to develop a preliminary Q-List for Repository Conceptual Design for Site Characterization. The second assessment will be performed during the Advanced Conceptual Design Studies (ACDS) and will contribute to the basis for the License Application Design (LAD). Finally, the third assessment will be performed during the LAD and will provide input to the License Application.

C.1. Conceptual Design Accident Conditions Predicted Exposures

a. Purpose: This task is the first iteration of this activity. This task will assess the radiological safety of the repository for accident conditions. The analysis detail will be consistent with the detail available in the current design. The scope of this task includes exposures of both workers and the public. This task will also provide the information necessary to make a preliminary determination of items important to saf[illegible] for inclusion in the SCP Q-List.
b. Issues and Information Needs: 2.3 and 3.6.8.
c. Methods, Techniques, and Equipment: standard engineering and risk assessment techniques.
d. Technical Procedures:
   Available Procedures - none.
   Needed Procedures - none.
e. Computer Codes:
   Available Computer Codes - A list of typical computer codes available to perform this task may be found in NUREG/CR-3209. Other computer codes may be used when necessary.
   Needed Computer Codes - Part of this task will be to select appropriate computer codes for this analysis and assess the verification/validation requirements of these codes.
f. Documentation of Results: The results of this task will be documented in SLTR86-1005.
g. Quality Assurance Level: II
h. Remarks: This task involves a preliminary phase of model and analysis development. A Quality Assurance Level II assignment is therefore required.

C.2. ACD Accident Conditions Predicted Exposures

a. Purpose: This task is the second iteration of this activity. This task will assess the radiological s[illegible] of the repository for accident conditions. The ana[illegible]s detail will be consistent with the detail available in the current design. The scope of this task includes

exposures of both workers and the public. This task will also provide the information necessary to verify and update the items important to safety included on th preliminary Q-List developed under task C.1. The results of this task will contribute to the basis for LAD.

b. Issues and Information Needs: 2.3 and 3.6.8.
c. Methods, Techniques, and Equipment: standard engineering and risk assessment techniques.
d. Technical Procedures:
   Available Procedures - none.
   Needed Procedures - none.
e. Computer Codes:
   Available Computer Codes - A list of typical computer codes available to perform this task may be found i NUREG/CR-3209. Other computer codes may be used when necessary.
   Needed Computer Codes - Part of this task will be to select appropriate computer codes for this analysis and assess the verification/validation requirements of thes codes.
f. Documentation of Results: The results of this task will be documented in SLTR86-1007.
g. Quality Assurance Level: II
h. Remarks: This task involves the continuing development of models and analytical methods for radiological safety analysis of the repository. A Quality Assurance Level II assignment is therefore required.

C.3. LAD Accident Conditions Predicted Exposures

a. Purpose: This task is the final iteration of this activity. This purpose of this task is to perform analyses to resolve preclosure public health and safety issues. This task will assess the repository design to ascertair compliance with radiological safety regulations as a part of the Safety Analysis Report and the License Application. The scope of this task includes exposures of both workers and the public. This task will also provide the information necessary to finalize the items important to safety included on the final Q-List.
b. Issues and Information Needs: 2.3 and 3.6.8.
c. Methods, Techniques, and Equipment: standard engineering and risk assessment techniques.
d. Technical Procedures:
   Available Procedures - none.
   Needed Procedures - none.
e. Computer Codes:
   Available Computer Codes - Computer codes will be selected in task C.2.
   Needed Computer Codes - none.
f. Documentation of Results: The results of this task will be documented in a SAND report whose title and number are still to be determined.
g. Quality Assurance Level: I

h. Remarks: Again, the purpose of this task is to perform analyses to resolve preclosure public health and safety issues. A Quality Assurance Level I assignment is therefore required.

D. Preclosure Criticality Assessment

For the normal and accident conditions of MGDS operation and decommissioning, the conditions of nuclear criticality will be evaluated. The criticality scenarios will be developed using many of the same risk assessment methodologies mentioned in activity C. The criticality scenarios that will be evaluated will be selected on the basis of the credibility of the initiating events. Evaluation of the criticality scenarios will be performed in accordance with 10 CFR 60.131(b)(7). Two iterations of this assessment will be performed. The first assessment will be performed during the Advanced Conceptual Design Studies (ACDS) and will contribute to the basis for the License Application Design (LAD). The second assessment will be performed during the LAD and will provide input to the License Application.

D.1. ACD Preclosure Criticality Assessment

a. Purpose: This task is the first iteration of this activity. This task will assess the potential for a criticality accident given the current repository design. The analysis detail will be consistent with the detail available in the current design. The results of this task will contribute to the basis for LAD.
b. Issues and Information Needs: 2.3, 2.6.6, and 3.6.8.
c. Methods, Techniques, and Equipment: standard engineering and criticality assessment techniques.
d. Technical Procedures:
   Available Procedures - none.
   Needed Procedures - none.
e. Computer Codes:
   Available Computer Codes - A list of typical computer codes available to perform this task may be found in NUREG/CR-3209. Other computer codes may be used when necessary.
   Needed Computer Codes - Part of this task will be to select appropriate computer codes for this analysis and assess the verification/validation requirements of these codes.
f. Documentation of Results: The results of this task will be documented in an SLTR whose title and number are still to be determined.
g. Quality Assurance Level: II
h. Remarks: This task involves a preliminary phase of model and analysis development supporting validation of methods. A Quality Assurance Level II assignment is therefore required.

D.2. LAD Preclosure Criticality Assessment

a. Purpose: This task is the final iteration of this activity. This task will assess the repository design to ascertain compliance with radiological safety regulations related to criticality safety as a part of the Safety Analysis Report and the License Application.
b. Issues and Information Needs: 2.3, 2.6.6, and 3.6.8.
c. Methods, Techniques, and Equipment: standard engineering and criticality assessment techniques.
d. Technical Procedures:
   Available Procedures - none.
   Needed Procedures - none.
e. Computer Codes:
   Available Computer Codes - A list of typical computer codes available to perform this task may be found in NUREG/CR-3209. Other computer codes may be used when necessary.
   Needed Computer Codes - Part of this task will be to select appropriate computer codes for this analysis and assess the verification/validation requirements of these codes.
f. Documentation of Results: The results of this task will be documented in a SAND report whose title and number are still to be determined.
g. Quality Assurance Level: I
h. Remarks: This purpose of this task is to perform analyses to resolve preclosure public health and safety issues. A Quality Assurance Level I assignment is therefore required.

E. Retrievability Assessment

For the normal and abnormal conditions under which retrieval may need to be performed, the ability to retrieve emplaced radioactive waste at any time prior to closure will be assessed. The retrieval scenarios involving abnormal conditions will be developed using risk assessment methodologies as discussed under activity C. The retrieval scenarios involving abnormal conditions that will be evaluated will be selected on the basis of the credibility of the initiating events. Two iterations of this assessment will be performed. The first assessment will be performed during the Advanced Conceptual Design Studies (ACDS) and will contribute to the basis for the License Application Design (LAD). The second assessment will be performed during the LAD and will provide input to the Safety Analysis Report and the License Application.

E.1. ACD Retrievability Assessment

a. Purpose: This task is the first iteration of this activity. The task will assess the ability of the repository design to preserve the option to retrieve emplaced waste. The assessment will be performed at a level of detail consistent with available design information. The results of this task will contribute to the basis for LAD.
b. Issues and Information Needs: 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.1.5, 4.1.6, 4.5.7, 4.5.8, 4.5.9, 4.5.10, and 4.5.12.

c. Methods, Techniques, and Equipment: standard enginee. techniques.
d. Technical Procedures:
Available Procedures - none.
Needed Procedures - none.
e. Computer Codes:
Available Computer Codes - none.
Needed Computer Codes - none.
f. Documentation of Results: The results of this task will documented in a SAND report whose title and number are still to be determined.
g. Quality Assurance Level: II
h. Remarks: This task involves a preliminary phase of model and analysis development supporting validation of methods. A Quality Assurance Level II assignment is therefore required.

E.2. LAD Retrievability Assessment

a. Purpose: This task is the final iteration of this activity This task will assess the repository design to ascertai compliance with retrievability requirements as a part c the Safety Analysis Report and the License Application.
b. Issues and Information Needs: 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.1.5, 4.1.6, 4.5.7, 4.5.8, 4.5.9, 4.5.10, and 4.5.12.
c. Methods, Techniques, and Equipment: standard engineerinc techniques.
d. Technical Procedures:
Available Procedures - none.
Needed Procedures - none.
e. Computer Codes:
Available Computer Codes - none.
Needed Computer Codes - none.
f. Documentation of Results: The results of this task will documented in a SAND report whose title and number are still to be determined.
g. Quality Assurance Level: I
h. Remarks: This purpose of this task is to perform baseline analyses required to resolve issues regarding waste retrievability. A Quality Assurance Level I assignment is therefore required.

4. Data and Materials Needed

Task A.1. Design and Performance Criteria Development

Data Needed - Regulatory requirements and DOE requirements.
Source of Data - Code of Federal Regulations and DOE Orders.
Quality of Data - N/A

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

Task A.2. Recommended Design Modifications

Data Needed - Design deficiencies.
Source of Data - Activities B, C, D, and E.
Quality of Data - Quality is to be consistent with the quality of the activities.

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

Task B.1. ACD Normal Conditions Predicted Exposures

Data Needed - Repository reference design, waste characteristics and amounts, repository operations plan.
Source of Data - Project baselined documents and the NNWSI Reference Information Base.
Quality of Data - Quality is to be consistent with the quality assigned to the baselined document or Reference Information Base.

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

Task B.2. LAD Normal Conditions Predicted Exposures

Data Needed - Repository reference design, waste characteristics and amounts, repository operations plan.
Source of Data - Project baselined documents and the NNWSI Reference Information Base.
Quality of Data - Quality is to be consistent with the quality assigned to the baselined document or Reference Information Base.

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

Task C.1. Conceptual Design Accident Conditions Predicted Exposures

Data Needed - Repository reference design, waste characteristics and amounts, repository operations plan, site data, and meteorological data.
Source of Data - Project baselined documents and the NNWSI Reference Information Base.
Quality of Data - Quality is to be consistent with the quality assigned to the baselined document or Reference Information Base.

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

Task C.2. ACD Accident Conditions Predicted Exposures

Data Needed - Repository reference design, waste characte
and amounts, repository operations plan, site data, an
meteorological data.
Source of Data - Project baselined documents and the NNWSI
Reference Information Base.
Quality of Data - Quality is to be consistent with the quality
assigned to the baselined document or Reference Informatio
Base.

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

Task C.3. LAD Accident Conditions Predicted Exposures

Data Needed - Repository reference design, waste characteristic
and amounts, repository operations plan, site data, and
meteorological data.
Source of Data - Project baselined documents and the NNWSI
Reference Information Base.
Quality of Data - Quality is to be consistent with the quality
assigned to the baselined document or Reference Information
Base.

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

Task D.1. ACD Preclosure Criticality Assessment

Data Needed - Repository reference design, waste characteristic
and amounts, repository operations plan.
Source of Data - Project baselined documents and the NNWSI
Reference Information Base.
Quality of Data - Quality is to be consistent with the quality
assigned to the baselined document or Reference Information
Base.

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

Task D.2. LAD Preclosure Criticality Assessment

Data Needed - Repository reference design, waste characteristic
and amounts, repository operations plan.
Source of Data - Project baselined documents and the NNWSI
Reference Information Base.
Quality of Data - Quality is to be consistent with the quality
assigned to the baselined document or Reference Information
Base.

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

Task E.1. ACD Retrievability Assessment

Data Needed - Repository reference design, waste characteristics and amounts, repository operations plan.
Source of Data - Project baselined documents and the NNWSI Reference Information Base.
Quality of Data - Quality is to be consistent with the quality assigned to the baselined document or Reference Information Base.

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

Task E.2. LAD Retrievability Assessment

Data Needed - Repository reference design, waste characteristics and amounts, repository operations plan.
Source of Data - Project baselined documents and the NNWSI Reference Information Base.
Quality of Data - Quality is to be consistent with the quality assigned to the baselined document or Reference Information Base.

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

5. <u>Non-Standard Methods or Techniques</u>

Task A.1. None.
Task B.1. None.
Task B.2. None.
Task C.1. None.
Task C.2. None.
Task C.3. None.
Task D.1. None.
Task D.2. None.
Task E.1. None.
Task E.2. None.

6. <u>Location of Work Performance</u>

Sandia National Laboratories, Albuquerque, NM

Contractors: Bechtel National, Inc. (BNI), San Francisco, CA
Parson, Brinckerhoff, Quade, and Douglas, Inc. (PBQ&D), San Francisco, CA

7. <u>Quality Assurance Requirements</u>

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

Quality Assurance Level I: B.2, C.3, D.2, and E.2.
Quality Assurance Level II: A.1, B.1, C.1, C.2, D.1, and E.1.

8. <u>Application of Results</u>

The results obtained from the activities of this WBS element will iteratively feed back to the design activities to guide the development of the MGDS. This feedback will ensure the development of a MGDS that will satisfy radiological protection, criticality, and retrievability requirements. The results will also be used to develop the Safety Analysis Report for the License Application and to develop the pertinen portions of the Environmental Impact Statement.

9. Schedule

Starting date: 1983; anticipated ending date: 1992

10. Past and Expected Achievements

A. Past Achievements

The following reports have been published:

"Preliminary Safety Assessment Study for the Conceptual Design of a Repository in Tuff at Yucca Mountain," SAND83-1504

Preclosure radiological safety section of the "NNWSI Project Final Environmental Assessment"

"Retrieval of Spent Fuel from a Repository in Tuff," SAND84-1748C

"Retrievability: Strategy for Compliance Demonstration," SAND84-2242

B. Expected Achievements

FY86

A radiological safety analysis of accident conditions will be completed to support a preliminary Q-List to be presented in the NNWSI Project site characterization Plan (SCP) and in "Repository Conceptual Design in Support of Site Characterization," SAND84-2641.

Issue resolution strategies will be developed for Issues 2.1, 2.2, 2.3, 2.6, and 4.1. The strategy for resolving these issues will be presented in complete form in the RDP with portions pertaining to site characterization presented in the SCP.

A SAND Report will be issued entitled "System Requirements and Design Guidance for Control of Radiation Exposures Associated with Naturally Occurring Radioactivity at the Yucca Mountain Repository," SAND84-0386 (Milestone N463).

A SAND Report will be issued entitled "Normal Conditions, Accident Scenarios, and Source Terms for Preclosure Safety Analysis of the Prospective Yucca Mountain Repository,"SAND85-2543 (Milestone N464).

FY87

Complete preclosure radiological safety, criticality, and retrievability assessments will be performed to a level of detail

consistent with the level of detail available in repository design information. These assessments, including an update of the preclosure Q-List, will be documented in a Preclosure Repository Performance Assessment Report (Milestone M038).

FY88 and FY89

Preclosure radiological safety, criticality, and retrievability assessments will be performed in complete detail necessary for the Safety Analysis Report (SAR) of the License Application and for the Environmental Impact Statement (EIS). These assessments will be documented within the SAR with necessary information presented in the EIS.

11. Milestones and Deliverables

Milestone Number	Description and Criteria	Completion Date
Level 2		
N463	System Requirements and Design Guidance for Control of Radiation Exposures Associated with Naturally Occurring Radioactivity at the Prospective Yucca Mountain Repository The deliverable is SAND Report 84-0386 that will contribute to the resolution of Issues 2.1, 2.2, and 2.6.	09/30/86
N464	Normal Conditions, accident Scenarios, and Source Terms for Preclosure Safety Analysis of the Prospective Yucca Mountain Repository. The deliverable is a SAND Report on source terms, normal conditions of the repository, and accident conditions of the repository derived from risk assessments of the repository advanced conceptual design.	09/30/86
M038	Preclosure Performance Assessment Report to Support the Advanced Conceptual Design Report	06/30/87
M064	Preclosure Performance Assessment Report to Support the License Application Design Report	06/30/89
M068	Preclosure Performance Assessment Input for Enclosure in the License Application	04/30/90

12. Costs

Costs are in thousands of expenditure-year dollars.

FY86

SNL Labor Costs: $ 60 Other Costs: $234

FY87

SNL Labor Costs: $236 Other Costs: $235

FY88

SNL Labor Costs: $256 Other Costs: $321

FY89

SNL Labor Costs: $266 Other Costs: $1,434

13. Performance Measurement

Level of effort.

NNWSI QUALITY ASSURANCE LEVEL ASSIGNMENT SNL-QA-0

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Rev. B

QALAS No. 084
Rev. B
Page 1 of 1

APPROVALS (Signature and Date)

PI T. W. Laub 8/4/86
Supervisor [illegible] 8/5/86
WMPO (PQM) James Blaylock 8/8/86

PQA Connie Chocas 8/5/86
TPO Thomas O. Hunter 8/5/86
WMPO (Tech) [illegible] 8-8-86

Activity: A. Radiation Protection Design and Performance Criteria and Design Options

Task Description	QA Level	QA Criteria	Level Justification
A.1. Design and Performance Criteria Development and Design Evaluation	II	1 thru 7, and 15 thru 18	Step 10 of the logic diagram applies to this task because this task supports comparative technical analysis of alternative designs.

QUALITY LEVEL ASSIGNMENT CRITERIA SHEET

WP No. 12463-86 QALAS No. 084
Rev. B Rev. B

Activity: A. Radiation Protection Design and Performance Criteria and Design Options

Task: A.1. Design and Performance Criteria Development and Design Evaluation PI T. W. Laub

QA Criterion	Applies	Does Not Apply	Comments
1. QA Organization	X		
2. QA Program	X		
3. Design & Scientific Investigation Control	X		Scientific Investigation requirements only
4. Procurement Document Control	X		
5. Instructions Procedures & Drawings	X		
6. Document Control	X		Applies to SLTR SAND document r
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 involve
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-0(

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QALAS No. 085
Rev. B
Page 1 of 1

APPROVALS (Signature and Date)

PI T. W. Laub 8/4/86
Supervisor [signature] 8/5/86
WMPO (PQM) James B Gaylord 8/8/86

PQA Connie Chocas 8/5/86
TPO Thomas O. Hunter 8/5/86
WMPO (Tech) [signature] 8-8-86

Activity: B. Radiation Exposures Under Normal Conditions

Task Description	QA Level	QA Criteria	Level Justification
B.1. ACD Normal Conditions Predicted Exposures	II	1 thru 7, and 15 thru 18	Step 8 of the logic diagram applies to this task, and this task involves a preliminary phase of model and analysis development supporting validation of methods.
B.2. LAD Normal Conditions Predicted Exposures	I	1 thru 7, and 15 thru 18	Step 1 to the logic diagram applies to this task because the purpose of this task is to perform baseline analyse required to resolve issues regarding pre-closure public health an safety.

QUALITY LEVEL ASSIGNMENT CRITERIA SHEET

WP No. 12463-86 QALAS No. 085
Rev. B Rev. B

Activity: B. Radiation Exposures Under Normal Conditions

Task: B.1. ACD Normal Conditions Predicted Exposures PI T. W. Laub

QA Criterion	Applies	Does Not Apply	Comments
1. QA Organization	X		
2. QA Program	X		
3. Design & Scientific Investigation Control	X		Scientific Investigation requirements only
4. Procurement Document Control	X		
5. Instructions Procedures & Drawings	X		
6. Document Control	X		Applies to SLTR and SAND document rev
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 involve
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		

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Activity: B. Radiation Exposures Under Normal Conditions

Task: B.2. LAD Normal Conditions Predicted Exposures PI T. W. Laub

QA Criterion	Applies	Does Not Apply	Comments
1. QA Organization	X		
2. QA Program	X		
3. Design & Scientific Investigation Control	X		Scientific Investigation requirements only
4. Procurement Document Control	X		
5. Instructions Procedures & Drawings	X		
6. Document Control	X		Applies to SLTR and SAND document review
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 involve
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-0

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QALAS No. 086
Rev. B
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APPROVALS (Signature and Date)

PI T. W. Laub 3/4/86

Supervisor Scott Sinnock 8/5/86

WMPO (PQM) James Blaylock 8/8/86

PQA Connie Chocas 3/5/86

TPO Thomas O. Hunter 8/5/86

WMPO (Tech) [illegible] 8-8-86

Activity: C. Radiation Exposures Under Accident Conditions

Task Description	QA Level	QA Criteria	Level Justification
C.1. Conceptual Design Accident Conditions Predicted Exposures	II	1 thru 7, and 15 thru 18	Step 10 of the logic diagram applies to this task, and this task involves a preliminary phase of model and analysis development.
C.2. ACD Accident Conditions Predicted Exposures	II	1 thru 7, and 15 thru 18	Step 8 of the logic diagram applies to task, and this task involves a preliminary phase of model and analysis development supporting validation of methods.
C.3. LAD Accident Conditions Predicted Exposures	I	1 thru 7, and 15 thru 18	Step 1 to the logic diagram applies to this task because the purpose of this task is to perform baseline analyse required to resolve issues regarding pre-closure public health an safety.

QUALITY LEVEL ASSIGNMENT CRITERIA SHEET

WP No. 12463-86 QALAS No. 086
Rev. B Rev. B

Activity: C. Radiation Exposures Under Accident Conditions

Task: C.1. Conceptual Design Accident Conditions Exposures PI T. W. Laub

QA Criterion	Applies	Does Not Apply	Comments
1. QA Organization	X		
2. QA Program	X		
3. Design & Scientific Investigation Control	X		Scientific Investigation requirements only
4. Procurement Document Control	X		
5. Instructions Procedures & Drawings	X		
6. Document Control	X		Applies to SLTR and SAND document review
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		

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WP No. 12463-86　　　　QALAS No. 086
Rev. B　　　　Rev. B

Activity: C. Radiation Exposures Under Accident Conditions

Task: C.2. ACD Accident Conditions Predicted Exposures　　　　PI T. W. Laub

QA Criterion	Applies	Does Not Apply	Comments
1. QA Organization	X		
2. QA Program	X		
3. Design & Scientific Investigation Control	X		Scientific Investigation requirements only
4. Procurement Document Control	X		
5. Instructions Procedures & Drawings	X		
6. Document Control	X		Applies to SLTR & SAND document re
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. 12463-86 QALAS No. 086
Rev. B Rev. B

Activity: C. Radiation Exposures Under Accident Conditions

Task: C.3. LAD Accident Conditions Predicted Exposures PI T. W. Laub

QA Criterion	Applies	Does Not Apply	Comments
1. QA Organization	X		
2. QA Program	X		
3. Design & Scientific Investigation Control	X		Scientific Investigation requirements only
4. Procurement Document Control	X		
5. Instructions Procedures & Drawings	X		
6. Document Control	X		Applies to SLTR and SAND document review
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		

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QALAS No. 087
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APPROVALS (Signature and Date)

PI T. W. Kaul 8/4/86

PQA Connie Chorus 8/5/86

Supervisor Scott Sinnock 8/5/86

TPO Thomas O. Hunter 8/5/86

WMPO (PQM) James Blaylock 8/5/86

WMPO (Tech) [illegible] 8-8-86

Activity: D. Preclosure Criticality Assessment

Task Description	QA Level	QA Criteria	Level Justification
D.1. ACD Preclosure Criticality Assessment	II	1 thru 7, and 15 thru 18	Step 8 of the logic diagram applies to this task and this task involves a preliminary phase of model and analysis development supporting validation of methods.
D.2. LAD Preclosure Criticality Assessment	I	1 thru 7, and 15 thru 18	Step 1 to the logic diagram applies to this task because the purpose of this task is to perform baseline analyse required to resolve issues regarding pre-closure public health an safety.

QUALITY LEVEL ASSIGNMENT CRITERIA SHEET

WP No. 12463-86 QALAS No. 087
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Activity: D. Preclosure Criticality Assessment

Task: D.1. ACD Preclosure Criticality Assessment PI T. W. Laub

QA Criterion	Applies	Does Not Apply	Comments
1. QA Organization	X		
2. QA Program	X		
3. Design & Scientific Investigation Control	X		Scientific Investigation requirements only
4. Procurement Document Control	X		
5. Instructions Procedures & Drawings	X		
6. Document Control	X		Applies to SLTR and SAND document review
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		

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QALAS No. 087
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Activity: D. Preclosure Criticality Assessment

Task: D.2. LAD Preclosure Criticality Assessment

PI T. W. Laub

QA Criterion	Applies	Does Not Apply	Comments
1. QA Organization	X		
2. QA Program	X		
3. Design & Scientific Investigation Control	X		Scientific Investigation requirements only
4. Procurement Document Control	X		
5. Instructions Procedures & Drawings	X		
6. Document Control	X		Applies to SLTR SAND document re
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		

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APPROVALS (Signature and Date)

PI T. W. Hunt 8/4/86
Supervisor Scott Sinnock 8/5/86
WMPO (PQM) James Blaylock 8/5/86

PQA Connie Chocas 8/5/86
TPO Thomas O. Hunter 8/5/86
WMPO (Tech) L R Kruse 5-8-86

Activity: E. Retrievability Assessment

Task Description	QA Level	QA Criteria	Level Justification
E.1. ACD Retrievability Assessment	II	1 thru 3, 5, 6, and 15 thru 18	Step 10 of the logic diagram applies to this task, and this task involves a preliminary phase of model and analysis development supporting validation of methods.
E.2. LAD Retrievability Assessment	I	1 thru 3, 5, 6, and 15 thru 18	Step 3 to the logic diagram applies to this task because the purpose of this task is to perform baseline analyse required to resolve an issue regarding waste retrievability.

QUALITY LEVEL ASSIGNMENT CRITERIA SHEET

WP No. 12463-86 QALAS No. 088
Rev. B Rev. B

Activity: E. Retrievability Assessment

Task: E.1. ACD Retrievability Assessment PI R. J. Flores

QA Criterion	Applies	Does Not Apply	Comments
1. QA Organization	X		
2. QA Program	X		
3. Design & Scientific Investigation Control	X		Scientific Investigation requirements only
4. Procurement Document Control		X	No procurement
5. Instructions Procedures & Drawings	X		
6. Document Control	X		Applies to SLTR and SAND document re[illegible]
7. Control of Purchased Material, Equipment, and Services		X	No purchase of materials, equipment, or services
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. 12463-86 QALAS No. 088
Rev. B Rev. B

Activity: E. Retrievability Assessment

Task: E.2. LAD Retrievability Assessment PI R. J. Flores

QA Criterion	Applies	Does Not Apply	Comments
1. QA Organization	X		
2. QA Program	X		
3. Design & Scientific Investigation Control	X		Scientific Investigation requirements only
4. Procurement Document Control		X	No procurement
5. Instructions Procedures & Drawings	X		
6. Document Control	X		Applies to SLTR and SAND document review
7. Control of Purchased Material, Equipment, and Services		X	No purchase of materials, equipment or services
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		

MODIFIED WORK PLAN TO SUPPORT QUALITY ASSURANCE LEVEL ASSIGNMENTS for Sandia National Laboratories

NNWSI WBS ELEMENT 1.2.4.2.1.1.S

ROCK-MASS ANALYSIS

Approvals (signature and date):

PI	Stephen J Bauer 7/25/86	PQA	Connie Chocas 7/25/86
Supervisor	Jack Tillerson 7/25/86	TPO	Thomas O. Hunter 7/25/86
WMPO (PQA)	James Blaylock 7/29/86	WMPO (Tech)	[illegible] 7/29/86

<u>List of Activities and Tasks</u>

A. Rock-Mass Thermomechanical Analysis

- A.1 Advanced Conceptual Design analysis of the in-situ stress state at Yucca Mountain including tectonics, field measurements and finite element calculations.
- A.2 Finite element calculations in support of the Advanced Conceptual Design using the compliant joint material model to better estimate rock-mass thermomechanical properties.
- A.3 Analysis to evaluate potential effects of faults (discrete discontinuities) on rock-mass integrity.
- A.4 Assessment of rock-mass properties leading to recommendations in support of analysis for the Advanced Conceptual Design and Site Characterization Plan.
- A.5 Assessment of rock-mass properties leading to recommendations in support of analysis for the License Application Design.

B. Post-Test Analysis of G-Tunnel Field Experiments

- B.1 Advanced Conceptual Design analysis of field experiments to evaluate the thermal and mechanical responses of the rock-mass.
- B.2 Finite element calculations in support of the Advanced Conceptual Design using the compliant joint model to better estimate rock-mass thermomechnical response.

WBS 1.2.4.2.1.1 ROCK-MASS ANALYSIS

1. Objective and Issues Addressed

A. The objective is to evaluate intact and rock-mass thermomechanical properties based on an analysis of available laboratory and field experiments and finite element analyses. This information will be used to recommend rock properties for calculations that support the Conceptual Design, Site Characterization Plan and License Application Design. Specifically, the laboratory and field data collected under WBS 1.2.4.2.1 will be used to determine recommended rock-mass properties.

B. Issues Addressed

The Issues and Information Needs addressed are based on the Yucca Mountain Issues Hierarchy dated 4/15/88.

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

Issue 1.7
- 1.7.3 Boundaries for the disturbed zone.

Issue 1.12
- 1.12.6 Predicted thermal and thermomechanical response of the host rock, surrounding strata, and groundwater system.

Issue 1.16
- 1.16.2 Spatial distribution of thermal and mechanical properties.
- 1.16.3 Spatial distribution of ambient stress and thermal conditions.

Issue 4.8
- 4.8.2 Spatial distribution of thermal and mechanical properties.
- 4.8.3 Spatial distribution of ambient stress and thermal conditions.

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

Issue 1.12
- 1.12.1 Site characterization information needed for design.

Issue 1.20
- 1.20.5 Potential effects of igneous and tectonic activity on rock characteristics.

Issue 4.8
- 4.8.1 Stratigraphy and structure necessary to locate the underground facility.

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 2 and Chapter 6 (Section 6.1.2). These chapters of the SCP will be prepared and updated using the material properties developed in this WBS. Information collected under WBS 1.2.4.2.1.2.S (Field Test), WBS 1.2.4.2.1.3.S (Laboratory Properties) and WBS 1.2.6.9.2.3.S (Exploratory Shaft Geomechanical Test) will be used to determine recommended properties. 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. <u>Principal Investigator</u>

S. J. Bauer, Division 6314, Sandia National Laboratories (SNL), Albuquerque, NM.

3. <u>Statement of Work</u>

A. Rock-Mass Thermomechanical Analysis

Rock-mass thermomechanical analysis will be performed to develop and evaluate techniques for combining data from (1) field tests that reflect rock-mass behavior and (2) laboratory tests that reflect the behavior of both fractures and the rock matrix. These analyses are essential to evaluate and recommend rock-mass properties for calculations used in determining the structural effects produced by excavation of the underground facilities and thermal effects due to heat produced by the emplaced waste. The following tasks will be performed in support of this activity.

A.1 Advanced Conceptual Design analysis of the In-Situ Stress State at Yucca Mountain Including Tectonics, Field Measurements and Finite Element Calculations.

a. Purpose: In order to determine the deformation moduli and other properties associated with the rock mass from field experimental data, the in-situ stress must be known. The normal compliance and shear strength of joints depend on the local state of stress. In-situ stress is also an important design parameter for all underground facilities design activities. In this task, the in-situ stress at Yucca Mountain will be derived from a combination of analytical methods and verified by field data.

b. Information Needs: 1.7.3, 1.12.1, 1.12.6, 1.16.2, 1.16.3, 1.20.5, 4.8.1, 4.8.2, 4.8.3

c. Methods, Techniques, and Equipment: Finite element methods, standard statistical methods for data analysis.

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

e. Computer Codes:
   Available Computer Codes - SANCHO, JAC2D, JAC3D, ABAQUS, COYOTE, and SPECTROM-31 may be used for thermomechanical analysis.
   Needed Computer Codes - None.

f. Documentation of Results: Results will be reported in SAND reports.

g. Quality Assurance Level: II

h. Remarks: Results will provide in-situ stress values for comparative technical analysis of alternatives in support of ACD activities.

A.2 Finite Element Calculations in support of the Advanced Conceptual Design Using the Compliant Joint Material Model to Better Estimate Rock-Mass Thermomechanical Properties.

a. Purpose: Thermomechanical properties of the rock mass cannot be determined directly but must be derived from the results of laboratory tests on intact rock and from field data that reflect the behavior of a small portion of the rock mass. Finite element analyses using a rock-mass model can be used to estimate the necessary properties. Scoping calculation will be performed to establish preliminary rock-mass properties and model parameters to be used in design analysis of the ES experiments (WBS 1.2.6.9.2.3.S).

b. Information Needs: 1.7.3, 1.12.1, 1.12.6, 1.16.2, 1.16.3, 1.20.5, 4.8.1, 4.8.2, 4.8.3

c. Methods, Techniques and Equipment: Finite element methods.

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

e. Computer Codes:
   Available Computer Codes - SANCHO, JAC2D, JAC3D, ABAQUS, COYOTE, and SPECTROM-31 may be used for thermomechanical analysis.
   Needed Computer Codes - None.

f. Documentation of Results: Results will be documented in SAND reports.

g. Quality Assurance Level: II

h. Remarks: Results will assist in defining rock mass properties from laboratory and field data and assist in model development. The methods developed will be used to estimate rock-mass mechanical and thermal properties for comparative technical analysis of alternatives in support of ACD. Several different codes may be used according to capability to solve three classes of mechanical problems (linear elastic/elastic-plastic, compliant joint and discrete discontinuities). Linear and nonlinear, steady and transient heat transfer codes are desired

for thermal analyses. When mechanical and thermal codes are used sequentially on a specific problem, the overall analysis is termed thermomechanical.

A.3 Analyses to Evaluate Potential Effects of Faults (Discrete Discontinuities) on Rock-Mass Integrity.

a. Purpose: The effect of the presence of discrete discontinuities (faults and fractures) on rock-mass integrity will be investigated. The local stress conditions required to initiate slip on a fault will be estimated from field data. Finite element calculations will be used to assess the potential for fault motion as a result of repository thermomechanical loading. This task will provide recommended values of fracture (fault) characteristics for analyses performed in WBS 1.2.4.2.1.3.S (Design Analysis).
b. Information Needs: 1.7.3, 1.12.1, 1.12.6, 1.16.2, 1.16.3, 1.20.5, 4.8.1, 4.8.2, 4.8.3
c. Methods, Techniques and Equipment: Finite elements methods, standard statistical methods for data analysis.
d. Technical Procedures:
   Available Procedures - None.
   Needed Procedures - None.
e. Computer Codes:
   Available Computer Codes - SANCHO, JAC2D, JAC3D, ABAQUS, COYOTE, and SPECTROM-31 may be used for thermomechanical analyses.
   Needed Computer Codes - None.
f. Documentation of Results: Results will be documented in SAND reports.
g. Quality Assurance Level: III
h. Remarks: QA Level III is assigned because this task includes scoping analysis for model development and to assess the influence of faults on rock mass properties. Analysis specific to observed NNWSI situations will not be done until approved at a higher QA level.

A.4 Assessments of Rock-Mass Properties Leading to Recommendations in Support of Analyses for the Advanced Conceptual Design and Site Characterization Plan.

a. Purpose: A data set of recommended matrix and rock-mass properties of the bulk, mechanical and thermal properties for thermomechanical stratigraphy of Yucca Mountain in support of the Reference Information Base (RIB) will be developed and updated, as required, using techniques developed and tested in Tasks A.1, A.2, A.3, B.1, and B.2. These data will be used in ACD analyses performed in WBS 1.2.4.2.1.3.S (Design Analysis).
b. Information Needs: 1.7.3, 1.12.1, 1.12.6, 1.16.2, 1.16.3, 1.20.5, 4.8.1, 4.8.2, 4.8.3
c. Methods, Techniques and Equipment: Finite element methods, standard statistical methods for data analysis.

d. Technical Procedures:
   Available Procedures - None.
   Needed Procedures - None.
e. Computer Codes:
   Available Computer Codes - SANCHO, JAC2D, JAC3D, ABAQUS, COYOTE, and SPECTROM-31 may be used for thermomechanical analyses.
   Needed Computer Codes - None.
f. Documentation of Results: Results will be documented in SAND reports.
g. Quality Assurance Level: II
h. Remarks: QA Level II is assigned because rock mass properties will be used for comparative technical analyses of alternatives in support of the SCP and ACD activities. A preliminary data set recommending matrix and rock mass properties of the bulk, mechanical and thermal properties for thermomechanical stratigraphy of Yucca Mountain has been assembled for modeling analyses.

A.5 Assessment of rock-mass properties leading to recommendations in support of analysis for the License Application Design.

a. Purpose: A data set of recommended matrix and rock-mass properties of the bulk, mechanical and thermal properties for thermomechanical stratigraphy of Yucca Mountain in support of the Reference Information Base (RIB) will be developed and updated, as required, using techniques developed and tested in Tasks A.1, A.2, A.3, B.1, and B.2. These data will be used in LAD analyses performed in WBS 1.2.4.2.1.3.S (Design Analysis).
b. Information Needs: 1.7.3, 1.12.1, 1.12.6, 1.16.2, 1.16.3, 1.20.5, 4.8.1, 4.8.2, 4.8.3
c. Methods, Techniques and Equipment: Finite element methods, standard statistical methods for data analysis.
d. Technical Procedures:
   Available Procedures - None.
   Needed Procedures - None.
e. Computer Codes:
   Available Computer Codes - SANCHO, JAC2D, JAC3D, ABAQUS, COYOTE, and SPECTROM-31 may be used for thermomechanical analyses.
   Needed Computer Codes - None.
f. Documentation of Results: Results will be documented in SAND reports.
g. Quality Assurance Level: I
h. Remarks: QA Level I is assigned because the rock-mass properties will be used to support LAD analysis.

B. Post-Test Analysis of G-Tunnel Field Experiments

Post-test analysis of G-Tunnel field experiments will be performed to develop and evaluate techniques for determining rock-mass response to mechanical and thermal loads. These analyses are essential to aid in our more complete understanding of the experiments and the phenomena which they monitored. The following investigations will be performed:

B.1 Advanced Conceptual Design analysis of Field Experiments to Evaluate the Thermal and Mechanical Responses of the Rock-Mass.

a. Purpose: Field experiments conducted in G-Tunnel (WBS 1.2.4.2.1.2.S) will be analyzed to develop and verify techniques for determining rock-mass response to thermomechanical loading. The analysis methods developed here will be used in the pre-test evaluation and analysis of the proposed ES experiments (WBS 1.2.6.9.2.3.S).

b. Information Needs: 1.7.3, 1.12.1, 1.12.6, 1.16.2, 1.16.3, 1.20.5 4.8.1, 4.8.2, 4.8.3

c. Methods, Techniques and Equipment: Finite element methods, standard statistical methods for data analysis.

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

e. Computer Codes:
Available Computer Codes - SANCHO, JAC2D, JAC3D, ABAQUS, COYOTE, and SPECTROM-31 may be used for thermomechanical analyses.
Needed Computer Codes - None.

f. Documentation of Results: Results will be documented in SAND reports.

g. Quality Assurance Level: II

h. Remarks: QA Level II is assigned because field data will be used to evaluate techniques for determining rock mass response and to develop methodology for deriving rock mass thermal and mechanical properties for ACD.

B.2 Finite Element Calculations in support of Advanced Conceptual Design Using the Compliant Joint Material Model to Better Estimate Rock-Mass Thermomechanical Response.

a. Purpose: Thermomechanical properties of the rock mass cannot be determined directly but must be derived from the results of laboratory tests on intact rock and from field data that reflect the behavior of a small portion of the rock mass. Finite-element analyses using a rock-mass model will be used to evaluate techniques for determining rock-mass properties and also used as a model verification exercise in conjunction with WBS 1.2.4.6.1.S. The analysis methods developed here will be used in the pre-test analysis of the ES experiments (WBS 1.2.6.9.2.3.S).

b. Information Needs: 1.7.3, 1.12.1, 1.12.6, 1.16.2, 1.16.3, 1.20.5, 4.8.1, 4.8.2, 4.8.3

c. Methods, Techniques and Equipment: Finite element methods.

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

e. Computer Codes:
Available Computer Codes - SANCHO, JAC2D, JAC3D, ABAQUS, COYOTE, and SPECTROM-31 may be used for thermomechanical analyses.
Needed Computer Codes - None.

f. Documentation of Results: Results will be documented in SAND reports.

g. Quality Assurance Level: II

h. Remarks: Rock mass properties determined in Task B.1 will be used as input to finite element calculations to assist in model development and refining techniques for property determination from field data. The values calculated will be used to provide guidance for the development of rock mass properties for ACD.

4. Data and Materials Needed

Task A.1. Advanced Conceptual Design analysis of the In-Situ Stress State at Yucca Mountain Including Tectonics, Field Measurements, and Finite Element Calculations

Data Needed - Regional geologic and tectonic studies. In-situ stress measurements at Yucca Mountain.
Source of Data - Regional geologic and tectonic data are available in the open literature.
Quality of Data - As identified in the Tuff Data Base or associated reports.

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

Task A.2. Finite Element Calculations in support of the Advanced Conceptual Design Using the Compliant Joint Material Model to Better Estimate Rock-Mass Thermomechanical Properties

Data Needed - The thermal, mechanical and thermomechanical properties of intact tuff and fractures, as well as fracture spatial orientations and abundancies.
Source of Data - Data will be obtained from the Tuff Data Base.
Quality of Data - As identified in the Tuff Data Base or associated reports.

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

Task A.3. Analyses to Evaluate Potential Effects of Faults (Discrete Discontinuities) on Rock-Mass Integrity

Data Needed - The thermal, mechanical, and thermomechanical properties of intact tuff and fractures, as well as fracture spatial orientations and abundancies.
Source of Data - Published Technical Reports.
Quality of Data - Not applicable since task is to screen analysis methods.

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

Task A.4. Assessments of Rock-Mass Properties Leading to Recommendations in Support of Analyses for the Advanced Conceptual Design and Site Characterization Plan.

Data Needed - The thermal, mechanical, and thermomechanical properties of intact tuff and fractures, as well as fracture spatial orientations and abundancies.
Source of Data - Tuff Data Base.
Quality of Data - As identified in the Tuff Data Base or associated reports.

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

Task A.5. Assessments of Rock-Mass Properties Leading to Recommendations in Support of Analyses for the License Appliction Design.

Data Needed - The thermal, mechanical, and thermomechanical properties of intact tuff and fractures, as well as fracture spatial orientations and abundancies.
Source of Data - Tuff Data Base.
Quality of Data - As identified in the Tuff Data Base or associated reports.

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

Task B.1. Advanced Conceptual Design analysis of Field Experiments to Evaluate the Thermal and Mechanical Responses of the Rock Mass

Data Needed - The thermal, mechanical, and thermomechanical tests results from appropriate field experiments.
Source of Data - Tuff Data Base.
Quality of Data - As identified in the Tuff Data Base or associated reports.

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

Task B.2. Finite Element Calculations in support of the Advanced Conceptual Design Using the Compliant Joint Material Model to Better Estimate Rock-Mass Thermomechanical Response

Data Needed - The thermal, mechanical, and thermomechanical test results from appropriate field experiments.
Source of Data - Tuff Data Base.
Quality of Data - As identified in the Tuff Data Base or Associated Reports.

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

5. Non-Standard Methods or Techniques

Task A.2. Finite Element Calculations in Support of Advanced Conceptual Design Using the Compliant Joint Material Model to Better Estimate Rock-Mass Thermomechanical Properties

Compliant joint material models are still being developed. These models are under evaluation in WBS 1.2.4.6.1.S (Repository Performance Code Development/Certification). Certain field, bench scale and laboratory-scale tests are also being developed under Laboratory Properties (WBS 1.2.4.2.1.3.S) and Field Test (WBS 1.2.4.2.1.2.S).

Task B.2. Finite Element Calculations in Support of Advanced Conceptual Design Using the Compliant Joint Material Model to Better Estimate Rock-Mass Thermomechanical Response.

Compliant joint material models are still being developed. These models are under evaluation in WBS 1.2.4.6.1.S (Repository Performance Code Development/Certification). Certain field, bench-scale, and laboratory-scale tests are also being developed under Laboratory properties (WBS 1.2.4.2.1.3.S) and Field Test (WBS 1.2.4.2.1.2.S).

6. Location of Work Performance

Sandia National Laboratories, Albuquerque, NM.

Contractors: RE/SPEC, Inc., Albuquerque, NM, portions of all tasks
Technadyne, Albuquerque, NM, portions of all tasks

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: Task A.5
Quality Assurance Level II: Tasks A.1, A.2, A.4, B.1, B.2
Quality Assurance Level III: Tasks A.3

8. Application of Results

The analysis of the field experiments conducted in G-Tunnel (WBS 2.4.2.1.2) will provide direct support for the design of related ES experiments by aiding in our more complete understanding of the experiments and the phenomena which they monitored. Analysis, assessment, and recommendations for in-situ stress and rock-mass thermomechanical properties will provide direct support for calculations being run for Design Analysis (WBS 2.4.6.2), Sealing (WBS 2.4.2.3), and Subsurface Excavations (WBS 2.4.3.4).

9. Schedule

Starting Date: 1984
Expected Ending Date: 1989

10. Past and Expected Achievements

Past Achievements

A data set recommending matrix and rock mass of the bulk, mechanical, and thermal properties for thermomechanical stratigraphy of Yucca Mountain has been assembled for modeling analyses. The data set includes some information from all of the stratigraphic units at Yucca Mountain and is required for Site Characterization, Performance Assessment, and Conceptual Design of the entire Yucca Mountain waste isolation system.

An analysis of the regional tectonics, stress measurements, and finite element calculations at Yucca Mountain was completed and published in order to provide in-situ stress values for use in design analyses.

An analysis of the relationship between effective porosity and bulk modulus was completed and published. The analysis provides a theoretical basis for estimating mechanical properties in areas where only bulk property data is available.

Completed an analysis of thermal and thermal/mechanical effects upon the near-field environment in order to provide an understanding of this near-field environment to Design Analysis (WBS 2.4.6.2).

Expected Achievements

FY86

Using the compliant joint material model, complete a series of finite element calculations which incorporate laboratory and field data of intact rock and fractures thus allowing estimations of rock-mass material properties.

Complete an analysis of the regional tectonics and stress measurements at Yucca Mountain using the compliant joint material model in order to provide in-situ stress values recommendations for design analyses.

Complete post-test analysis of Small-Diameter Heater and Heated Block experiments from the G-Tunnel Underground Facility (GTUF).

Complete an analysis of available data of fracture characteristics, based on field data reports from the USGS and laboratory data (WBS 2.4.2.1.3) to provide recommended values of fracture characteristics for analyses to be performed by Design Analysis (WBS 2.4.6.2).

Update recommended rock-mass properties, based on field data (WBS 2.4.2.1.2) and laboratory data (WBS 2.4.2.1.3) for input to the SCP and Advanced Conceptual Design Report.

FY87

Complete a series of finite element analyses to determine the relative effects of anisotropic material properties upon rock-mass response to in-situ stress state, and superposed thermomechanical loadings.

Complete and report on post-test analysis of Pressurized Slot and Mining Evaluation experiments from the G-Tunnel Underground Facility (GTLUF).

Update recommended rock-mass properties, based on field data (WBS 2.4.2.1.2) and laboratory data (WBS 2.4.2.1.3).

FY88

Complete an analysis of the regional tectonics and stress measurements at Yucca Mountain using the compliant joint material model to provide an updated in-situ mechanical model recommendation of Yucca Mountain for design analyses.

Update recommended fracture characteristics, based on field data reports from the USGS and laboratory data (WBS 2.4.2.1.3), to provide recommended values of fracture characteristics for analyses to be performed by Design Analysis (WBS 2.4.6.2).

Update recommended rock-mass properties, based on field data (WBS 2.4.2.1.2) and laboratory data (WBS 2.4.2.1.3).

FY89

Update recommended fracture characteristics, based on field data reports from the USGS and laboratory data (WBS 2.4.2.1.3) to provide recommended values of fracture characteristics for analyses to be performed by Design Analysis (WBS 2.4.6.).

Update recommended rock-mass properties, based on field data (WBS 2.4.2.1.2) and laboratory data (WBS 2.4.2.1.3).

11. Milestones and Deliverables

Milestone Number	Description and Criteria	Completion Date
Level 2		
M443	CH 2 Site Characterization Plan Complete This deliverable will be an input to Chapter 2, "Geoengineering," of the SCP which will contain rock-mass geotechnical properties as they pertain to site characterization.	05/09/85

Milestone Number	Description and Criteria	Completion Date
M444	Update on Rock-Mass Properties for Conceptual Design This deliverable will be a draft SAND report which contains all recommended bulk, thermal, and mechanical properties for the thermal/mechanical stratigraphy at Yucca Mountain.	07/30/86
R083	Numerical Analysis of Small-Diameter Heater Experiments This deliverable will be a draft SAND report which contains the results of numerical analyses of the small-diameter heater experiments run in the G-Tunnel Underground Facility.	08/31/86
M445	Rock-Mass Properties for Title I Design Criteria The deliverable will be an input draft to the Title I Design Criteria, recommending rock-mass thermal and mechanical properties based on laboratory and field measurements and finite element calculations.	05/27/87
N480	Compilation of ES Construction Phase Rock Properties for License Application Design	11/30/88
M473	Rock-Mass Title I and ES Preliminary Data Summary This deliverable will be an update on recommended rock-mass thermal and mechanical properties based on laboratory and field measurements and finite element calculations.	05/30/89

12. Costs

Costs are in thousands of expenditure-year dollars.

FY86

SNL Labor Costs: $119 Other Costs: $167

FY87

SNL Labor Costs: $161 Other Costs: $287

FY88

SNL Labor Costs: $154 Other Costs: $280

FY89

SNL Labor Costs: $133 Other Costs: $180

13. Performance Measurement

Percent complete.

NNWSI QUALITY ASSURANCE LEVEL ASSIGNMENT SNL-QA-[illegible]

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APPROVALS (Signature and Date)

PI Stephen J Bauer 7/25/86
Supervisor [illegible] 7/25/86
WMPO (PQM) James Blaylock 7/29/86

PQA Connie Chavez 7/25/86
TPO Thomas [illegible] 7/25/86
WMPO (Tech) [illegible] 7/29/86

Activity: A. Rock-Mass Thermomechanical Analysis

Task Description	QA Level	QA Criteria	Level Justification
A.1 Advanced Conceptual Design analysis of in-situ stress state	II	1-7, 15-18	Results will provide in-situ stress values for ACD analysis. This task is assigned QA Level II because Step 10 of the Logic Diagram applies.
A.2 Finite element calculations in support of Advanced Conceptual Design using the compliant joint model	II	1-7, 15-18	Results will assist in defining rock mass properties from laboratory and field data, and will assist in compliant joint model development (WBS 1.2.6.6.1.S) for ACD. This task is assigned QA Level II because step 10 of the Logic Diagram applies.
A.3 Analysis to evaluate potential effects of faults on rock mass integrity	III	* 1-7, 15-18	Scoping analysis for model development and to assess influence of faults on rock mass properties. This Task is assigned QA Level III because steps 1 through 11 of the Logic Diagram do not apply.
A.4 Assessments of rock-mass properties for the ACD and SCP	II	1-7, 15-18	Development of preliminary rock mass properties to be used in analyses in support of ACD. This Task is assigned QA Level II because Step 10 of the Logic Diagram applies.

* QA LEVEL III CRITERIA FOR SNL USE ONLY

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Page 2 of 2

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TPO Thomas O. Hunter 7/25/86

WMPO (PQM) Jane Blaylock 7/29/86

WMPO (Tech) [illegible] 7/29/86

Activity: A. Rock-Mass Thermomechanical Analysis

A.5 Assessments of rock-mass properties for the LAD	I	1-7, 15-18	Development of preliminary rock mass properties to be used in analyses in support of LAD. This Task is assigned QA Level I because Step 6 of the Logic Diagram applies.

QUALITY LEVEL ASSIGNMENT CRITERIA SHEET

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Activity: A. Rock-Mass Thermomechanical Analysis

Task: A.1 Advanced Conceptual Design
Analysis of In-Situ Stress State

PI S. J. Bauer

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		Control of contractor services applies
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		

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Activity: A. Rock-Mass Thermomechanical Analysis

Task: A.2 Finite Element Calculations in Support of ACD Using Compliant Joint Model

PI S. J. Bauer

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		Control of contractor services applies
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		

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Activity: A. Rock-Mass Thermomechanical Analysis

Task: A.3 Analysis to Evaluate Potential Effects of Faults on Rock-Mass Integrity

PI S. J. Bauer

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		Control of contractor services applies
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		

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Activity: A. Rock-Mass Thermomechanical Analysis

Task: A.4 Assessment of Rock-Mass Properties for the ACD and SCP

PI: S. J. Bauer

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		Control of contractor services applies
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		

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Activity: A. Rock-Mass Thermomechanical Analysis

Task: A.5 Assessment of Rock-Mass Properties for the LAD PI S. J. Bauer

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		Control of contractor services applies
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-Q.

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Page 1 of 1

APPROVALS (Signature and Date)

PI Stephen J Bauer 7/25/86

PQA Connie Chocas 7/25/86

Supervisor for K Tillerson 7/25/86

TPO Thomas O. Hunter 7/25/86

WMPO (PQM) James Blaylock 7/29/86

WMPO (Tech) [illegible] 7/24/86

Activity: B. Post-Test Analysis of G-Tunnel Field Experiments

Task Description	QA Level	QA Criteria	Level Justification
B.1 Advanced conceptual design analysis of field experiments to evaluate response of rock-mass	II	1-7, 15-18	Field data will be used to evaluate techniques for determining rock mass response for ACD. This task is assigned QA Le[illegible] II because Step 10 of Logic Diagram applies.
B.2 Finite element calculations in support of the ACD using the compliant joint model to estimate rock-mass response	II	1-7, 15-18	Rock mass properties estimated in Task B.1 will be used as input to finite element calculations to assist in model developing and refining techniques for property determination to support ACD. This task is assigned QA Level II because step 10 of the Logic Diagram applies.

QUALITY LEVEL ASSIGNMENT CRITERIA SHEET

WP No. 124211-86 QALAS No. 121
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Activity: B. Post-Test Analysis of G-Tunnel Field Experiments

Task: B.1 Advanced Conceptual Design Analysis of Field Experiments to Evaluate Respone of Rock-Mass PI S. J. Bauer

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		Control of contractor services applies
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

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Activity: B. Post-Test Analysis of G-Tunnel Field Experiments

Task: B.2 Finite Element Calculations in Support of the Advanced Conceptual Design Using the Compliant Joint Model PI S. J. Bauer

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		Control of contra. services applies
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		

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

Approvals (signature and date):

PI	Francis B. Nimick 8/5/86	PQA	Connie Chocas 8/5/86
Supervisor	Thomas E Blejwas 8/5/86	TPO	Thomas O. Hunter 8/5/86
MPO (PQA)	James Blaylock 8/8/86	WMPO (Tech)	[illegible] 8-8-86

List of Activities and Tasks

A. Laboratory Property Measurement

- A.1. Preparation of report on thermal conductivity and thermal expansion of lithophysae-rich Topopah Spring Member.
- A.2. Preparation of report on sample size effects on mechanical properties of welded, devitrified Topopah Spring Member.
- A.3. Preparation of report on mechanical properties of Topopah Spring Member from USW G-2.
- A.4. Compression testing to determine temperature sensitivity of mechanical properties of welded, devitrified Topopah Spring Member.
- A.5. Heat capacity measurements for tuff units expected to be within the region of elevated temperatures surrounding the repository.
- A.6. Mechanical properties of welded, devitrified Topopah Spring Member at high temperature and/or low strain rates.
- A.7. Anisotropy of mechanical properties of welded, devitrified Topopah Spring Member.

A.8. Tensile strength of welded, devitrified Topopah Spring Member.
A.9. Mechanical properties of fractures in welded, devitrified Topopah Spring Member.
A.10. Spatial variability of bulk, thermal, and mechanical properties.
A.11. Laboratory large block test.

B. Laboratory Property Analysis

B.1. Development of empirical relationships between porosity and mechanical properties.
B.2. Analysis of spatial variation of properties and of the effects of parameter variation of properties.
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.

<u>Issue 1.11</u>

1.11.1 Definition of the near field environment of the waste packages following emplacement.

<u>Issue 1.12</u>

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.

<u>Issue 1.13</u>

1.13.1 Site, waste package, and underground facility information needed for design of seals and their placement methods.

<u>Issue 1.14</u>

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.

<u>Issue 1.17</u>

1.17.4 Potential effects of future climatic conditions on rock characteristics.

<u>Issue 1.18</u>

1.18.6 Potential effects of erosion on rock characteristics.

<u>Issue 1.20</u>

1.20.5 Potential effects of igneous and tectonic activity on rock characteristics.

<u>Issue 1.21</u>

1.21.4 Potential effects of exploiting natural resources on rock characteristics.

<u>Issue 2.6</u>

2.6.1 Site information needed for design.

<u>Issue 4.1</u>

4.1.1 Site and design information needed to assess the ability to retrieve emplaced waste.

<u>Issue 4.3</u>

4.3.1 Site and performance assessment information needed for design.

<u>Issue 4.5</u>

4.5.1 Site and performance assessment information needed for design.

4.5.4 Potential impacts of rock characteristics on design.

<u>Issue 4.5</u>

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 qual 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 rat AND TEMPERATURE EFFECTS OVER THE RANGE OF 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.

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 qualityof 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 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 equatiions 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 be it is the intended of this activity to provide data for use in license application.

4. <u>Data and Materials Needed</u>

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 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. <u>Non-Standard Methods or Techniques</u>

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
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

Milestone Number	Description and Criteria	Completion Date
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

FY88

SNL Labor Costs: $205 Other Costs: $264

FY89

SNL Labor Costs: $ 66 Other Costs: $267

13. Performance Measurement

Percent complete

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APPROVALS (Signature and Date)

PI Francis Minnick 8/5/86
PQA Connie Chocas 8/5/86
Supervisor Thomas E Blejwas 8/5/86
TPO Thomas Hunter 8/5/86
WMPO (PQM) James Blaylock 8/8/86
WMPO (Tech) [illegible] 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 comparision 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

Task Description	QA Level	QA Criteria	Level Justification
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 i: 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 Lev 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 sc 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 Topoapah 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 Leve applies to the testing and not to the data.

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Activity: A. Laboratory Property Measurement

Task Description	QA Level	QA Criteria	Level Justification
A.10. Spatial variability of bulk, thermal, and mechanical properties.	I	1-8, 10-18	QA Level I is assigned to this task because the data is intended to support license application (Step 4).
A.11. Laboratory large block test.	I	1-8, 10-18	QA Level I is assigned to this task because the data is intended to support validation of computer programs intended for use in license application. (Step 4).

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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. 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.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. 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.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.
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. 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. 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.
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. QA Records	X		
18. QA 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. 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.
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. QA Records	X		
18. QA 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. QA Organization	X		
2. QA 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.
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. QA Records	X		
18. QA 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. QA Organization	X		
2. QA 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.
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. QA Records	X		
18. QA 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.
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. 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. 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.
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. QA Records	X		
18. QA Audits	X		

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Activity: A. Laboratory Property Measurement

Task: A.11. Laboratory large block test.

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.
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. QA Records	X		
18. QA Audits	X		

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APPROVALS (Signature and Date)

PI Francis B Nimick 8/5/86
PQA Connie Chocas 8/5/86
Supervisor Thomas E Blejwas 8/5/86
TPO Thomas O. Hunter 8/5/86
WMPO (PQM) James Blaylock 8/5/86
WMPO (Tech) [illegible] 8-8-86

Activity: B. Laboratory Property Analysis

Task Description	QA Level	QA Criteria	Level Justification
B.1. Porosity/mechanical properties relationships.	II	1-8, 10-18	QA Level II is assigned to this task because result- estimates will be used to support ACD analyses (Step 10).
B.2. Analysis of spatial and parameter effects variations.	II	1, 2, 3, 5, 6, 15-18	QA Level II is assigned to this task because resulting values will be used to support ADC analyses (Step 10).
B.3. Analysis of spatial variation using QA Level I data.	I	1, 2, 3, 5, 6, 15-18	QA Level I is assigned to this task because the analysis is intended to provide data for use in license application (Step 4).

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Activity: B. Laboratory Property Analysis

Task: B.1 Porosity/mechanical properties relationships.   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.
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. QA Records	X		
18. QA Audits	X		

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Activity: B. Laboratory Property Analysis

Task: B.2. Analysis of spatial and parameter effects variations. 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	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	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, hardward 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		

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Activity: B. Laboratory Property Analysis

Task: B.3. Analysis of spatial variation using QA Level I data 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	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	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, hardward 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		