WBS: 2.1

TITLE: Systems

OBJECTIVE: To integrate systems with the Geologic Repository Program and to describe the NNWSI Project Waste-Disposal System, to evaluate the performance of the natural and engineered-barrier system, and to the entire system performance for meeting regulatory standards.

DESCRIPTION OF WORK: All efforts required to:

- identify functions of the waste disposal system, subsystem, and components and the interactions; provide a detailed definition of performance requirements for all components
- evaluate the performance of both the natural subsystem and the engineered-barrier subsystem to determine their ability to meet regulatory criteria and to contribute properly to the performance of the entire system
- acquire data and develop codes to enable total systems performance assessment.

WBS: 2.1.1.S

TITLE: Systems Management and Integration

PARTICIPANT: Sandia National Laboratories

OBJECTIVE: To manage and integrate work performed within the systems WBS elements.

DESCRIPTION OF WORK: All efforts required to:

- o provide overall management of the systems activities, including planning, scheduling, budgeting, controlling, and reporting
- o provide for interaction with other OCRWM participants in the systems area (e.g., participation in the Performance Assessment Coordinating Group)
- o prepare and implement QA program procedures for systems activities.

WBS: 2.1.2

TITLE: Systems Engineering

OBJECTIVE: To develop and implement a systems engineering management plan which will provide DOE/NV with the means of managing and integrating the technical plan.

DESCRIPTION OF WORK: All efforts required to:

- perform special studies of technical issues that affect the overall waste-isolation system, including transportation interface considerations
- perform risk assessments, system optimization studies, and analyses of cost/schedule consequences of alternative approaches
- develop estimates of total system life-cycle costs except for cost estimates related solely to the waste-package, exploratory shaft, and repository which are included in their respective end functions
- develop, operate, and maintain a configuration management system that identifies, controls, and records all changes to the technical baseline documents. The technical baseline documents will include a description of the waste-isolation system configuration indicating the interrelationships among the system components, their functions, and their performance requirements.

WBS: 2.1.2.1.S

TITLE: System Requirements Description

PARTICIPANT: Sandia National Laboratories

OBJECTIVE: To develop and implement a system engineering plan that shall include systems design treating the system as a complete entity (hardware, software, personnel, training, data facilities and service).

DESCRIPTION OF WORK: All efforts required to:

- define the total technical design requirements
- translate requirements into functional requirements
- perform a functional analysis and develop design facilities, personnel, training and procedural data
- integrate requirements into project end item deliverables
- perform system design engineering trade-off studies validating requirements, design approach and cost
- develop, operate and maintain a configuration management system that identifies, controls and records all changes to the technical baseline documents
- baseline the major requirements for the overall waste isolation system
- develop life cycle cost estimates of the total system.

WBS: 2.1.2.2.S

TITLE: System Studies

PARTICIPANT: Sandia National Laboratories

OBJECTIVE: To perform analyses of the repository systems to resolve uncertainties and provide information to better focus design and performance confirmation activities. Representative systems that will be addressed are the site system, waste-receiving system, waste emplacement system, repository ventilation, instrumentation and control system, and the utilities system.

ISSUES: 3.3.3, 3.4.3, 3.4.8

DESCRIPTION OF WORK: All efforts required to:

- assess the effect of a monitored retrievable storage facility on the design and operation of the repository
- determine waste container inspections necessary to verify compliance with acceptance criteria
- assess the level of mine contamination by naturally occuring radon daughters and recommend methods for controlling the contamination under various repository operating conditions
- determine whether fuel rod consolidation at the Yucca Mountain repository is justifiable
- determine whether transuranic waste will have to be incinerated or digested before disposal in the underground facilities
- study the impacts of transportation system interfaces on repository facilities and waste receiving operations
- examine alternative methods to meet the requirement for retrieval of emplaced waste and present concepts for design development.

WBS: 2.1.3

TITLE: Technical Data Base Management

OBJECTIVE: To manage and accumulate data on the geometric, geologic, hydrologic, thermomechanical, and geochemical features and properties of the Yucca Mountain site.

DESCRIPTION OF WORK: All efforts required to:

- establish and maintain a base of significant technical data that will be used in evaluating the performance of the waste-isolation system. Includes activities to ensure that data can be documented, traced, and controlled

- support licensing activities, establish and maintain an administrative record that documents the development of the data base

- provide access to the technical data base and historical records to outside agencies.

WBS: 2.1.3.1.S

TITLE: Tuff Data Base

PARTICIPANT: Sandia National Laboratories

OBJECTIVE: To develop a data base from which data can be easily obtained for use in licensing and as support for the data used in performance assessment, design, and for use as a reference for the interim performance assessment analyses and design analyses.

DESCRIPTION OF WORK: All efforts required to:

- o develop a data base using the System 2000 data management system on the time-sharing CDC Cyber 170/855 computer
- o define structure of the data base to include data on geometric, geologic, hydrologic, thermomechanical, and geochemical features and properties of the Yucca Mountain site and environs that are pertinent to performance assessment and design
- o produce quarterly tuff data base documents that contain microfiche copies of the information in the data base.

WBS: 2.1.3.2.S

TITLE: Computer Graphics

PARTICIPANT: Sandia National Laboratories

OBJECTIVE: To provide support for the computer-aided, three-dimensional modeling and mapping activities for the Yucca Mountain site.

DESCRIPTION OF WORK: All efforts required to:

- maintain and control the data extracted from outside resources
- develop new procedures for incorporating information in the graphics data base
- follow quality assurance procedures to help ensure the integrity of the model definition
- data log the source of raw data and process tracing to identify software and graphics operations that were used to incorporate raw data in the 3-D graphics model data base
- develop digital terrain modeling, finite element model generation, and the generation of cross sections and surface and isopach maps of the various geological layers of interest.

WBS: 2.1.4

TITLE: Total Systems Performance Assessment

OBJECTIVE: To ensure total repository system and subsystem performance thru the acquisition of data, design, and code development and benchmarking.

DESCRIPTION OF WORK: All efforts required to:

- coordinate, integrate, and utilize the models developed to assess specific elements of the Project including performance evaluation of waste-package designs, performance evaluation of repository designs, and assessment of the long-term performance of the repository in isolating radioactive waste

- provide the results of performance assessments as input to technical decisions regarding design or siting alternatives, input to safety assessments required for licensing, and guidance directed at enhancing confidence in system performance based on sensitivity and uncertainty analyses

- develop, verify, validate, benchmark, and document codes for assessing the performance of the overall waste-isolation system

- allocate the total system performance objectives among the waste-package, repository, and site subsystems

- identify and prioritize data requirements for the total system performance assessment

- analyze the performance of the overall waste-isolation system, utilizing input from waste-package, site and repository performance assessment activities

- manage preclosure safety analyses of overall waste-isolation system except for safety analyses related solely to the waste-package, exploratory shaft, and repository which are included in their respective WBS elements

- provide for peer review of the systems performance assessment activity.

WBS: 2.1.4.1.S

TITLE: Flow and Radionuclide Transport

PARTICIPANT: Sandia National Laboratories

OBJECTIVE: 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.

ISSUES: 1.2.3, 1.2.4, 1.2.6, 1.3.3, 1.3.4, 2.1.5, 2.2.4, 2.2.5, 2.3.1 2.3.2, 2.3.3

DESCRIPTION OF WORK: All efforts required to:

- o develop a conceptual model of the flow and radionuclide transport features at Yucca Mountain for use in analysis of water and radionuclide movement from the repository
- o develop a theoretical framework for mathematically representing water flow and radionuclide transport through the tuffaceous rocks at Yucca Mountain
- o determine appropriate ranges of behavior for the hydrologic and radionuclide transport systems at Yucca Mountain
- o address uncertainty by providing a distribution of potential flow and transport times and estimates of their relative likelihoods
- o estimate and analyze the effects of credible disruptive scenarios on the movement of water and radionuclides through Yucca Mountain.

WBS: 2.1.4.2.S

TITLE: Radionuclide Source Term

OBJECTIVE: To formulate the models that describe the rate of radionuclides released to the host rock and to assess the performance of the engineered barrier system (EBS) to determine whether it complies with containment and limited release requirements.

DESCRIPTION OF WORK: All efforts required to:

- o formulate the source-term models required by the multi-dimensioned analysis of flow and transport and the single-dimensioned analysis of release from the total system
- o develop descriptions of radionuclide release from the waste package, based on detailed waste-package studies
- o develop descriptions of flow of water, vapor, and radionuclides in the thermally and mechanically disturbed host rock surrounding the waste packages
- o assess the performance of the EBS to determine compliance with NRC and EPA regulations.

WBS: 2.1.4.3.S

TITLE: Development and Certification of Computer Codes

PARTICIPANT: Sandia National Laboratories

OBJECTIVE: To acquire the computational tools necessary for integrated performance assessment analyses of a repository in the Topopah Spring Member of Yucca Mountain and to develop and document the degree of confidence that can be placed in those computational codes.

ISSUES: 1.2.3, 1.2.4, 1.2.6, 1.3.3, 1.3.4, 2.1.5, 2.2.4, 2.2.5, 2.3.1, 2.3.2, 2.3.3, 1.1.6, 1.2.5, 1.2.6, 1.3.4, 1.4.1, 1.4.2

DESCRIPTION OF WORK: All efforts required to:

- identify off-the-shelf codes and evaluate for applicable physics, ease of acquisition, documentation, etc., and select appropriate codes for acquisition
- acquire off-the-shelf codes and documentation, archive a copy of the code to be used in performance assessment, store it in a protective Project library at SNLA
- test the acquired version a code to check both the compatibility with the computing system and the integrity of the version
- report updates and changes made to a code by supplier or NNWSI Project user
- compare the archived version on an annual basis with the running version and document the differences
- provide documentation of the verification and validation of the running version of the code.

WBS: 2.1.4.4.S

TITLE: Radionuclide Releases from Total System

PARTICIPANT: Sandia National Laboratories

OBJECTIVE: To develop the mathematical models and perform the calculations necessary to evaluate the postclosure performance of a total waste disposal system at Yucca Mountain against long-term containment standards.

ISSUES: 1.4.2, 2.1.5, 2.2.5, 2.3.1, 2.3.2, 2.3.3

DESCRIPTION OF WORK: All efforts required to:

- o develop, prove, and document a mathematical model for predicting radionuclide releases from a total waste - disposal system to the accessible environment expected at the repository
- o develop, prove, and document special-purpose mathematical models to predict radionuclide releases from the total waste-disposal system to the accessible environment under disturbed surface and subsurface conditions at the repository and the site
- o assess the performance of the total system for inclusion in (1) the NNWSI Project Environmental Assessment, (2) the NNWSI Project Site Characterization Plan, (3) the Environmental Impact Statement (EIS) for a high-level waste repository at Yucca Mountain and (4) the Safety Analysis Report for a high-level waste repository at Yucca Mountain by using models, parametric studies, sensitivity analyses, and probalistic uncertainty calculations.

WBS: 2.2

TITLE: Waste Package

OBJECTIVE: To integrate the development of a waste package for tuff with the Geologic Repository Program and to design, construct, and qualify waste packages which allow for the safe handling, storage, and containment of the waste and which permit safe retrieval of the waste package, i.e., everything placed into a repository emplacement hole.

ISSUE: 3.2, 1.1, 1.4

DESCRIPTION OF WORK: All efforts required to:

- o identify and define interfaces between waste package elements
- o integrate waste-package elements among themselves and with site, repository, systems, test, and other elements
- o recommend solutions to major waste-package issues which affect the overall system
- o support major waste-package technical and programmatic decisions
- o provide technical planning and integration for the tuff waste-package development efforts
- o design, develop, fabricate, evaluate, and qualify waste packages for use in the tuff repository that meet Program criteria and specifications and can be licensed
- o establish design bases to guide the waste-package design activities
- o develop data bases on the performance of the waste form and barrier materials in the tuff repository environment, including efforts to
  - (a) characterize candidate waste forms and evaluate their potential degradation under expected tuff repository conditions
  - (b) develop and test waste-package component materials that meet package design functions and criteria including materials screening and detailed testing, over a range of conditions appropriate to the tuff repository
- o fabricate and test waste-package components
- o develop and fabricate full-scale waste-package models for use in field testing.

WBS: 2.2.1.L

TITLE: Waste Package Management and Integration

PARTICIPANT: Lawrence Livermore National Laboratory

OBJECTIVE: To manage and integrate work performed within the waste package WBS elements.

DESCRIPTION OF WORK: All efforts required to:

- o provide overall management of waste package activities including planning, scheduling, budgeting, controlling, and reporting
- o implement QA program procedures for Waste Package activities
- o interact with all NNWSI Project and OCRWM participants (e.g., participation in the Waste Package Coordination Groups).

WBS: 2.2.2.L

TITLE: Waste Package Environment

PARTICIPANT: Lawrence Livermore National Laboratory

ISSUE: 1.1, Information Needs 1.1.1 - 1.1.6

OBJECTIVE: To characterize the time-dependent behavior of the hydrogeologic environment in which the waste packages will reside in order to establish the envelope of conditions that define package design parameters, materials testing conditions, and boundary conditions for performance analysis.

DESCRIPTION OF WORK: All efforts required to:

- characterize the near-field environment in which the waste-packages would reside, including the physical, hydrologic, geochemical, and geomechanical conditions in the vicinity of the waste-package. This characterization is based on the data obtained from the site and repository test programs and on data obtained through additional tests required to characterize the near-field environment. The waste package function includes the development and confirmation of testing methods for the required additional tests; planning and conduct of the tests; and performance of mathematical modeling and analyses

- determine how the near-field environment might change in response to repository construction and closure as well as waste emplacement

- conduct experimental and modeling activities to characterize the waste-package environment and to provide input to the waste-package and repository design and performance assessment tasks

- provide input to and provide a data base on the environment into which the waste-packages are to be introduced

- analyze and evaluate data obtained and use the data as input to validate geochemical modeling code EQ3/6

- carry out experiments to evaluate the effects of dehydration-re-hydration cycles on tuff and to determine hydrologic properties of tuff in a temperature gradient (to simulate effects from heating of tuff by radioactive waste emplacement)

- evaluate various techniques and methods for stability analysis of waste emplacement boreholes, using geological and geophysical properties of Yucca Mountain tuff in order to evaluate the retrievability of waste packages from the tuff repository.

WBS: 2.2.3

TITLE: Waste-Form and Materials Testing

OBJECTIVE: To perform the testing and evaluation necessary to identify the waste package components required by specific host rock and to select the matrials for those components.

DESCRIPTION OF WORK: All efforts required to:

- o characterize the behavior and determine radionuclide release rates and mechanisms for spent fuel, commercial high-level waste (CHLW) and other waste forms under both expected and unexpected repository conditions. including the development and confirmation of testing methods and the planning and conduct of tests, such as interaction tests between the waste form and the barrier material
- o develop conceptual models to describe radionuclide release rates from the waste forms for use in evaluating waste package performance
- o develop waste-form acceptance requirements and specifications
- o provide input to waste-package and repository design and performance assessment tasks
- o fabricate and test of waste-package components
- o test the metals for the canister to establish mechanisms of potential failure and to establish numerical values for parameters for the design and specifications of the waste-package
- o determine the rate of degradation of spent-fuel cladding and the rate of radionuclide release from UO_2, defense high-level waste (DHLW), and reference CHLW in the unsaturated zone environment.

WBS: 2.2.3.1.L

TITLE: Waste-Form Testing

PARTICIPANT: Lawrence Livermore National Laboratory

ISSUES: 1.1, Information Needs 1.1.2, 1.1.6

OBJECTIVE: To characterize the behavior of and determine the radionuclide release rates for the various waste forms in the environment in order to establish data base to support predictions of engineered barrier system performance required for license applications in accord with the requirements of 10CFR60 and 40CFR191.

DESCRIPTION OF WORK: All efforts required to:

- determine radionuclide release rates from spent fuel; the containment effectiveness of defective fuel cladding will be estimated by comparing the relative radionuclide release rates from bare fuel pellets and from clad fuel pins where defects of known size and configuration have been intentionally created in cladding

- carry out corrosion rate tests on specimens of irradiated zircaloy cladding by conducting experiments over a range of temperatures using J-13 water in contact with tuff; effects of a radiation field (radiolysis products) and of containing the system with austenitic steel (to simulate the presence of a waste-package canister) will also be investigated

- determine the oxidation rate for spent fuel under expected repository conditions and the effects of fuel oxidation on release rates from spent fuel

- determine radionuclide release rates from DHLW under saturated conditions, by carrying out parametric testing of defense waste processing facility (DWPF) borosilicate glass waste using both inactive (simulated) and fully active samples over a range of temperatures using J-13 water; some experiments will be conducted using tuff reaction vessels and the effect of placing canister materials in contact with the tuff - J-13 water system will be also be studied

WBS: 2.2.3.1.L (continued)

- o determine radionuclide release rates from CHLW under saturated conditions by carrying out parametric testing of various doped and undoped specimens of PNL 76-68 borosilicate glass under conditions similar to those described in the previous item

- o develop a method for the determination of radionuclide release rates from various waste forms in an unsaturated environment by measuring release rates from spent fuel, DHLW, and CHLW under a range of conditions bracketing those expected in the Yucca Mountain repository

- o formulate interim product specifications for CHLW, DHLW, and spent fuel to provide guidelines for waste-form producers and requirements on products to assure compatibility with waste-package and repository designs.

WBS: 2.2.3.2.L

TITLE: Metal-Barrier Testing

PARTICIPANT: Lawrence Livermore National Laboratory

ISSUES: 1.1, Information Needs 1.1.4

OBJECTIVE: To characterize the behavior of the metal barrier and to determine corrosion rates and corrosion mechanisms, including the interaction between the metal barrier and its surrounding environment.

DESCRIPTION OF WORK: All efforts required to:

- plan and conduct metal degradation tests to determine corrosion modes of candidate materials for the waste-package canister and overpack under both expected and unexpected repository conditions, including the development and confirmation of testing methods and the planning and conduct of tests

- develop conceptual models of corrosion for use in evaluating waste-package performance

- provide input to canister and overpack design and to waste-package and repository design and performance assessment tasks

- determine general and localized corrosion properties of the candidate alloys under saturated conditions over a range of temperatures in water, as well as in steam using J-13 water in some cases the water will be in contact with tuff to determine whether the presence of tuff will affect the corrosion properties of the candidate alloys

- perform stress-corrosion cracking (SCC) susceptibility tests on candidate alloys in J-13 water and in steam over a range of temperatures relevant to the emplaced waste package including bent beam tests, slow strain rate tests, and fracture mechanics tests conducted at appropriate stress and strain levels

- evaluate the effect of gamma irradiation and radiolysis products on metal alloy corrosion (repeat experiments described in the previous two items in a gamma-irradiation facility)

- determine corrosion properties of candidate alloys under postulated extreme conditions; actual conditions in a tuff repository may lead to the formation of concentrated ionic solutions resulting from evaporation of ground water and the corrosive effect of such concentrated ionic solutions on the candidate metal alloys will be studied.

WBS: 2.2.3.3.L

TITLE: Other Materials

PARTICIPANT: Lawrence Livermore National Laboratory

ISSUES: 1.1, Information Needs 1.1.5

OBJECTIVE: To characterize the properties and behavior of other engineered barrier waste-package components that may be present in a repository in order to establish the predicted performance of other materials, such as packing materials, that may be present to assist waste forms and metals barriers in meeting 10CFR60 performance requirements.

DESCRIPTION OF WORK: All efforts required to:

- perform the assessment of the chemical effects of grouts and concrete used in repository construction and/or shaft sealing on the performance of waste-package components
- analyze data on release of radionuclides from spent fuel (with cladding defects) to evaluate the need for packing material emplaced around spent-fuel waste-package canisters
- select suitable packing material for possible use as part of the waste-package system
- develop a data base of the physical and chemical properties of the selected packing material(s) to ensure that the material(s) will function as required in the repository environment
- determine fabrication methods for packing material(s).

WBS: 2.2.4.L

TITLE: Design, Fabrication, and Prototype Testing

PARTICIPANT: Lawrence Livermore National Laboratory

ISSUES: 3.1, Information Needs 3.1.2 - 3.1.3

OBJECTIVE: To develop, analyze, fabricate and test waste-package designs that incorporate qualified materials and which are fully compatible with the repository design in order to support license application by demonstrating conformance with requirements for safe handling, emplacement, possible retrieval, and credible accident conditions per 10CFR60 and 40CFR191 in a cost-effective manner.

DESCRIPTION OF WORK: All efforts required to:

- establish waste-package design requirements
- provide engineering design and analysis to develop and evaluate alternative waste-package concepts, including thermal, structural, criticality, economic, and other analyses
- develop the waste-package design, including drawings and specifications
- plan and conduct tests to qualify the waste-package design, including the fabrication of test components as well as the development and confirmation of testing methods
- provide input to the waste-package performance assessment task and to repository design and performance assessment tasks
- analyze and complete documentation of selected conceptual engineering designs for waste-package assemblies; perform technical and economic analyses using appropriate models and computer codes; technical analyses will include:
  - (a) safety (nuclear criticality potential associated with the disposal of spent fuel)
  - (b) thermal (models, assumptions, and approximations used to provide temperature history predictions)
  - (c) structural (models, assumptions, and approximations used to demonstrate package integrity).
- develop and analyze selected prototype engineering designs for waste-package assemblies based on input from package environment and materials testing and evaluation, as well as from conceptual package design studies.

WBS: 2.1.2.3.S

TITLE: Cost Schedule

PARTICIPANT: Sandia National Laboratories

OBJECTIVE: To compile and analyze costs and schedules for the design, construction, operation, and decommissioning of a repository in tuff at Yucca Mountain.

ISSUES: 3.1.4, 3.4.8

DESCRIPTION OF WORK: All efforts required to:

- o develop estimates and analyze total system life-cycle costs
- o revise and update estimates as required until all conceptual studies are complete.

WBS: 2.2.5.L

TITLE: Performance Assessment

PARTICIPANT: Lawrence Livermore National Laboratory

ISSUES: 1.1; 1.4; Information Needs 1.1.6, 1.4.2, 3.1.2

OBJECTIVE: To provide a quantitative prediction of long-term waste-package performance including uncertainties, in order to 1) provide feedback to design optimization studies, 2) to demonstrate compliance with NRC performance objectives for the waste package subsystem, and 3) provide a source term for the engineered barrier system and the total system performance assessments required by 10CFR60 and 40CFR191.

DESCRIPTION OF WORK: All efforts required to:

- o provide a quantitive prediction of long-term waste-package performance
- o develop the analytical models which characterize the long-term performance of a waste-package emplaced in unsaturated tuff
- o develop system submodels to represent the physical state of each waste-package component as a function of time
- o assemble a system data base to characterize the geochemical degradation rates and mechanisms appropriate to the component materials and their physical states
- o integrate the physical process submodels and the geochemical system data base to calculate the long-term performance of a waste-package emplaced in unsaturated tuff.

WBS: 2.3

TITLE: Site Investigations

OBJECTIVE: To characterize the Yucca Mountain vicinity to identify and technically qualify a possible site for the construction and operation of a mined geological repository for high-level radioactive waste.

DESCRIPTION OF WORK: All efforts required to identify and characterize a potential site for nuclear waste isolation in tuff.

WBS: 2.3.1

TITLE: Management and Integration

OBJECTIVE: To manage and integrate work performed within the site WBS elements.

DESCRIPTION OF WORK: All efforts required to:

- o provide for the overall management of site characterization activities, including planning, scheduling, budgeting, controlling, and reporting
- o provide for interaction with other OCRWM program participants on site activities (e.g., participation in the Site Characterization Coordinating Group)
- o prepare and implement QA program procedures for site activities.

WBS: 2.3.1.A

TITLE: Management and Integration

PARTICIPANT: Los Alamos National Laboratory

OBJECTIVE: To provide for the overall management of site characterization activities, including planning, scheduling, budgeting, controlling, and reporting; to provide for interaction with other OCRWM program participants on site activities (e.g., participation in the Site Characterization Coordinating Group); to prepare and implement QA program procedures for site activities.

DESCRIPTION OF WORK: All efforts required to:

- develop, implement and maintain procedures to ensure that all appropriate NNWSI Project actions, decisions and documentation are in accordance with the applicable administrative, technical and legal requirements of regulatory agencies, WMPO/NV, and OCRWM Program requirements of the DOE and are supported with proper bases and facts
- participate as directed in OCRWM Program-wide committees and in coordinating or steering groups as directed by WMPO/NV
- develop, implement and monitor procedures to ensure that all site-related activities are performed in accordance with applicable QA plans and programs.

WBS: 2.3.1.S

TITLE: Management and Integration

PARTICIPANT: Sandia National Laboratories

OBJECTIVE: To provide for the overall management of site characterization activities, including planning, scheduling, budgeting, controlling, and reporting; to provide for interaction with other OCRWM program participants on site activities (e.g., participation in the Site Characterization Coordinating Group); to prepare and implement QA program procedures for site activities.

DESCRIPTION OF WORK: All efforts required to:

- o develop, implement and maintain procedures to ensure that all appropriate NNWSI Project actions, decisions and documentation are in accordance with the applicable administrative, technical and legal requirements of regulatory agencies, WMPO/NV, and OCRWM Program requirements of the DOE and are supported with proper bases and facts
- o participate as directed in OCRWM Program-wide committees and in coordinating or steering groups as directed by WMPO/NV
- o develop, implement and monitor procedures to ensure that all site-related activities are performed in accordance with applicable QA plans and programs.

WBS: 2.3.1.G

TITLE: Management and Integration

PARTICIPANT: United States Geological Survey

OBJECTIVE: To provide for the overall management of site characterization activities, including planning, scheduling, budgeting, controlling, and reporting; to provide for interaction with other OCRWM program participants on site activities (e.g., participation in the Site Characterization Coordinating Group); to prepare and implement QA program procedures for site activities.

DESCRIPTION OF WORK: All efforts required to:

- develop, implement and maintain procedures to ensure that all appropriate NNWSI Project actions, decisions and documentation are in accordance with the applicable administrative, technical and legal requirements of regulatory agencies, WMPO/NV, and OCRWM Program requirements of the DOE and are supported with proper bases and facts
- participate as directed in OCRWM Program-wide committees and in coordinating or steering groups as directed by WMPO/NV
- develop, implement and monitor procedures to ensure that all site-related activities are performed in accordance with applicable QA plans and programs.

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WBS: 2.3.1.T

TITLE: Management and Integration

PARTICIPANT: Science Applications International Corporation

OBJECTIVE: To provide for the overall management of site characterization activities, including planning, scheduling, budgeting, controlling, and reporting; to provide for interaction with other OCRWM program participants on site activities (e.g., participation in the Site Characterization Coordinating Group); to prepare and implement QA program procedures for site activities.

DESCRIPTION OF WORK: All efforts required to:

- o develop, implement and maintain procedures to ensure that all appropriate NNWSI Project actions, decisions and documentation are in accordance with the applicable administrative, technical and legal requirements of regulatory agencies WMPO/NV and OCRWM Program requirements of the DOE and are supported with proper bases and facts
- o participate as directed in OCRWM Program-wide committees and in coordinating or steering groups as directed by WMPO/NV
- o develop, implement and monitor procedures to ensure that all site-related activities are performed in accordance with applicable QA plans and programs.

WBS: 2.3.2

TITLE: Geology

OBJECTIVE: Evaluate the suitability of the subsurface environment for siting a nuclear waste repository.

DESCRIPTION OF WORK: All efforts required to:

- plan and conduct tests needed to evaluate the geological characteristics of the site, including stratigraphy, geomorphology, seismicity, geomechanics, geophysics, and tectonics except for the development of rock mechanics data required for repository design is included in the repository end function

- analyze geological data and develop conceptual models to describe the geological characteristics of the site.

WBS: 2.3.2.1

TITLE: Geologic Investigations

OBJECTIVE: To develop an understanding of the stratigraphic and structural framework of volcanic rocks underlying Yucca Mountain to confidently analyze conditions relating to hydrology, mineability, and stability of the rock mass.

DESCRIPTION OF WORK: All efforts required to:

- design the geologic model, including stratigraphy and structure of rock underlying Yucca mountain, to provide a means of analyzing conditions related to hydrology, mineability, and stability of the rock mass

- conduct surface investigations, including detailed geologic mapping (scale of 1:21,000) of zonal features primarily within the Tiva Canyon and Topopah Spring members to provide a means of recognizing small-scale structural features at Yucca Mountain

- analyze core samples, construct and interpret exposed-pavement and surface-fracture traverses, and compile data on fractures identified on low-level aerial photographs to determine the lateral and vertical distribution of fractures and faults to characterize the structural setting

- develop high resolution topographic information about Yucca Mountain by conducting field surveys, aerial photography, compilation of detailed contour maps and the collection of digital terrain data for production of large-scale geologic base maps

- use digital image processing to portray subtle structural information in the topographic data and generate a three dimensional computer model of the Yucca Mountain site to interpolate geologic units, structures, bulk properties, etc., for a variety of needs ranging from planning, excavation, and construction to testing geophysical and hydrologic models of the actual environment

- conduct core and bit cutting samples, compile data from fractures identified along borehole walls, geophysical logs, and television camera observations to enhance the knowledge of the lithologic and structural characteristics of subsurface rock units.

WBS: 2.3.2.1.1

TITLE: Site Geology

OBJECTIVE: To provide geologic data important to conditions and processes related to the geohydrology, geology, and stability of the proposed NNWSI Project site.

DESCRIPTION OF WORK: All efforts required to:

- o develop a geologic model which describes the structural and stratigraphic characteristics of the site
- o develop an understanding of the geologic framework and history of Yucca Mountain.

WBS: 2.3.2.1.1.G

TITLE: Site Geology

PARTICIPANT: United States Geological Survey

OBJECTIVE: To provide geologic data important to conditions and processes related to the geohydrology, geology and stability of the site; to develop a geologic model which describes the structral and stratigraphic characteristics of the site; to develop an understanding of the geologic framework and history of Yucca Mountain.

ISSUE: 1.2.1, 2.1.1, 2.3.2, 2.3.3, 3.2.1, 3.2.4, 3.3.1, 3.3.5, 3.3.6 and 3.4.1

DESCRIPTION OF WORK: All efforts required to:

- complete geologic mapping (1:12,000) of the surface features, primarily within the Tiva Canyon and Topopah Spring members, to identify small-scale structural features at Yucca Mountain
- construct and interpret exposed-pavement and surface-fracture traverses to establish the distribution of fractures and faults
- identify and map structural and stratigraphic features, including concealed faults and fractures through aerial photography (high-altitude, low-sun-angle-impaired, side-looking radar)
- investigate the subsurface geologic conditions by use of borehole drilling and coring
- analyze drillholes and core to enhance the knowledge of the lithologic and structural characteristics of subsurface rock units
- interpret core logs and analyze core samples and describe features of the core including fractures, bedding, lithophysae, and other stratigraphic discontinuities
- conduct stratigraphic studies to determine the distribution of major rock units
- design geologic models, including the stratigraphy and structure of rock underlying Yucca Mountain, as a means of analyzing conditions related to hydrology, mineability, and stability of the rock mass.

WBS: 2.3.2.1.1.S

TITLE: Site Geology

PARTICIPANT: Sandia National Laboratories

OBJECTIVE: To provide geologic data important to conditions and processes related to the geohydrology, geology and stability of the site; to develop a geologic model which describes the structral and stratigraphic characteristics of the site; to develop an understanding of the geologic framework and history of Yucca Mountain.

ISSUE: 1.2.1, 2.1.1, 2.3.2, 2.3.3, 3.2.1, 3.2.4, 3.3.1, 3.3.5, 3.3.6 and 3.4.1

DESCRIPTION OF WORK: All efforts required to:

- o conduct surface geologic studies to evaluate the geologic framework and history of the Yucca Mountain site
- o complete geologic mapping (1:12,000) of the surface features, primarily within the Tiva Canyon and Topopah Spring members, to identify small-scale structural features at Yucca Mountain
- o construct and interpret exposed-pavement and surface-fracture traverses to establish the distribution of fractures and faults
- o identify and map structural and stratigraphic features, including concealed faults and fractures through aerial photography (high altitude, low sun angle impaired, side looking radar)
- o analyze drillholes and core to enhance the knowledge of the lithologic and structural characteristics of subsurface rock units
- o interpret the core logs relative to stratigraphy and structure
- o analyze core samples and describe structural features of the core including fractures, bedding, lithophysae, and other discontinuities
- o study the distribution structural discontinuities (i.e., fractures, faults, voids, etc.) and stratigraphic anomalies (i.e., contacts, folds)
- o conduct stratigraphic studies to determine the distribution of major rock units
- o investigate the subsurface geologic conditions by use of borehole drilling and coring
- o design geologic models, including the stratigraphy and structure of rock underlying Yucca Mountain, as a means of analyzing conditions related to hydrology, mineability, and stability of the rock mass.

WBS: 2.3.2.1.2.G

TITLE: Topographic Analysis

PARTICIPANT: United States Geological Survey

ISSUE: 1.2.1, 2.1.4 and 3.2.1

OBJECTIVE: To collect and analyze high resolution topographic information of the Site; to prepare topographic contour maps.

DESCRIPTION OF WORK: All efforts required to:

- conduct ground surface field surveys to define ground target points for primary control in the aerial photographic surveys including the review and evaluation of published topographic maps of the Site and region
- take aerial photographs of the Site and vicinity as part of the geologic investigations of subsurface structure and of the topographic and geomorphic investigations of the surface features to provide full coverage of the Yucca Mountain topography as required by the photogrammetric analysis
- evaluate aerial photographs using photogrammetric analysis techniques to identify and to collect detailed information necessary for topographic and geologic mapping
- obtain digitized topographic data from the photogrammetric analysis of the aerial photographs to portray subtle topographic features which may be interpreted as a reflection of subsurface structure.

WBS: 2.3.2.2

TITLE: Geophysical Investigations

OBJECTIVE: To interpret the subsurface geologic framework of Yucca Mountain, which is specifically important to the hydrologic flow paths; to characterize the subsurface geologic framework of the crust, upper mantle, volcanic and Paleozoic rocks, and surface facility underlying Yucca Mountain; to evaluate rock properties of the principal stratigraphic units; to assess the hydrologic implications of heat flow variations within and adjacent to the candidate repository site.

DESCRIPTION OF WORK: All efforts required to:

- compile a regional gravity map of Yucca Mountain and vicinity
- evaluate detailed gravity profiles with respect to concealed faults and other geologic structures within the Tertiary volcanics
- measure changes in gravity with time
- evaluate low level aeromagnetic data with emphasis on the subsurface geologic framework and Curie isotherm surface
- obtain magnetic property measurements to aid in stratigraphic and structural interpretations of magnetic anomalies
- maintain geophysical logs from all boreholes at Yucca Mountain to support geologic characterization
- prepare a three dimensional model of the structure of the crust and upper mantle under Yucca Mountain and vicinity

WBS 2.3.2.2 (Continued)

- o use uranium trend, fission-track, and uranium-series dating techniques to estimate dates of the rocks, alluvium, and faulting
- o characterize the isotopes of uranium, thorium, carbon, and oxygen in order to characterize rock/water interactions in the tuff units
- o monitor the 47-station seismic network installed at Yucca Mountain and vicinity
- o automate the compilation of earthquake data, location of earthquakes, and information for archival yearly reports
- o use travel time studies, focal mechanisms, and spectral analysis of earthquake P&S phases to determine seismic moment, stress drop, nad source dimensions
- o develop a ground-motion model to simulate the expected ground motion
- o monitor tectonic adjustments in the Yucca Mountain area using geodetic leveling in the site vicinity
- o determine first order crustal deformation
- o make in situ stress measurements to establish dominant fracture orientations nad states of stress

WBS: 2.3.2.2.1.G

TITLE: Gravity and Magnetics

PARTICIPANT: United States Geological Survey

ISSUE: 1.2.1, 3.3.1, and 3.4.1

OBJECTIVE: To interpret the distribution and configuration of subsurface stratigraphy and geologic structure of the Yucca Mountain Site based on geophysical gravity and magnetic investigations; to evaluate the stability of the subsurface conditions.

DESCRIPTION OF WORK: All efforts required to:

- o conduct gravity surveys to gather specific gravity data of the Yucca Mountain vicinity
- o compile gravity data into gravity maps of Yucca Mountain and vicinity to be interpreted in terms of the subsurface geologic framework
- o prepare regional gravity maps and detailed gravity profiles of the Yucca Mountain vicinity from survey data
- o coordinate interpretation of the gravity data with other information concerning the regional and Site geology
- o evaluate maps and profiles with respect to concealed faults and other geologic structures within the Tertiary volcanic rocks
- o measure changes in gravity data over time to evaluate changes in subsurface mass movements such as the water table elevation and/or changes in saturation
- o evaluate aeromagnetic data with emphasis on the subsurface geologic framework and Curie isotherm surface
- o surveys surface-based and low level aeromagnetic to conduct collect and compile specific magnetic data of the Yucca Mountain vicinity
- o prepare regional magnetic maps of the Yucca Mountain vicinity from survey data
- o coordinate interpretation of the magnetic data with other information concerning the regional Site geology
- o evaluate the cause and distribution of magnetic argillite located beneath Yucca Mountain
- o compare thermal interpretation with heat flow studies to evaluate geothermal potential.

WBS: 2.3.2.2.2.G

TITLE: Seismic Investigations

PARTICIPANT: United States Geological Survey

ISSUE: 1.2.1, 3.3.1 and 3.4.1

OBJECTIVE: To characterize the subsurface geologic framework of the crust, upper mantle, volcanic and Paleozoic rocks, and surface facility in the vicinity of Yucca Mountain, based on geophysical reflection and refraction seismic investigations.

DESCRIPTION OF WORK: All efforts required to:

- o provide refraction survey data to determine the geologic structure of subsurface boundaries in volcanic and Paleozoic rocks underlying Yucca Mountain and vicinity in southern Nevada
- o investigate the pre-tertiary subvolcanic basement rock by use of deep seismic refraction surveys, east and west of Yucca Mountain
- o coordinate interpretation of seismic profiles with other information regional and Site geology
- o use P-wave residuals from teleseismic records to prepare a three dimensional model of the structure of the crust and upper mantle under Yucca Mountain and vicinity
- o use seismic reflection and shallow seismic refraction surveys, using human induced sources to investigate the shallow Tertiary volcanic rock of Yucca Mountain and the potential surface facility sites.

WBS: 2.3.2.2.3.G

TITLE: Rock Properties

PARTICIPANT: United States Geological Survey

ISSUE: 1.2.1, 1.2.5 and 3.3.2

OBJECTIVE: To evaluate rock properties which can be used to identify and to distinguish the principal stratigraphic units of Yucca Mountain.

DESCRIPTION OF WORK: All efforts required to:

- conduct borehole core sample collection and preparation immediately after the core is removed from the borehole and at intervals of no more than 15 m
- obtain and analyze core samples from boreholes intersecting Yucca Mountain to evaluate rock properties of the principal stratigraphic units
- make resistivity measurements on selected core samples at in situ saturation and at full saturation and compare with the data obtained from borehole and surface geophysical resistivity surveys
- determine in situ density, dry bulk density, saturated bulk density, grain density and fractional porosity for selected core samples and compare values of in situ bulk density and porosity with data obtained from borehole geophysical graity surveys
- make induced polarization measurements on saturated core samples in the time (rather than frequency) domain and compare laboratory measurements with equivalent data obtained from in situ borehole surveys
- make compressional wave velocity measurements on saturated core samples and compare laboratory measurements with borehole and surface geophysical seismic survey data
- measure three orthogonal components of magnetization in selected core samples to determine magnetic intensity inclination and moment values
- make magnetic susceptibility measurements on the same samples as the remanent magnetization measurements
- make hydraulic conductivity (water permeability) measurements on selected saturated core samples using constant flow velocity and driving pressure conditions
- obtain magnetic property measurements to aid in stratigraphic and structural interpretations of magnetic anomolies and interpretations of geophysical log data of various rock units underlying Yucca Mountain and vicinity

WBS 2.3.2.2.3.G (Continued)

- identify and relate magnetic anomalies to possible subsurface discontinuties (e.g. faults) and intrusions (e.g. dikes)
- use geophysical logs from all boreholes at Yucca Mountain to support geologic characterization, heat flow studies, tectonic stress analysis and in situ rock-property characteristics.

WBS: 2.3.2.2.4.G

TITLE: Heat Flow

PARTICIPANT: United States Geological Survey

OBJECTIVE: To assess the hydrologic implications of heat flow variations within and adjacent to the candidate repository site.

DESCRIPTION OF WORK: All efforts required to:

- o measure variations of temperature with depth to provide reliable baseline temperatures within possible repository locations
- o measure thermal conductivity (near 25°C) of preserved core samples to provide baseline data for engineering studies and cross checks on independent thermal property determinations at various temperatures
- o measure thermal conductivity at constant and variable temperatures
- o examine data from drillholes to determine heat flow and its variation in the immediate area of Yucca Mountain to identify sites of vertical water circulation and of lateral water movement and to estimate vertical seepage velocities based on simple models
- o evaluate heat flow and hydrologic data to resolve ambiguities and to determine the most likely regional average heat flux
- o use heat flow and geohydrologic data from southern Nevada to determine the regional heat flux magnitude and direction and compare these data obtained from in situ measurements at Yucca Mountain
- o use spatial and temporal variations of in situ temperature (regional and site) with thermal conductivity data to determine heat flux patterns within Yucca Mountain
- o evaluate the influences of the geothermal conditions on the geohydrologic conditions within Yucca Mountain.

WBS: 2.3.2.3

TITLE: Site Stability

OBJECTIVE: To develop a framework for understanding Cenzoic tectonic dislocation of the pre-Cenzoic crust, faulting, vertical or horizontal movement, erosion, and structurally-controlled ground water flow paths; to analyze the age and isotopic characteristics of tuff units and calcite veins selected from geologic samples; to assess the seismic hazard to the proposed repository from all available seismic and geologic information.

DESCRIPTION OF WORK: All efforts required to:

- o integrate Quaternary fault studies with seismicity and earthquake-hazard studies
- o map the nature and extent of erosional and depositional features at the site and integrate this data with paleoclimate data to assess the nature and rates of erosion and deposition during the life of the repository
- o integrate the descriptions and chemical and physical analyses of soils along altitudinal transects with other studies to determine paleoclimate
- o map surficial deposits to locate Quaternary fault movements and to define a stratigraphic basis for interpreting the history of recurrent fault movement
- o compile a 1:100,000-scale geologic map of the site vicinity and a 1:500,000-scale map of the candidate area to provide the basis for developing a tectonic model(s) that will serve as a framework for interpreting the geologic setting of faulting and volcanism in the region of the site
- o age-date bedrock and surficial deposits to provide a time frame for interpreting geologic history and for determining recurrent history of faults
- o use the K/Ar technique to date tuff and basalt samples in order to determine the age of youngest volcanism in or near the Nevada Test Site
- o design the tectonic model and analyze changes resulting from climate and tectonic activity near Yucca Mountain
- o evaluate hazards of future volcanism.

WBS: 2.3.2.3.1

TITLE: Tectonics and Volcanism

OBJECTIVE: To evaluate the hazards of future volcanism and to provide integration of structural, seismic, geodetic, and volcanic information in terms of overall site stability.

ISSUE: 2.1

DESCRIPTION OF WORK: All efforts required to:

- perform in situ stress measurements and data reduction
- investigate the rate, characteristics, and distribution of faulting during last 25 million years
- evaluate volcanism hazards
- study petrology of basaltic rocks from Yucca Mountain vicinity
- map erosional and depositional features
- map surficial deposits to identify Quaternary fault movement
- date bedrock and surficial deposits to determine integration time frame.

WBS: 2.3.2.3.1.A

TITLE: Tectonics and Volcanism

PARTICIPANT: Los Alamos National Laboratory

OBJECTIVE: Evaluate the hazards of future volcanism with respect to burial of high level radioactive wastes at Yucca Mountain; evaluate the history of volcanism in the candidate area.

ISSUE: 2.1

DESCRIPTION OF WORK: All efforts required to:

- evaluate volcanic hazards through studies of the geology and geochronology, tectonic setting, eruptive history of basaltic centers, geochemistry and petrology probability calculations, and consequence analyses of Late Cenozoic volcanic rocks of the candidate area
- evaluate petrologic trends through time for basaltic rocks of the candidate vicinity, compare these trends with time-petrologic trends of large-volume basalt fields in the candidate area and, evaluate potential importance of future hydrovolcanic-volcanic activity
- conduct geomorphic mapping to determine the nature and extent of erosional and depositional processes occuring at the site, and integrate the data with paleoclimate data to assess the nature and rates of erosion and deposition during the life of the repository.

WBS: 2.3.2.3.1.G

TITLE: Tectonics and Volcanism

PARTICIPANT: United States Geological Survey

OBJECTIVE: To develop a framework for understanding Cenzoic tectonic dislocation of the pre-Cenzoic crust, faulting, vertical or horizontal movement, erosion, and structurally-controlled ground-water flow paths.

ISSUE: 2.1, 2.2, 3.2, 3.3

DESCRIPTION OF WORK: All efforts required to:

- integrate Quaternary fault studies with seismicity and earthquake hazard studies
- map the nature and extent of erosional and depositional features occurring at the site and integrate these data with paleoclimate data to assess the nature and rate of erosion and deposition during the life of the repository
- integrate the description and chemical and physical analyses of soils along altitudinal transects with other studies to determine paleoclimate
- map surficial deposits to locate Quaternary fault movements and to define a stratigraphic basis for interpreting the history of recurrent fault movement
- compile a 1:100,000-scale geologic map of the site vicinity and a 1:500,000-scale map of the candidate area to provide the basis for developing a tectonic model(s) that serves as a framework for interpreting the geologic setting of faulting and volcanism in the region of the site
- date bedrock and surficial deposits to provide a time frame for interpreting geologic history and for determining recurrent history of faults
- develop a tectonic model as a means of analyzing changes resulting from climate and tectonic activity near Yucca Mountain

WBS: 2.3.2.3.2.G

TITLE: Isotope Geology

PARTICIPANT: United States Geological Survey

OBJECTIVE: To analyze the age and isotopic characteristics of tuff units and calcite veins selected from geologic samples.

ISSUE: 2.1

DESCRIPTION OF WORK: All efforts required to:

- use the K/Ar technique to age date tuff and basalt samples in order to determine the age of the youngest volcanism on or near the NTS
- use fission-track dating to age date various blocks of rocks containing apatite in order to determine when the rocks most recently passed through the 100°C isochron
- use uranium-trend dating to age date the time of deposition of alluvial, eolian, or colluvial deposits and volcanic ash in lakebeds
- use uranium-series dating to age-date faulting and occurrence of faulting
- characterize the isotopes of uranium, thorium, carbon, and oxygen in order to characterize rock/water interactions in the tuff units.

WBS: 2.3.2.3.3.G

TITLE: Seismicity and Strain

PARTICIPANT: United States Geological Survey

OBJECTIVE: To assess the seismic hazard to the proposed repository using all available seismic and geologic information.

ISSUE: 3.3.2 and 3.3.3

DESCRIPTION OF WORK: All efforts required to:

- o conduct seismicity monitoring and analysis using the regional seismic network to provide information necessary for tectonic studies and seismological data
- o maintain a 47-station seismic network to cover the tectonic features of greatest significance relative to seismic hazard assessment at the NTS including 6 permanent stations that are installed in a closely-spaced pattern on Yucca Mountain, to obtain improved detection thresholds and greater location accuracy for earthquakes near the proposed repository site
- o conduct data analysis using data from the stations to interpret relative changes in the regional stress field
- o compile earthquake data, location of earthquakes, and information for archival yearly reports
- o study travel time for velocity structure and station delays, focal mechanisms, and spectral analyses of earthquake P and S phases to determine seismic movement, stress drop, and source dimensions
- o construct a ground-motion model using simple probablistic ground-motion maps, better estimates of acceleration and velocity attenuation, and improved probabilistic models to realistically simulate the expected ground motion
- o conduct a strain survey at the site in order to indicate the rate and nature of tectonic activity
- o conduct geodetic leveling in the site vicinity to provide a long-term technique for monitoring tectonic adjustments in the Yucca Mountain area
- o conduct trilateration strain studies to determine first-order crustal deformation over a relatively short period of monitoring
- o measure in situ stress using a combination of televiewer logging and hydro-fracture stress-measuring techniques to identify dominant fracture orientations and states of stress.

WBS: 2.3.2.3.4.S

TITLE: Weapons-Test Seismicity

PARTICIPANT: Sandia National Laboratories

OBJECTIVE: To acquire seismic data to document ground motion at Yucca Mountain due to weapons testing at the NTS in order to establish design criteria for surface and underground facilities, and to support the safety analysis of these facilities.

ISSUE: 2.1, 3.3

DESCRIPTION OF WORK: All efforts required to:

- make measurements at surface and downhole locations at Yucca Mountain; obtain additional measurements from other locations on selected events; document gage calibrations pertaining to each of the recent measurements; and modify data processing software to meet QA specifications
- derive prediction equations for individual vertical, radial, and transverse components of peak acceleration, velocity, and displacement
- provide PSRV's for the same individual components for use in determining design response spectra and for use in design of repository structures.

WBS: 2.3.3

TITLE: Hydrology

OBJECTIVE: To assess the potential of radionuclide transport in the groundwater system of the NTS and the surrounding region.

ISSUES: 1.2, 2.2

DESCRIPTION OF WORK: All efforts required to:

- plan and conduct tests needed to evaluate the hydrologic characteristics of the site under both expected and unexpected conditions, including water level, water flowpath and travel times, hydraulics, recharge rates, and water age and origin

- analyze hydrologic data, including data from the Exploratory Shaft in situ testing program, and to develop conceptual models to describe the hydrologic characteristics of the site.

WBS: 2.3.3.1.G

TITLE: Stream Flow

PARTICIPANT: United States Geological Survey

ISSUES: 2.1.2 and 2.2.1

OBJECTIVE: To improve the capabilities for predicting flood and debris flow hazards.

DESCRIPTION OF WORK: All efforts required to:

- measure modern runoff events to estimate peak runoff, flood magnitudes, and recurrence intervals in order to design for safety of and access to repository facilities

- use maps and analyses of paleoflood deposits exposed at the surface and in trenches to estimate peak discharges and possible precipitation conditions necessary to understand paleoclimate and paleohydrology.

WBS: 2.3.3.2

TITLE: Groundwater Flow Analysis

OBJECTIVE: To evaluate the suitability of siting a repository at Yucca Mountain by determining water velocity and retardation mechanisms with sufficient accuracy; to evaluate climatic changes to determine if adverse conditions could develop during the life of the repository.

DESCRIPTION OF WORK: All efforts required to:

- o model regional flow in two dimensions to understand the major hydrologic framework and provide boundary conditions for subregional modeling (Yucca Mountain and down gradient)
- o investigate recharge to provide more detail on head distribution and flow paths used to evaluate recharge conditions
- o investigate discharge to identify flow paths in vertical as well as horizontal directions to assess travel time to an accessible environment
- o conduct tracer studies to provide hydraulic parameters needed to model the fractured rock systems to define flow paths and groundwater velocities
- o synthesize all hydrologic information from field studies to develop an understanding of flow paths and travel times in the saturated zone beneath Yucca Mountain
- o develop new codes modify existing codes to evaluate fow and transport.

WBS: 2.3.3.2.B

TITLE: Groundwater Flow Analysis

PARTICIPANT: Lawrence Berkeley Laboratory

OBJECTIVE: To develop models and codes that adequately describe flow and transport processes in the unsaturated and saturated fractured tuffs of Yucca Mountain.

DESCRIPTION OF WORK: All efforts required to:

- modify existing codes and develop new codes to evaluate flow and transport processes
- simulate field and laboratory tests in order to modify the codes that describe the flow and transport processes
- assist in the design of new tests using the modified models and codes.

WBS: 2.3.3.2.G

TITLE: Groundwater Flow Analysis

PARTICIPANT: United States Geological Survey

ISSUES: 1.2.3, 1.2.4, 1.2.6 and 2.2.3

OBJECTIVE: To identify groundwater flow paths and groundwater travel times in order to develop an understanding of flow in fractured rock and evaluate travel time in the saturated zone.

DESCRIPTION OF WORK: All efforts required to:

- o use two-dimensional flow and transport models in support of regional scale modeling to estimate travel times in the saturated zone and to estimate sensitivity of the regional groundwater system to potential increases in recharge
- o investigate recharge to provide detail on head distribution and flow paths to evaluate recharge conditions
- o conduct discharge investigations to identify flow paths in vertical horizontal directions and to assess travel time to the accessible environment, including refinement of the understanding of the hydrology of the Amargosa Desert, measurements of evapotrans-piration at Alkalai Flat and synthesis of available data
- o conduct single-well and multiple-well tracer experiments to measure ground-water flow velocity and effective porosity in the vicinity of the well and to determine dispersion effects in fractured media
- o determine fracture orientations and frequencies in drillholes from televiewer logs to estimate the volume of rock necessary to constitute a Representative Elementary Volume (Rev) and to estimate anisotropic characteristics of the rock in order to evaluate the role of the saturated zone as a barrier between the repository and the assessible environment.

WBS: 2.3.3.3.G

TITLE: Saturated Zone Hydrology

PARTICIPANTS: United States Geological Survey

ISSUES: 1.2.4, 1.2.5, 1.2.6, and 2.3.1

OBJECTIVE: To compile parametric data used in hydrologic models and hydrologic characterization of the saturated zone beneath Yucca Mountain, and to define the hydrology of Yucca Mountain and its relationship to the regional hydrologic system.

DESCRIPTION OF WORK: All efforts required to:

- o develop a three-dimensional model to synthesize all hydrologic information from field studies to provide and understanding of flow paths and travel times beneath Yucca Mountain
- o develop a saturated zone model to propose ways in which the saturated zone hydrologic system may function, including boundary conditions and control on flow paths and flow rates
- o monitor water levels to determine spatial and temporal distributions of hydraulic head necessary to define flow paths and gradients
- o drill, test, and log H-series and WT-series drillholes to provide data to define the distribution of permeable zones, hydraulic head, and hydraulic conductivity
- o conduct long-term pumping tests with observation wells to assess directional permeability and other characteristics that cannot be determined from single-well tests
- o describe the saturated zone hydrologic system based on hydrologic and geologic field studies to provide an integrated understanding of the saturated zone hydrology as input to computer models.

WBS: 2.3.3.4.G

TITLE: Unsaturated Zone Hydrology

PARTICIPANT: United States Geological Survey

ISSUES: 1.2.3, 1.2.5 and 1.2.6

OBJECTIVE: To compile parametric data for hydrologic characterization of unsaturated zone beneath Yucca Mountain as a potential repository horizon.

DESCRIPTION OF WORK: All efforts required to:

- monitor instrumentation in shallow unsaturated zone drillholes to study moisture conditions and temperature and pressure changes to assess recharge pulses permeability
- use infiltration tests to simulate current and past influxes of water to the saturated zone
- drill and test the unsaturated zone to provide data to define hydrologic conditions such as moisture content, metric potential, relative hydrologic conductivity, and occurrence of perched zones as a basis for estimating flux and locations of recharge
- use flow models to simulate hydrologic tests in the unsaturated zone to better understand the flow mechanism
- develop a conceptual unsaturated zone model to describe proposed ways in which the unsaturated, control on flow paths and rates, and mode of flow in fractures and matrices
- describe the unsaturated zone hydrologic system, based on hydrologic and geologic field studies in order to provide an integrated understanding and characterization of unsaturated zone hydrology as input to performance models.

WBS: 2.3.3.5

TITLE: Future Hydrologic Conditions

OBJECTIVE: To assess the Quaternary hydrology and climatic conditions to serve as a basis for predicting future conditions and to evaluate how climatic changes may affect waste isolation by analyzing the differences between present hydrology systems and those that would occur under wetter climates in the future.

DESCRIPTION OF WORK: All efforts required to:

- determine the degree of vertical chemical inhomogeneity and the redox state of the Yucca Mountain grounwater
- investigate the potential evidence recharge events more than 17,000 years old at depth in the subregional flow system
- evaluate the isotope and composition of carbonates located on top of Yucca Mountain and in the Fortymile Canyon drainage and recharge system
- evaluate hydrologic effects of climate changes in the Ash Meadow quadrangle
- measure modern runoff events to estimate peak runoff, flood magnitudes, and recurrence intervals necessary to design for safety of and access to repository facilities
- map and analyze paleoflood deposits exposed at the surface and in trenches to estimate peak discharges and possible precipitation conditions necessary to understand paleoclimates and paleohydrology
- compare pack rat communities presently living in an environmental and geologic setting similiar to past settings to provide information concerning the paleoclimate and paleohydrology
- estimate impacts of changing climate and recharge patterns.

WBS: 2.3.3.5.1.G

TITLE: Future Climates

PARTICIPANT: United States Geological Survey

OBJECTIVE: To assess the Quaternary climate and hydrologic conditions as a basis for predicting future conditions and for evaluating the effects of climatic changes on waste isolation.

DESCRIPTION OF WORK: All efforts required to:

- date and analyze plant microfossils in pack rat middens to provide data to estimate precipitation and temperature parameters during major recharge times in the NTS and Yucca Mountain areas
- collect core drillholes in closed basins to provide the long, continuous records necessary to verify data obtained from ecologic studies
- define parameters for controlling recharge and runoff, for use in water balance models, or to place bounds on expected changes of recharge
- make preliminary estimates from water balance modeling of the impacts of changing climates on recharge patterns and rates to provide a basis for evaluating changes in flux in the unsaturated zone and changes in water table elevation, gradient, and flow paths in the saturated zone
- make preliminary estimates from flow modeling to provide a basis for evaluating impacts of changing recharge patterns and rates on hydrologic conditions in the saturated zone
- obtain data on present day inputs to the Yucca Mountain unsaturated zone from precipitation collectors installed along Yucca Mountain ridge
- obtain evidence of recharge events more than 17,000 years old at depth in the subregional flow system
- collect data to evalute the isotopes and composition of carbonates located on top of Yucca Mountain and in the Fortymile Canyon drainage and recharge system
- determine the degree vertical chemical inhomogeneity and the redox state of Yucca Mountain groundwater using data on present-day isotope inuts to the Yucca Mountain unsaturated zone.

WBS: 2.3.3.5.2.G

TITLE: Future Groundwater Systems

PARTICIPANT: United States Geological Survey

ISSUES: 2.1.1 and 2.2.1

OBJECTIVE: To assess Quaternary hydrologic conditions as a basis for predicting future conditions.

DESCRIPTION OF WORK: All efforts required to:

- construct a geologic map of part of the Ash Meadow Quadrangle and derive a hydrologic history from sequences of spring, alluvial, and lacustrine deposits and to evaluate hydrologic effects of climate
- compare pack rat communities presently living in an environmental and geologic setting similar to past settings to provide information concerning the paleoclimate and paleohydrology of the area.

WBS: 2.3.4

TITLE: Geochemistry

OBJECTIVE: To plan and conduct tests needed to evaluate the geochemical characteristics of the site under both expected and unexpected conditions, including the composition and chemistry of the groundwater, the composition and chemistry of the host rock, and the sorption, precipitation, and diffusion of radionuclides; and to analyze geochemistry data, including data from the exploratory shaft in situ test program, and develop conceptual models to describe the geochemical characteristics of the site.

DESCRIPTION OF WORK: All efforts required to:

- plan and conduct tests needed to evaluate the geochemical characteristics of the site, including composition and chemistry of the groundwater; the composition and chemistry of the host rock; the sorption, precipitation, and diffusion of radionuclides; and salt dissolution studies

- analyze geochemistry data, including data from the exploratory shaft in-situ test program, and develop conceptual models to describe the geochemical characteristics of the site.

WBS: 2.3.4.1

TITLE: Geochemistry

OBJECTIVE: To determine the geochemical properties of tuff and the geochemical environment at Yucca Mountain as a basis for predicting the migration of radionuclides to the accessible environment and for assessing the response of potential repository horizons at Yucca Mountain to a repository environment.

ISSUE: 1.3

DESCIPTION OF WORK: All efforts required to:

- determine host rock geochemistry including detailed mineralogical and chemical analysis of core samples from drilling exploration
- determine kinetics of reaction of potential Eh-controlling mineral phases with ground water
- measure the oxidation states of components of such mineral phases
- determine the geochemical composition of the pore fluid in the unsaturated zone
- describe the groundwater geochemistry and perform investigations both in the laboratory and under field conditions
- determine the effect of hydrothermal conditions on the geochemical and hydraulic environment by performing laboratory studies under simulated repository conditions
- identify and analyze the dominant retardation processes that occur in the hydrostratigraphic units encountered along the pathways from the potential repository units at Yucca Mountain
- develop mathematical models that describe the chemical, geochemical, and hydraulic processes that are dominant in the various hydrostratigraphic units in Yucca Mountain
- investigate the application of natural chemical analogs to the NNWSI Project geochemical environment
- characterize the infiltration of precipitation and velocity of water movement through the unsaturated zone
- determine sorption coefficients for minerals and tuff samples from Yucca Mountain.

WBS: 2.3.4.1.1.A

TITLE: Groundwater Chemistry

PARTICIPANT: Los Alamos National Laboratory

ISSUES: 1.2.4, 1.2.6, 1.3.1, 1.3.2, 1.3.4, 1.4.2, 2.1.5, 2.2.4, 2.2.5 and 3.1.3.

OBJECTIVE: To determine the composition of the groundwater in and near Yucca Mountain from a limited number of wells drilled for overall site characterization. From these determinations and any other available information, model the groundwater composition along flow paths from the repository to the accessible environment before and after waste emplacement.

DESCRIPTION OF WORK: All efforts required to:

- sample and analyze groundwaters from wells drilled or used for site characterization in the Yucca Mountain area
- analyze changes in groundwater composition for water pre-equilibrated with tuffs to be used in sorption experiments
- collect particulates from the groundwater by filtration, measure size distribution, analyze for chemical composition, and calculate quantity per unit volume moving with the flowing water
- determine the potential for microbiological activity supported by drilling fluids used in the wells to alter the groundwater composition locally
- develop a model of the groundwater chemistry showing the chemical composition of Yucca Mountain groundwater as a function of location along potential pathways from the repository to the accessible environment
- develop a model of the Eh and pH buffering capacities of the tuff/water/air system that is applicable to past, present, and future conditions of Yucca Mountain
- estimate the effects of particulate transport for waste elements in the saturated zone of Yucca Mountain on total transport and retardation
- demonstrate in a field test the overall retardation of waste elements in the saturated zone of Yucca Mountain, including matrix diffusion and particulate transport.

WBS: 2.3.4.1.2.A

TITLE: Natural Isotope Chemistry

PARTICIPANT: Los Alamos National Laboratory

ISSUES: 1.2.3, 1.2.6, 1.3.1, 1.3.2, 1.3.3, 1.3.4, and 1.4.2.

OBJECTIVE: To determine the distributions of naturally occurring radioactive materials at Yucca Mountain as part of the work to characterize the infiltration of precipitation, the velocity of water movement through the unsaturated zone, and the retardation of radionuclide transport relative to water velocity.

DECRIPTION OF WORK: All efforts required to:

- conduct infiltration measurements during the past 25 years by determining the $^{36}Cl/Cl$ distribution in the top few meters of soil from Yucca Mountain
- collect samples of fractured tuff from the surface of Yucca Mountain to measure infiltration into this medium during the past 25 years
- measure the depth of penetration of ^{99}Tc from atmospheric nuclear weapons tests to determine the rate of technetium movement at Yucca Mountain relative to ^{36}Cl
- measure naturally occurring uranium, thorium, and radium concentrations in rock and water samples from Yucca Mountain.

WBS: 2.3.4.1.3.A

TITLE: Hydrothermal Chemistry

PARTICIPANT: Los Alamos National Laboratory

ISSUES: 1.1.1, 1.1.2, 1.2.1, 1.2.3, 1.3.1, 1.3.2, 1.3.4, 1.4.1, 1.4.2, 2.1.1 and 2.2.5.

OBJECTIVE: To produce a conceptual model and supporting data to explain the present distribution of minerals and water compositions in Yucca Mountain and to predict future mineralogy and water composition.

DESCRIPTION OF WORK:

- o conduct literature survey to identify hot springs in welded tuffs for which mineralogic and petrologic characterization have been completed
- o conduct microprobe analyses of critical alteration-mineral solid solutions (e.g., zeolites) from selected core samples
- o conduct reaction-path calculations using published water compositions and temperatures for the hot spring systems, mineralogic data from original characterization work, and microprobe data
- o document discrepancies between predicted and observed alteration mineral assemblages, if appropriate, and attempt to define causes of discrepancies
- o obtain thermodynamic models for clinoptilolite/heulandite, mordenite, smectite, and smectite/illite interlayer clays, analcime, and alkali feldspars.
- o investigate the effect of silica activity on mineral stability in hydrothermal experiments
- o develop a model for the kinetics of evolution of silica phases (quartz, cristobalite, and glass) and aqueous silica activity
- o produce a conceptual model to explain the observed distribution of minerals and water chemistries in Yucca Mountain.

WBS: 2.3.4.1.4.A

TITLE: Solubility Determination

PARTICIPANT: Los Alamos National Laboratory

ISSUES: 1.3.1, 1.3.2, 1.3.4, 1.1.6, 1.4.2, 2.1.5, 2.2.4, 2.2.5, 2.3.3 and 3.5.4.

OBJECTIVE: To determine the solubilities and speciation of important waste elements under conditions characteristic of the repository and along flow paths from the repository to the accessible environment.

DESCRIPTION OF WORK: All efforts required to:

- determine the waste elements for which solubility measurements are required
- determine the conditions (water compositions, oxidation-reduction state, and temperatures) for solubility measurements
- measure the solubilities of waste elements
- conduct identification and characterization of solid phases that control solubility and should approach equilibrium concentrations from oversaturation and undersaturation
- develop the thermodynamic data base and modeling capabilities necessary to calculate waste-element solubilities under conditions expected at the repository and along flow paths toward the environment
- determine the identity and measure the formation constants of aqueous complexes of waste elements
- determine the ability of waste elements to form natural colloids
- characterize the chemical and physical nature of the colloids that form
- calculate solubilities of waste elements as necessary to support assessments of radionuclide transport from the repository to the accessible environment.

WBS: 2.3.4.1.5.A

TITLE: Sorption and Precipitation

PARTICIPANT: Los Alamos National Laboratory

ISSUES: 1.3.1, 1.3.3, 1.3.4, 1.4.2, 2.2.4 and 2.2.5

OBJECTIVE: To provide sorption coefficients for elements of interest on pure minerals and on tuff samples representative of Yucca Mountain as a function of mineralogy, water composition, waste-element concentration, microbiological activity, presence of drilling fluids, and the presence of particulates and colloids.

DESCRIPTION OF WORK: All efforts required to:

- conduct measurement of batch sorption coefficients on tuff samples representative of Yucca Mountain as a function of mineralogy and time
- conduct a literature search on the use of ^{14}C for water dating and base estimates of its retardation on the information available
- prepare plutonium and americium as known species [Pu(IV), Pu(IV) polymer, Pu(V), Pu(VI), Am(III)] for sorption studies
- measure sorption coefficients as a function of concentration of sorbing species on several pure minerals and later on Yucca Mountain tuff samples
- measure changes in sorption coefficients as a function of changes in groundwater composition and as a function of CO_2 pressure for plutonium, neptunium and americium on tuff samples from Yucca Mountain
- study the sorption of technetium and iodine (anionic species) on layered, mixed hydroxides containing Ni and Al or Ni and Fe
- study the sorption of radionuclides (Sr, Cs, Am, Pu) on particulates found in Yucca Mountain water
- measure aerobic and anaerobic growth properties of microbes isolated from Yucca Mountain on drilling detergent and on polymer

WBS 2.3.4.1.5.A (Continued)

- o evaluate existing sorption data using various statistical methods to identify and characterize sorption behavior of the elements of interest for the variables studied and to identify any important gaps in the data

- o develop and use, as far as possible, a model for sorption for the elements of interest and the principal sorbent minerals in Yucca Mountain

WBS: 2.3.4.1.6.A

TITLE: Dynamic Transport Process

PARTICIPANT: Los Alamos National Laboratory

ISSUES: 1.3.1, 1.3.3, 1.3.4, 1.4.2 and 2.2.5.

OBJECTIVE: To determine the rate of movement of radionuclides along the potential flow paths to the accessible environment and to examine the effect of diffusion, adsorption, dispersion, anion exclusion, sorption kinetics, and colloid movement in the flow geometries and hydrologic conditions that are expected to exist along the flow path to the accessible environment in the scenarios to be used for Performance Assessment.

DESCRIPTION OF WORK: All efforts required to:

- measure the rate of movement of radionuclides relative to tritiated water (and other well defined chemical species or colloids) through crushed tuff columns
- measure the elution rate of radionuclides as a function of water velocity
- measure the relative migration rate of radionuclides through partially unsaturated rock columns
- measure the transport and diffusion of radionuclides through naturally fractured tuff
- measure the diffusivity and kinetics of adsorption in a purely diffusive system, that is, no advection
- evaluate tracers for use in tracer tests that will be performed in cooperation with the USGS
- measure the filtration of particulates by Yucca Mountain tuff as a function of particle size.

WBS: 2.3.4.1.7.A

TITLE: Retardation Sensitivity Analysis

PARTICIPANT: Los Alamos National Laboratory

OBJECTIVE: To construct a geophysical/geochemical description of Yucca Mountain based on the results of the other geochemistry and mineralogy/petrology tasks.

DESCRIPTION OF WORK: All efforts required to:

- o participate in computer code benchmarking activities (COVE and COVA)
- o perform computer calculations in support of diffusion experiments in the Exploratory Shaft Facility and to develop fracture flow experimental design
- o perform geochemical transport calculations to determine sensitivity of retardation equilibrium coefficients to groundwater chemistry
- o examine the feasibility of combining TRACR3D and EQ3/6
- o develop a particulate transport model and determine impact on radionuclide transport
- o calculate heat-load effects on repository-area hydrology, including vapor transport
- o develop stochastic methods and apply them to determine sensitivity of transport times to uncertainties in Yucca Mountain geochemical/geophysical properties
- o perform sensitivity analyses of radionuclide transport using input from the geochemistry and mineralogy/petrology tasks and the conceptual models of Yucca Mountain
- o construct a geophysical/geochemical description of Yucca Mountain based on the results of the geology, geochemical, and mineralogy/petrology tasks and combine this description with the hydrology models from the USGS to construct conceptual models
- o perform analyses of coupled-phenomena testing needs.

WBS: 2.3.4.1.8.A

TITLE: Applied Diffusion

PARTICIPANT: Los Alamos National Laboratory

ISSUES: 1.3.3 and 1.3.4

OBJECTIVE: To determine, through field experiments, whether the results of laboratory-scale diffusion measurements can be extrapolated accurately to predict the rates of aqueous transport of such nonsorbing radioactive waste species as TcO_4 and ^{129}I under the in situ conditions at the Yucca Mountain repository.

DESCRIPTION OF WORK: All efforts required to:

- conduct laboratory measurements to select tracers for the in situ diffusion experiments
- conduct laboratory analyses of tracer concentrations in the tuffs to determine tracer diffusion distances from emplacement

WBS: 2.3.4.2.A

TITLE: Mineralogy and Petrology

PARTICIPANT: Los Alamos National Laboratory

ISSUES: 1.2.1, 1.2.1, 1.2.3, 1.2.5, 1.3.1, 1.3.2, 1.3.4, 3.3.1, 3.4.1 and 3.4.2.

OBJECTIVE: To study bulk rock and fracture alteration, including the alteration of primary glass to sorptive minerals (alteration mineralogy); to conduct studies of mineral stability to assess the impact of the repository's thermal aureole on minerals that are important parts of the natural retardation system (mineral stability); and to determine retardation of the waste host-rock mineralogy and petrology with emphasis placed on transport in the unsaturated zone where near-canister transport may be particularly slow (mineralogy of transport pathways).

DESCRIPTION OF WORK: All efforts required to:

- conduct petrographic studies of fracture surfaces and fillings and whole rock samples
- perform low-temperature heating tests of long duration
- perform low-temperature heating tests of long duration; x-ray diffraction studies in an analysis cell under controlled humidity and temperature; thermogravimetric and differential scanning calorimetry studies on drill core samples
- perform tuff matrix and phenocryst analyses
- perform synthesis of quantitative x-ray diffraction data, using input from petrographic and electron microprobe studies and based on three-dimensional functional stratigraphy developed by USGS and SNL
- conduct petrographic, electron microprobe, x-ray diffraction, and thermal analyses of oxidizable iron in minerals and glasses
- development of enhanced precision and accuracy in quantitative x-ray diffraction analysis of primary and secondary mineral abundance in tuff
- evaluate statistical methods applied to finite data base from quantitative x-ray and petrographic data
- study samples underlying the devitrified Topopah Spring Member to determine alteration in rock samples.

WBS: 2.3.5

TITLE: Drilling

OBJECTIVE: To provide NNWSI Project participants with technical and planning expertise in support of drilling, trenching, and construction related to the NNWSI Project.

DESCRIPTION OF WORK: All efforts required to:

- o provide design drawings and calculations
- o prepare criteria letters
- o conduct field operations monitoring
- o provide survey of site area
- o provide construction labor and materials
- o provide drilling equipment and support personnel.

WBS: 2.3.5.1

TITLE: Core Library

OBJECTIVE: To provide NNWSI Project participants with the development and management of a core library.

DESCRIPTION OF WORK: All efforts required to:

- o provide technical coordination and instruction to the geologists on the storage, handling, labeling, retrieval, and shipping of core and cuttings samples at the Mercury Core Library
- o provide support for the NNWSI Project core library by processing rock samples and preparing reports
- o provide Project participants with general support with regard to core facilities.

WBS: 2.3.5.1.A

TITLE: Core Library

PARTICIPANT: Los Alamos National Laboratory

OBJECTIVE: To provide technical coordination and direction relating to management of the NNWSI Project portion of the Mercury Core Library.

DESCRIPTION OF WORK: All efforts required to provide technical coordination and direction on the storage, handling, labeling, retrieval, and shipping of rock samples at the Mercury Core Library.

WBS: 2.3.5.1.F

TITLE: Core Library

PARTICIPANT: Fenix & Scisson

OBJECTIVE: To provide support for the NNWSI Project core library by processing rock samples and preparing reports.

DESCRIPTION OF WORK: All efforts required to:

- process rock samples
- prepare reports
- support the core library.

WBS: 2.3.5.1.G

TITLE: Core Library

PARTICIPANT: United States Geological Survey

OBJECTIVE:

Awaiting USGS input.

DESCRIPTION OF WORK: All efforts required to:

Awaiting USGS input.

WBS: 2.3.5.1.R

TITLE: Core Library

PARTICIPANT: Reynolds Electrical & Engineering Company, Inc.

OBJECTIVE: To provide general support to Project participants with regard to the core library facilities.

DESCRIPTION OF WORK: All efforts required to:

- o provide general support, office space and clerical assistance
- o procure and maintain vehicles
- o provide radio support
- o provide logistical support to the USGS.

WBS: 2.3.5.2

TITLE: Drilling, Construction, Engineering

OBJECTIVE: To provide NNWSI Project participants with technical and planning expertise in support of drilling, trenching, and construction related to the NNWSI Project.

DESCRIPTION OF WORK: All efforts required to:

- o provide design drawings and calculations
- o prepare criteria letters
- o monitor field operations
- o provide a survey of the site area
- o provide construction labor and materials
- o provide drilling equipment and support personnel.

WBS: 2.3.5.2.A

TITLE: Drilling, Construction, Engineering

PARTICIPANT: Los Alamos National Laboratory

OBJECTIVE: To provide NNWSI Project participants with technical and planning expertise in support of drilling, trenching, and construction related to the NNWSI Project.

DESCRIPTION OF WORK: All efforts required to:

- assist the USGS in determining specific locations for drilling and construction work
- prepare design criteria letters
- participate in general Project management.

WBS: 2.3.5.2.F

TITLE: Drilling, Construction, Engineering

PARTICIPANT: Fenix & Scisson

OBJECTIVE: To provide NNWSI Project participants with technical and planning expertise in support of drilling, trenching, and construction related to the NNWSI Project.

DESCRIPTION OF WORK: All efforts required to:

- o provide underground design calculations, drawings, cost estimates, and project engineering
- o provide geologists for drillhole monitoring
- o identify, describe, and distribute rock samples from NNWSI drillholes
- o report on current progress of drilling operations
- o prepare completion reports for drillholes.

WBS: 2.3.5.2.G

TITLE: Drilling, Construction, Engineering

PARTICIPANT: United States Geological Survey

OBJECTIVE: To provide NNWSI Project participants with technical and planning expertise in support of drilling, trenching, and construction related to the NNWSI Project.

DESCRIPTION OF WORK: All efforts required to:

- evaluate, plan and update the needs of the NNWSI Project siting efforts
- initiate design for various drilling and testing activities
- prepare design criteria letters
- review final designs
- monitor field operations.

PROPOSED NNWSI PROJECT WORK BREAKDOWN STRUCTURE DICTIONARY DRAFT 20-May-85

WBS: 2.3.5.2.H

TITLE: Drilling, Construction, Engineering

PARTICIPANT: Holmes & Narver

OBJECTIVE: To provide NNWSI Project participants with technical and planning expertise in support of drilling, trenching, and construction related to the NNWSI Project.

DESCRIPTION OF WORK: All efforts required to:

- o provide a site survey for potential drilling locations
- o provide design drawings and calculations
- o prepare work orders to be given to REECo for construction authorization.

WBS: 2.3.5.2.R

TITLE: Drilling, Construction, Engineering

PARTICIPANT: Reynolds Electrical & Engineering Company, Inc.

OBJECTIVE: To provide NNWSI Project participants with expertise in support of drilling, trenching, and construction related to the NNWSI Project.

DESCRIPTION OF WORK: All efforts required to provide the necessary labor and materials necessary for drilling, construction, and trenching related to the NNWSI Project.

WBS: 2.3.5.3.F

TITLE: Field Geology/Hydrology

PARTICIPANT: Fenix & Scission

OBJECTIVE: To provide technical engineering support for geology and hydrology field studies.

DESCRIPTION OF WORK: All efforts required to provide geologist support design drawings and calculations as required

PROPOSED NNWSI PROJECT WORK BREAKDOWN STRUCTURE DICTIONARY DRAFT 20-May-85

WBS: 2.3.5.4.P

TITLE: Site Photography

PARTICIPANT: Pan Am

OBJECTIVE: To provide photographs of site area for NNWSI Project participants.

DESCRIPTION OF WORK: All efforts required to produce aerial photographs of site areas.

WBS: 2.3.6

TITLE: Environment

OBJECTIVE: To identify data requirements, plan and conduct tests to obtain site environmental data, e.g., meteorological, ecological, noise, archaeological, and soil data, and to develop data on human health and safety and the physical environment.

DESCRIPTION OF WORK: All efforts required to:

- analyze environmental data and develop conceptual models to describe the environmental characteristics of the site
- develop strategies to mitigate significant environmental impacts.

WBS: 2.3.6.1

TITLE: Environmental Surveys

OBJECTIVE: To plan and conduct tests to obtain site environmental data.

DESCRIPTION OF WORK: All efforts required to:

- o analyze environmental data and develop conceptual models to describe the environmental characteristics of the site
- o develop strategies to mitigate significant environmental impacts
- o perform ecological studies of the flora and fauna
- o screen state-funded environmental data to obtain usable NNWSI information
- o plan and implement a meteorological monitoring program
- o develop data on human health and safety and the physical environment.

WBS: 2.3.6.1.E

TITLE: Ecology

PARTICIPANT: EG&G

ISSUES: 3.1.4, 3.5.1 and 3.4.1.

OBJECTIVE: To characterize the flora and fauna at the Yucca Mountain site and to provide supporting environmental data.

DESCRIPTION OF WORK: All efforts required to:

- conduct preconstruction surveys of existing soil and native vegetation conditions at the site
- suggest reasonable alternatives to either avoid or minimize adverse effects from mining and construction
- initiate conservation planning for the Mojave fishhook cactus and the desert tortoise to comply with the Endangered Species Act of 1973
- conduct field studies to identify mule deer population, seasonal use of the range, movement patterns, and size of the mule deer population that leaves the public lands during autumn
- conduct field studies to determine burro population distribution, migration patterns, and seasonal use of the Project area
- design field trials to study reclamation that was done at the site for earlier road and drill pad construction activities
- design techniques for preparing mining spoils for revegetation
- assist DOE/NV, their contractors, and NNWSI Project participants with ecological expertise.

WBS: 2.3.6.1.H

TITLE: Site Monitoring

PARTICIPANT: Holmes and Narver

ISSUES: 2.3.1 and 2.3.2

OBJECTIVE: To provide engineering services needed to construct the meteorological monitoring program monitoring stations.

DESCRIPTION OF WORK: All efforts required to:

- o provide monitoring station construction drawings, site plans and electrical drawings
- o provide planning reviews, including review of the proposed monitoring equipment instrument shelter for compliance with NTS fire and safety codes
- o conduct engineering calculations to support REECo procurement.

WBS: 2.3.6.1.R

TITLE: Site Monitoring

PARTICIPANT: Reynolds Electrical and Engineering Company

ISSUES: 2.3.1 and 2.3.2

OBJECTIVE: To procure monitoring towers for the meteorological monitoring program and erect the towers.

DESCRIPTION OF WORK: All efforts required to:

- procure meteorological monitoring towers
- procure equipment elevator system for 60 meter tower
- prepare sites for tower erection and equipment installation
- erect five(s) monitoring towers.

WBS: 2.3.6.1.S

TITLE: Site Monitoring

PARTICIPANT: Sandia National Laboratories

ISSUES: 3.4.1, 3.4.2, 3.5.1 and 3.6.2

OBJECTIVE: To provide engineering information as required for preparation of the NNWSI Project EA and EIS.

DESCRIPTION OF WORK: All efforts required to:

- analyze proposed activitied to minimize environmental and socioeconomic impacts
- develop strategies to minimize significant environmental impacts
- develop design and operating procedures for avoiding or reducing unacceptable risks to public health and safety
- develop labor force data associated infrastructure and construction schedules for input to the socioeconomics impact analyses.

WBS: 2.3.6.1.T

TITLE: Environmental Monitoring

PARTICIPANT: Science Applications International Corporation

ISSUES: 2.3.1 and 2.3.2

OBJECTIVE: To continuously monitor meteorological conditions at Yucca Mountain in order to characterize climatic conditions and to assure compliance with state and federal regulatory requirments.

DESCRIPTION OF WORK: All efforts required to:

- prepare a formal monitoring and quality assurance plan for the meteorological monitoring program
- implement the program, beginning with equipment ordering and proceeding through installation, calibration, and initiation of routine monitoring
- operate and maintain data-gathering equipment and meteorological towers
- report data to NNWSI Project participants and regulatory agencies
- archive and store data in the Project Records Center.

WBS: 2.3.6.1.U

TITLE: Archaeology

PARTICIPANT: Desert Research Institute - University of Nevada at Reno

ISSUES: 3.1.9, 3.4.1 and 3.5.1.

OBJECTIVE: To identify and characterize the cultural resources at the Yucca Mountain site and on lands proposed to be used for repository support facilities.

DESCRIPTION OF WORK: All efforts required to:

- perform preconstruction surveys to identify and characterize cultural resources on lands proposed for surface disturbing activities
- monitor identified sites and provide the NNWSI Project with updated composite maps
- develop a data recovery program in consultation with the Nevada State Historical Preservation Office
- assist DOE/NV, their contractors, and NNWSI Project participants with cultural resource expertise.

WBS: 2.3.6.2.T

TITLE: Transportation

PARTICIPANT: Science Applications International Corporation

OBJECTIVE: To identify data requirements and plans and conduct studies to obtain transportation data.

ISSUES: 3.3.1, 3.3.2, 3.3.3, 3.3.4, 3.3.5, 3.3.6, 3.3.7, 3.3.8

DESCRIPTION OF WORK: All efforts required to:

- assess transportation-related environmental impacts
- develop strategies to mitigate significant transportation impact
- quantify transportation, related radiological, and nonradiological health impacts
- develop regional quantification of radiological risk of selected Nevada routes, using route-specific data
- assess the need and requirements for an expanded radiological risk study related to transportation accident scenarios
- track and assess transportation issues that may affect the Yucca Mountain site, e.g., cask development issues, emergency response surveys, regulations, permits and DOE/HQ transportation policy.

WBS: 2.3.7.T

TITLE: Socioeconmic

PARTICIPANT: Science Applications International Corporation

OBJECTIVE: To determine the economic implications of a Yucca Mountain repository and the potential effect of a repository on the quality of life of southern Nevada residents.

DESCRIPTION OF WORK: All efforts required to:

- prepare a socioeconomic investigations plan incorporating economic and socioeconomic studies to be performed during site characterization
- identify specific issues to be the subject of detailed research and analysis during site characterization
- obtain the data needed to establish the social and economic cnoditions in the area likely to be affected by the construction and operation of a repository, including field activities required to obtain data.

WBS: 2.3.8

TITLE: Performance Assessment

OBJECTIVE: To assess the site performance traces of the potential transport of radionucides by groundwater and potential geochemical reactions during such transport.

DESCRIPTION OF WORK: All efforts required to:

- o develop, verify, validate, benchmark, and document codes for assessing the performance of the site
- o identify data requirements for the site performance assessment
- o utilize codes in assessing site performance

WBS: 2.3.8.L

TITLE: Geochemical Modeling Code EQ3/6

PARTICIPANT: Lawrence Livermore National Laboratory

ISSUES: 1.1, 1.3, 1.4; Information Needs 1.1.2, 1.1.3, 1.1.6, 1.3.1, 1.3.2, 1.3.4, 1.4.2

OBJECTIVE: To further develop the geochemical modeling code EQ3/6 for use in long-term predictions for site stability and radionuclide release from a nuclear waste repository.

DESCRIPTION OF WORK: All efforts required to:

- upgrade the EQ3/6 code package and supporting data base, thereby allowing the NNWSI Project to model chemical processes to determine the relative contribution of these processes to the potential transport of radionuclides in groundwater from a nuclear waste repository in tuff
- document codes (EQ6 and MCRT) such that user manuals satisfying NRC's requirements for computer codes (NUREG-0856) are made available to the NNWSI Project
- perform code and data base maintenance tasks to insure that the code package meets user requirements and QA specifications.

WBS: 2.3.9

TITLE: Deferred Site Closeout

OBJECTIVE: To perform those activities required to return the site to satisfactory condition if the site is eliminated from further consideration.

WBS: 2.4

TITLE: Repository Investigations

OBJECTIVE: To establish the technological basis for repository development necessary to assure adequate repository and waste package containment and isolation capabilities.

DESCRIPTION OF WORK: All efforts required to:

- o provide overall management and integration of the repository design, testing, and development activities
- o develop and test rock mechanics, equipment, instrumentation, sealing requirements
- o provide conceptual design of repository facilities to include site preparation, surface facilities, shafts/ramps, subsurface excavations, and underground service systems
- o develop repository operations and maintenance concepts for systems/equipment
- o develop repository decommissioning concepts and requirements
- o conduct repository performance assessment

WBS: 2.4.1.S

TITLE: Management and Integration

PARTICIPANT: Sandia National Laboratories

OBJECTIVE: To provide for the overall management and integration of the repository design, testing, and development activities including project management of subcontractors and preparation of an integrated repository design report.

DESCRIPTION OF WORK: All efforts required to:

- provide for the overall management of repository design, testing, and development activities, including, planning, scheduling, budgeting, controlling, and reporting
- provide project management and support activities of the architect-engineer and the construction-manager, such as development of cost estimates and preparation of schedules
- prepare the integrated repository design report
- prepare and implement QA procedures related to all repository activities
- develop and baseline the functional criteria, standards, analytical methods, assumptions, and interface requirements required to design the repository surface facilities, shafts, subsurface excavations, and underground service systems
- assemble thermal, mechanical, hydrologic, and other data to support the design of the repository
- evaluate repository subsystem options, including the cost and schedule and consequences of alternative approaches
- provide for interaction with other OCRWM program participants on repository activities, e.g., participation in the Repository Coordination Group performance assessment tasks.

WBS: 2.4.2

TITLE: Development and Testing

OBJECTIVE: To provide for repository development and testing by implementing a rock mechanics test and analysis plan; evaluating and developing an equipment and instrumentation plan; establishing sealing requirements, concepts, materials evaluation, materials testing; providing input to repository design and performance assessment tasks.

DESCRIPTION OF WORK: All efforts required to:

- plan and implement field and laboratory tests
- evaluate and develop equipment and instrumentation
- establish sealing requirements, including requirements due to both expected and unexpected conditions, and develop concepts for the repository
- provide input to repository design and performance assessment tasks.

WBS: 2.4.2.1

TITLE: Rock Mechanics

OBJECTIVE: To develop and implement a Rock Mechanics Test and Analysis Plan.

DESCRIPTION OF WORK: All efforts required to:

- plan and conduct field and laboratory tests, including subsurface drilling to determine the properties of host rock required for repository design
- develop and confirm testing methods and validate and optimize mathematical models and codes
- perform thermomechanical analysis of the host rock, using the results of field and laboratory tests
- provide input to repository design and performance assessment tasks

WBS: 2.4.2.1.1.S

TITLE: Rock Mass Analysis

PARTICIPANT: Sandia National Laboratories

OBJECTIVE: To evaluate intact and rock mass thermomechanical properties in order to develop and evaluate techniques for combining data from field tests that reflect rock mass behavior and from laboratory tests that reflect both the behavior of individual fractures and that of the rock matrix.

ISSUES: 2.1.3, 3.3.2, 3.3.4, and 3.3.6

DESCRIPTION OF WORK: All efforts required to:

- plan and conduct field and laboratory tests
- analyze the in situ stress state at Yucca Mountain, including regional tectonics, field measurements, and finite element calculations
- analyze field experiments to evaluate the thermal and mechanical responses of the rock mass
- perform rock mass property assessments and recommendations in support of analyses for the EA, conceptual design, and SCP
- evaluate potential effects of faults (discrete discontinuities) on rock mass integrity
- perform finite element calculations using the compliant joint material model to better estimate rock mass thermomechanical properties.

WBS: 2.4.2.1.2.S

TITLE: Field Testing

PARTICIPANT: Sandia National Laboratories

OBJECTIVE: To develop and conduct field experiments designed to determine and evaluate the thermal, mechanical, thermomechanical, and hydrothermal phenomena for welded tuff; to determine the responses of tuff to excavation of an underground facility of a repository; to evaluate effects of the heat released by the waste.

ISSUES: 3.3.2, 3.3.4

DESCRIPTION OF WORK: All efforts required to:

- o provide technical and planning expertise for tuff rock properties field testing
- o perform thermomechanical analysis of the host rock and use the results of field tests to conduct rock-mass evaluation tests considered to be essential by NRC as input into understanding how subsurface structures will respond
- o develop experiments for the evaluation of models used in predictive calculations necessary for the early performance evaluation of a proposed repository
- o develop generic data and testing experience in welded tuff using thermal loads representative of the canister-scale environment to verify reference repository conditions to support conceptual design activities
- o develop techniques for making geotechnical measurements in welded tuff, and to allow as rapid as possible deployment of in situ experiments when at-depth testing is possible.

WBS: 2.4.2.1.3

TITLE: Laboratory Properties

OBJECTIVE: To develop, through laboratory measurements, a database for the bulk, thermal, and mechanical properties of tuff; to determine the responses of tuff to excavation of an underground facility of a repository; to evaluate effects of the heat released by the waste.

ISSUES: 1.2.5, 3.3.2, 3.3.4, 3.4.2

DESCRIPTION OF WORK: All efforts required to:

- o perform water migration laboratory experiments and numerical modeling to determine how the increased repository temperature will drive the pore water from the rock and to evaluate its path of movement
- o perform laboratory measurement of rock properties to establish the data base necessary to understand the statistical variability of the mechanical and thermal properties within the Topopah Spring Tuff as specified for inclusion in the Site Characterization Plan
- o develop a three-dimensional jointed rock-mass code to predict thermo-mechanical stability of a repository in tuff
- o develop a fluid-transport code for partially saturated tuffs above the water table
- o develop an understanding in the laboratory of the response of tuff to waste emplacement (i.e., rock-mass dehydration and fracture permeability-stress relations).

WBS: 2.4.2.1.3.A

TITLE: Laboratory Properties

PARTICIPANT: Los Alamos National Laboratory

OBJECTIVE: To determine experimentally the time dependence of the mechanical properties of Topopah Spring and Calico Hills Tuff in support of the design and interpretation of experiments in the ES and the design of performance models.

DESCRIPTION OF WORK: All efforts required to perform long-term deformation tests on tuff samples at conditions of stress, temperature, and pressure appropriate to a repository environment.

WBS: 2.4.2.1.3.S

TITLE: Laboratory Properties

PARTICIPANT: Sandia National Laboratories

OBJECTIVE: To develop, through laboratory measurements, a data base for the bulk, thermal, and mechanical properties of tuff.

DESCRIPTION OF WORK: All efforts required to:

- collect laboratory measurements of bulk, thermal and mechanical properties of tuff
- provide analysis of the lateral and vertical variability of the measured laboratory properties
- provide analysis of the data to determine the effects of testing parameters on the tuff measured properties.

WBS: 2.4.2.1.4.S

TITLE: Water Migration Analysis

PARTICIPANT: Sandia National Laboratories

OBJECTIVE: To investigate, through laboratory experiments and analysis, the water movement under simulated repository conditions to support waste isolation and containment analyses. The information obtained by these experiments support the determination of the mechanisms of water movement and the evaluation of its path in support of radionuclide transport analyses, waste package environment definition, and heat transfer mechanism evaluation.

ISSUES: 1.1.1, 1.2.3, 1.2.5

DESCRIPTION OF WORK: All efforts required to:

- determine experimentally the hydrologic properties of tuffaceous rock from Yucca Mountain in modeling water movement induced by thermal effects and for assessing pathways
- perform laboratory experiments designed to investigate hydrologic mechanisms of water movement through tuff matrix and fractures and to obtain data for code validation
- perform analysis/modeling of thermally-induced water migration to determine water fluxes of pressure/temperature gradients.

WBS: 2.4.2.2

TITLE: Equipment and Instrumentation Development

OBJECTIVE: To evalute and develop equipment and instrumentation to support the repository.

DESCRIPTION OF WORK: All efforts required to:

- o evaluate equipment needs and develop equipment as required, including the design, fabrication, and testing of prototypes of excavation/transport equipment, waste-handling equipment, and backfill equipment.
- o develop an operational plan around equipment concepts
- o conduct subsystem tests to verify new concepts
- o evaluate equipment and operational plans to assure that performance objectives are met
- o prepare specifications for repository equipment procurement including excavation/transport equipment, waste-handling equipment, and back-fill equipment
- o evaluate monitoring and instrumentation needs, adapt existing and develop new instruments as required.

WBS: 2.4.2.2.1.S

TITLE: Equipment Engineering

PARTICIPANT: Sandia National Laboratories

OBJECTIVE: To design, build, and test elements of the repository system.

DESCRIPTION OF WORK: This element includes equipment for the waste emplacement configuration, waste emplacement envelope and its associated hardware, system for drilling and lining waste emplacement holes, vehicle to transport waste from the surface facilities to the underground waste disposal location, and equipment used to emplace and retrieve waste. All efforts required to:

- design the waste emplacement envelope
- design, build, and test drilling systems required to construct the waste emplacement boreholes
- design, build, and test waste transportation equipment
- design, build, and test waste-handling equipment
- fabricate and test proof-of-concept equipment
- develop and test prototype equipment.

WBS: 2.4.2.3

TITLE: Sealing

OBJECTIVE: To develop and test repository sealing concepts for tuff which will ensure that repository integrity will not be breached as a result of the sealing method employed.

DESCRIPTION OF WORK: All efforts required to:

- o establish sealing requirements, including requirements due to both expected and unexpected conditions, and develop concepts for the repository
- o evaluate preclosure and postclosure concepts and designs for sealing shafts, underground excavations, and boreholes. [Note: Development of backfill equipment is under equipment development.]
- o evaluate potential materials for sealing shafts, underground excavations, and boreholes
- o test the performance of selected sealing materials and design, including the development and confirmation of testing methods.
- o develop designs for sealing shafts, underground excavations, and boreholes
- o provide input to repository design and performance assessment tasks.

WBS: 2.4.2.3.1.S

TITLE: Seal Performance Requirements

PARTICIPANT: Sandia National Laboratories

OBJECTIVE: To establish the sealing requirements for shafts, inclined ramps, boreholes, drifts, and discrete fault and fracture zones; to ensure that the seals do not become pathways that compromise the geologic repository's ability to meet the performance objectives.

DESCRIPTION OF WORK: All efforts required to:

- address the need and extent for sealing a repository
- define sealing issues and develop a plan for their resolution
- evaluate the performance of specific sealing concepts and designs through numerical analyses of unsaturated hydrologic flow.

WBS: 2.4.2.3.2

TITLE: Seal Materials Evaluation

OBJECTIVE: To evaluate materials for use in various sealing components and to obtain confidence in the performance capabilities of geochemical and geomechanical properties.

DESCRIPTION OF WORK: All efforts required to:

- o develop a strategy for the selection of shaft/borehole sealing materials for a tuff environment and make a preliminary selection of possible seal materials
- o evaluate the geochemical and mechanical properties of materials under consideration for use in sealing
- o investigate the compatibility of sealing materials with the host media.

WBS: 2.4.2.3.2.A

TITLE: Seal Materials Evaluation

PARTICIPANT: Los Alamos National Laboratory

OBJECTIVE: To develop sealing materials for fractures, boreholes, and access shafts and drifts and to assess their chemical stability and possible effects upon water chemistry; to determine how changes in mineralogy or dissolution may affect the permeability of the seals and if interaction between water and the seals can change the water chemistry in such a way as to increase waste-element solubility.

ISSUES: 1.4.2 and 3.4.6

DESCRIPTION OF WORK: All efforts required to:

- determine the thermodynamic properties of the sealing material/tuff systems and determine a material that is chemically similar to the stratigraphic unit in contact with the sealing material
- evaluate the stability of a fault seal exposed to a high-temperature and high-moisture environment
- initiate laboratory testing to determine the degraded mechanical, bulk, and hydrologic properties of the potential seal materials
- develop a degradation model that will provide insight into how material properties of sealing components, especially permeability and strength, could alter after being in contact with tuff.

WBS: 2.4.2.3.2.S

TITLE: Seal Materials Evaluation

PARTICIPANT: Sandia National Laboratories

OBJECTIVE: To develop sealing materials for fractures, boreholes, and access shafts and drifts and to assess their chemical stability and possible effects upon water chemistry; to determine how changes in mineralogy or dissolution may affect the permeability of the seals and if interaction between water and the seals can change the water chemistry in such a way as to increase waste-element solubility.

DESCRIPTION OF WORK: All efforts required to:

- determine the thermodynamic properties of the sealing material/tuff systems and determine a material that is chemically similar to the stratigraphic unit in contact with the sealing material
- evaluate the stability of a fault seal exposed to a high-temperature and high-moisture environment
- perform laboratory tests to determine the degraded mechanical, bulk, and hydrologic properties of the potential seal materials
- develop a degradation model that will provide insight into how material properties of sealing components, especially permeability and strength, could alter after being in contact with tuff.

WBS: 2.4.2.3.3.S

TITLE: Seal Concept Development

PARTICIPANT: Sandia National Laboratories

OBJECTIVE: To develop designs for all sealing components to satisfy repository decommissioning requirements and to investigate selected sealing designs through field testing in order to evaluate performance of the sealing components.

DESCRIPTION OF WORK: All efforts required to:

- o develop the designs for sealing components
- o develop physical construction requirements of sealing components
- o develop a cost estimate and schedule of construction activities for emplacement of the components in a repository
- o develop field test plans to validate the performance of the sealing components.

WBS: 2.4.3

TITLE: Facilities

OBJECTIVE: To prepare the conceptual designs and related activity for site preparation, surface facilities, shafts/ramps, underground excavations, and underground service systems.

DESCRIPTION OF WORK: All efforts required to:

- o provide conceptual designs for preparation of the site requirements including surface general arrangements, off-site improvements, and on-site improvements
- o prepare a conceptual design for the repository surface facilities and to integrate this activity with the underground requirements
- o prepare conceptual designs for the shafts and ramps, determining size, location, access, ventilation, and related requirements
- o develop the conceptual design for the underground portion of the repository
- o complete the conceptual design, gather data, and establish capacity requirements and all operating aspects for an underground service system.

PROPOSED NNWSI PROJECT WORK BREAKDOWN STRUCTURE DICTIONARY 20-May-85

WBS: 2.4.3.1.S

TITLE: Site Preparation

PARTICIPANT: Sandia National Laboratories

OBJECTIVE: To provide designs for preparation of the site requirements up to a distance of five feet from the buildings.

ISSUE: 3.2.1, 3.2.2, 3.2.3, 3.2.4, 3.4.5, 3.5.2, 5.5.2

DESCRIPTION OF WORK: All efforts to required to:

- o perform engineering studies and evaluate design options
- o perform all surface general arrangement activity
- o define and design off-site improvements required for the repository, including roads, rails, utilities, communications, etc., to the boundary of the site
- o identify and plan for removal of existing on-site structures not required for the repository
- o define and design on-site improvements (inside fenced boundaries, excluding areas within 5 feet of all buildings, structures, and components) including:
  - clearing, grading, excavation, and filling
  - landscaping
  - roads, rails, walks, bridges, culverts, curbing, guard rails, and traffic barriers
  - utilities
  - sewers, drains, and catch basins outside building lines
  - surface installations for on-site haulage, storage, and disposal of surplus mined material.

WBS: 2.4.3.2.S

TITLE: Surface Facilities

PARTICIPANT: Sandia National Laboratories

OBJECTIVE: To prepare designs for the repository surface facilities and to coordinate with the design of the repository underground requirements and equipment development.

ISSUES: 1.4.2, 2.3.2, 3.4.7, 3.4.8, 3.5.2

DESCRIPTION OF WORK: All efforts required to:

- o perform engineering studies and evaluate design options
- o design the waste handling facility for the receipt and handling of waste packages
- o design the exhaust shaft filtration facility, including structure, utilities, and equipment
- o design all balance of plant facilities and systems, excluding building equipment and structures related to the shafts/ramps, and including, but not limited to, the following facilities:
  - health/medical
  - fire protection
  - security, including fences, gates, guardhouse, and tower
  - maintenance
  - administrative and personnel
  - laboratory and testing
  - warehousing and receiving
  - visitors center
  - backup power generation
  - change room
  - compressed air and steam
  - cooling tower and chilled water
  - excavated material/storage/backfill
  - fuel storage
  - chemical storage
  - control
  - potable water/sewage.

WBS: 2.4.3.3.S

TITLE: Shafts/Ramps

PARTICIPANT: Sandia National Laboratories

OBJECTIVE: To prepare design requirements by determining the optimum size, location, and means of access for the men, materials, mined rock removal, waste-emplacement vehicles, and the ventilation intake and exhaust.

DESCRIPTION OF WORK: All efforts required to:

- develop a conceptual design of access from the surface to the underground portion of the repository, including access for personnel, radioactive waste, general support hardware and equipment, ventilation, and mined material removal
- perform a design analysis to verify that the accesses meet required safety margins and comply with the long-term stability requirements of the repository
- perform optimization studies to determine the type, size, and location of the accesses
- design repository shafts, including hoist, headframes, shaft collars, and other shaft-connected but surface-located equipment and structures, and shaft liners
- design all shaft stations (out to only 5 ft beyond liner for repository horizon stations)
- perform engineering studies and evaluate design options.

WBS: 2.4.3.4.S

TITLE: Underground Excavations

PARTICIPANT: Sandia National Laboratories

OBJECTIVE: To develop design requirements for the underground portion of the repository.

DESCRIPTION OF WORK: All efforts required to:

- o design repository subsurface excavations
- o perform engineering studies and evaluate design options
- o develop a master plan for the underground portion of the repository that details all haulageways, ventilation drifts, and underground support facilities such as shops and warehouses
- o perform the analysis to support the conceptual designs presented, e.g., an analysis of the stability of the openings to the underground facilities
- o design material flow and ventilation flow diagrams and development of diagrams of both construction and waste emplacement
- o prepare operational plans sufficient in detail to establish operational times and equipment needs
- o develop trade-off studies on which mining-method selection will be based.

WBS: 2.4.3.5.S

TITLE: Underground Service Systems

PARTICIPANT: Sandia National Laboratories

OBJECTIVE: To provide the design requirements and to gather data to determine the size, volume, location, and nature of the underground service system.

DESCRIPTION OF WORK: All efforts required to:

- o perform engineering studies and evaluate design options
- o design repository underground service systems including
  - material handling system
  - support systems, e.g., fire protection, dewatering, ventilation, medical, and maintenance
  - utilities
  - monitoring and control systems, including facilities and equipment required for confirmation testing
- o complete the detail design to support license applications
- o design underground utilities for electrical, communications, water, and compressed air
- o provide the definitions of underground service systems, including underground shops and warehouses, emergency medical service, decontamination facilities, sanitation, and general mine monitoring and control.

WBS: 2.4.4.S

TITLE: Operations and Maintenance

PARTICIPANT: Sandia National Laboratories

OBJECTIVE: To develop repository operating and maintenance requirements.

ISSUE: 3.4

DESCRIPTION OF WORK: All efforts required to:

- o develop repository operating concepts, perform trade-offs and optimization studies
- o determine operating modes for all systems and equipment
- o provide input to the design and safety analyses of the repository through definition of modes of operation of all systems and equipment; procedures for assembly, emplacement, monitoring, and retrieval of waste package; and maintenance requirements of the operational facility.

PROPOSED NNWSI PROJECT WORK BREAKDOWN STRUCTURE DICTIONARY 20-May-85

WBS: 2.4.5.S

TITLE: Decommissioning

PARTICIPANT: Sandia National Laboratories

OBJECTIVE: To develop repository decommissioning concepts and requirements.

DESCRIPTION OF WORK: All efforts required to:

- o develop repository decommissioning concepts and requirements
- o provide input to repository design and safety analysis standards
- o perform the analyses of closure concepts and requirements
- o develop a plan for site restoration, decontamination, dismantlement, operation of monitoring instruments, and site security.

WBS: 2.4.6

TITLE: Repository Performance Assessment

OBJECTIVE: To support the development of design concepts that will reasonably ensure that the decommissioning of the repository will be timely, safe, economical, and environmentally acceptable.

DESCRIPTION OF WORK: All efforts required to:

- o develop, verify, validate, benchmark, and document codes for assessing the performance of the repository, including preclosure (e.g., impacts of facility construction and operation, radiological releases from both expected and unexpected conditions) and postclosure phases
- o utilize codes in assessing the preclosure and postclosure performance of the repository
- o conduct preclosure safety analyses of repository under both expected and unexpected conditions
- o provide for peer review of the repository performance assessment activity.

WBS: 2.4.6.1.S

TITLE: Performance Code Development and Certification

PARTICIPANT: Sandia National Laboratories

OBJECTIVE: To develop material models (constitutive models embodied in computer codes designed to approximate the rock mass response to thermomechanical loading).

DESCRIPTION OF WORK: All efforts required to:

- o assess the applicability of existing material-model codes to repository performance calculations
- o verify computer codes to ensure that they correctly perform the operations specified in the numerical model
- o validate each model to ensure that it is an appropriate representation of the process or system for which it is intended
- o benchmark material models/codes (i.e., cross-check the models/codes by solving identical thermal, mechanical, and thermomechanical boundary value problems)
- o evaluate material models 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.

WBS: 2.4.6.2.S

TITLE: Design Analysis

PARTICIPANT: Sandia National Laboratories

OBJECTIVE: To establish the analytic basis for the underground facility design; and to provide the relationship of the underground facility to the physical model of Yucca Mountain.

DESCRIPTION OF WORK: All efforts required to:

- o provide the type and sequence of calculations and analyses supporting the licensing of the underground facility
- o obtain data on rock properties, geology, and excavation dimensions from the work performed to satisfy other WBS elements
- o develop models to predict the response of the host rock to excavation and thermal load
- o to determine the relationship of the heat generated by the waste to the layout of the underground facility and to the design of the underground openings
- o establish the design parameters for the repository thermal loading; to analyze the stability of the underground openings
- o provide data related to these parameters for use by the architect/engineer to design the underground openings.

WBS: 2.4.6.3.S

TITLE: Preclosure Safety Analysis

PARTICIPANT: Sandia National Laboratories

OBJECTIVE: To determine the probability of releases of radioactive material from the repository during its operating lifetime and to determine the amount and effects of such releases with respect to occupational safety and the health and safety of the public.

DESCRIPTION OF WORK: All efforts required to:

- determine the maximum release of radioactive materials under normal operating conditions and establish the consequences of these releases

- investigate and determine the radionuclide source terms for operational units and the features (e.g., radiation shielding, filters) required to mitigate releases; levels of radionuclides in routine operational releases; radiation doses to the repository worker, maximum individual, or public; and comparisons of calculated releases and exposures to established regulatory limits.

WBS: 2.4.6.4.S

TITLE: Performance Confirmation

PARTICIPANT: Sandia National Laboratories

OBJECTIVE: To plan and conduct field and laboratory experiments; to perform engineering analyses and evaluations to identify nonreference geologic conditions and waste and waste package characteristics; and to test the performance of the natural and engineered barriers (i.e., identify nonreference conditions and out-of-specification performance of the site, repository, and waste-handling systems).

DESCRIPTION OF WORK: All efforts required to:

- o develop interim test plan guidelines for planning the testing and evaluation work to be performed during the period between completion of the ES testing and the beginning of operation of the repository
- o prepare the Draft Performance Confirmation Interim Test Plan which will describe the testing and evaluation work to be performed during the period between the completion of ES testing and beginning of operation of the repository
- o prepare the Performance Confirmation (PC) System Conceptual Operations Plan (to accompany the Conceptual Design Report) to define the preliminary operational plans for the PC system and to form the basis for the PC system design requirements
- o develop the PC system facility design requirements for inclusion in the Title I Facility Requirements Report
- o prepare the Final Performance Confirmation Interim Test Plan which describes testing and evaluation work to be performed during the period between the completion of ES testing and the beginning of operation of the repository
- o conduct performance confirmation testing and evaluation during the period between completion of ES testing and the beginning of construction of the repository
- o conduct performance confirmation testing and evaluation during repository construction
- o conduct performance confirmation testing and evaluation during operations and closure.

WBS: 2.5

TITLE: Regulatory and Institutional

OBJECTIVE: To assess and document the safety and environmental characteristics of a repository system in a manner which meets anticipated NRC licensing requirements, requirements of the National Environmental Policy Act (NEPA), and the requirements of the NWPA for state and public participation.

DESCRIPTION OF WORK: All efforts required to:

- ensure that NNWSI Project licensing assumptions and plans are consistent with Program assumptions and plans
- prepare licensing-related documentation including the Site Characterization Plan, Construction Authorization Application, Preliminary Safety Analysis Report, etc.
- prepare environmental documentation including the Environmental Assessment and Environmental Impact Statement
- inform and coordinate with affected community and government institutions.

WBS: 2.5.1

TITLE: Management and Integration

OBJECTIVE: To provide for management and integration of the regulatory and institutional effort.

WBS: 2.5.1.A

TITLE: Management and Integration

PARTICIPANT: Los Alamos National Laboratory

OBJECTIVE: To provide overall management of the work and integration of the respective parts.

DESCRIPTION OF WORK: All efforts required to:

- plan, schedule, and budget activities
- control costs and prepare management reports activities
- participate in coordinating groups
- provide for interaction with other OCRWM program participants on regulatory and institutional activities (e.g., participation in Licensing and Institutional Coordinating Groups)
- prepare and implement QA program procedures for regulatory and institutional activities.

WBS: 2.5.1.G

TITLE: Management and Integration

PARTICIPANT: United States Geological Survey

OBJECTIVE: To provide overall management of the work and integration of the respective parts.

DESCRIPTION OF WORK: All efforts required to:

- plan, schedule, and budget activities
- control costs and prepare management reports activities
- participate in coordinating groups
- provide for interaction with other OCRWM program participants on regulatory and institutional activities (e.g., participation in Licensing and Institutional Coordinating Groups)
- prepare and implement QA program procedures for regulatory and institutional activities.

WBS: 2.5.1.S

TITLE: Management and Integration

PARTICIPANT: Sandia National Laboratories

OBJECTIVE: To provide overall management of the work and integration of the respective parts.

ISSUES:

DESCRIPTION OF WORK: All efforts required to:

- plan, schedule, and budget activities
- control costs and prepare management reports activities
- participate in coordinating groups
- provide for interaction with other OCRWM program participants on regulatory and institutional activities (e.g., participation in Licensing and Institutional Coordinating Groups)
- prepare and implement QA program procedures for regulatory and institutional activities.

WBS: 2.5.1.T

TITLE: Management and Integration

PARTICIPANT: Science Applications International Corporation

OBJECTIVE: To provide overall management of the work and integration of the respective parts.

DESCRIPTION OF WORK: All efforts required to:

- plan, schedule, and budget activities
- control costs and prepare management reports activities
- participate in coordinating groups
- provide for interaction with other OCRWM program participants on regulatory and institutional activities (e.g., participation in Licensing and Institutional Coordinating Groups)
- prepare and implement QA program procedures for regulatory and institutional activities.

WBS: 2.5.2

TITLE: Licensing

OBJECTIVE: To ensure that the NNWSI Project actions are in accordance with applicable administrative, technical, and legal requirements of regulatory agencies.

DESCRIPTION OF WORK: All efforts required to:

- o review, analyze, and interpret regulatory requirements to provide licensing guidance to project activities that integrate licensing concerns and the needs of the project
- o participate in defining licensing strategies
- o prepare licensing documents, including site characterization plans, safety analysis reports, and construction authorization application
- o provide for peer review of licensing activities.

WBS: 2.5.2.1

TITLE: Regulatory Interactions

OBJECTIVE: To review, analyze, and interpret regulatory requirements and provide NRC licensing guidance to DOE/NV and Project participants in anticipation of potential NRC license application for a HLW repository; to support NNWSI Project interactions with the NRC and other regulatory bodies and integrate results into the Project; and to assist in integration of licensing needs and concerns within the Project.

WBS: 2.5.2.1.A

TITLE: Regulatory Interactions

PARTICIPANT: Los Alamos National Laboratories

OBJECTIVE: To assist with assessments, documentation, presentations, and technical support to ensure the NNWSI Project meets anticipated NRC licensing requirements.

DESCRIPTION OF WORK: All efforts required to:

- o review and interpret licensing documentation
- o support technical evaluations and eventual defense of the Program license application.

WBS: 2.5.2.1.G

TITLE: Regulatory Interactions

PARTICIPANT: United States Geological Survey.

OBJECTIVE: To assist with assessments, documentation, presentations, and technical support to ensure the NNWSI Project meets anticipated NRC licensing requirements.

DESCRIPTION OF WORK: All efforts required to:

- o review and interpret licensing documentation
- o support technical evaluations and eventual defense of the Program license application.

WBS: 2.5.2.1.L

TITLE: Regulatory Interactions

PARTICIPANT: Lawrence Livermore National Laboratory

OBJECTIVE: To assist with assessments, documentation, presentations, and technical support to ensure the NNWSI Project meets anticipated NRC licensing requirements.

DESCRIPTION OF WORK: All efforts required to:

- o review and interpret licensing documentation
- o support technical evaluations and eventual defense of the Program license application.

WBS: 2.5.2.1.S

TITLE: Regulatory Interactions

PARTICIPANT: Sandia National Laboratories

OBJECTIVE: To assist with assessments, documentation, presentations, and technical support to ensure the NNWSI Project meets anticipated NRC licensing requirements.

DESCRIPTION OF WORK: All efforts required to:

- o review and interpret licensing documentation
- o support technical evaluations and eventual defense of the Program license application.

WBS: 2.5.2.1.T

TITLE: Regulatory Interactions

PARTICIPANT: Science Applications International Corporation

OBJECTIVE: To ensure that all appropriate NNWSI Project actions, decisions, and documentation are in accordance with applicable administrative, technical, and legal requirements of regulatory agencies and program requirments of the DOE and are supported with proper basis and facts.

DESCRIPTION OF WORK: All efforts required to:

- o review and analyze rules and regulations, technical positions, regulatory guides, and criteria applicable to geologic repositories and associated activities in order to maintain current awareness of all licensing issues; review Project plans and other documentation to ensure compliance with regulatory requirements
- o maintain a library of current codes and standards applicable to the NNWSI Project and notify of Project participants of new codes and standards applicable to their activities
- o brief NNWSI Project management on a quarterly basis on the status of regulatory compliance
- o review, analyze, and interpret regulatory requirements in order to give appropriate licensing guidance and control to NNWSI Project activities and to integrate licensing concerns and needs into the Project
- o develop a data base for preparation of licensing documents
- o participate in defining licensing strategies and review of, or input to, licensing documents
- o develop licensing documents.

WBS: 2.5.2.2

TITLE: Site Characterization Plan

OBJECTIVE: To prepare plans for the collection of geotechnical information describing the detailed exploration of the preferred location in southwestern NTS, Yucca Mountain, so that the eventual license application will be complete and a meaningful evaluation can be made about the suitability of the site and the compatibility of the repository design with the particular site; and to provide a vehicle for early NRC, state, and public input on the data gathering and development work so as to avoid postponing issues.

DESCRIPTION OF WORK: All efforts required to:

- prepare the NNWSI Project SCP
- update the SCP
- coordinate with other OGR elements
- adhere to national program guidance
- integrate NNWSI Project elements
- integrate technical data

WBS: 2.5.2.2.A

TITLE: Site Characterization Plan

PARTICIPANT: Los Alamos National Laboratory

OBJECTIVE: To assist in the preparation and updates of the Site Charateriza-tion Plan (SCP) that is intended to detail the plans for collecting the geotechnical information needed for the eventual license application for the Yucca Mountain location as a nuclear waste repository.

DESCRIPTION OF WORK: All efforts required to:

- assist in the general preparation and review of the SCP
- prepare portions concerning geochemistry of Yucca Mountain.

WBS: 2.5.2.2.G

TITLE: Site Characterization Plan

PARTICIPANT: United States Geological Survey

OBJECTIVE: To assist in the preparation and updates of the Site Charateriza-tion Plan (SCP) that is intended to detail the plans for collecting the geotechnical information needed for the eventual license application for the Yucca Mountain location as a nuclear waste repository.

DESCRIPTION OF WORK: All efforts required to:

- o assist in the general preparation and review of the SCP
- o prepare portions concerning the geology, hydrology, and climatology of Yucca Mountain.

WBS: 2.5.2.2.L

TITLE: Site Characterization Plan

PARTICIPANT: Lawrence Livermore National Laboratory

OBJECTIVE: To assist in the preparation and updates of the Site Characterization Plan (SCP) that is intended to detail the plans for collecting the geotechnical information needed for the eventual license application for the Yucca Mountain location as a nuclear waste repository.

DESCRIPTION OF WORK: All efforts required to:

- assist in the general preparation and review of the SCP
- prepare SCP chapters concerned with waste-package design and environment.

WBS: 2.5.2.2.S

TITLE: Site Characterization Plan

PARTICIPANT: Sandia National Laboratories

OBJECTIVE: To assist in the preparation and updates of the Site Characterization Plan (SCP) that is intended to detail the plans for collecting the geotechnical information needed for the eventual license application for the Yucca Mountain location as a nuclear waste repository.

DESCRIPTION OF WORK: All efforts required to:

- assist in the general preparation and review of the SCP
- prepare portions concerning geoengineering and repository design.

WBS: 2.5.2.2.T

TITLE: Site Characterization Plan

PARTICIPANT: Science Applications International Corporation

OBJECTIVE: To compile a comprehensive Site Characterization Plan that addresses data needs required to assess the suitability of the proposed site and to update the document as required.

DESCRIPTION OF WORK: All efforts required to:

- develop an SCP Network (schedule) for SCP production and review
- update the SCP
- coordinate with other Program elements
- adhere to national program guidance
- integrate NNWSI Project elements
- integrate technical data
- guide development of Chapter 10.

WBS: 2.5.2.3

TITLE: Construction Authorization Application

OBJECTIVE: To prepare a construction authorization application in accordance with applicable regulatory guidelines and OCRWM licensing requirements.

WBS: 2.5.2.4

TITLE: Preliminary Safety Analysis Report

OBJECTIVE: To prepare a PSAR consistant with regulatory guidelines and program licensing requirements.

WBS: 2.5.3

TITLE: Environmental Compliance

OBJECTIVE: To ensure that NNWSI Project actions are in accordance with applicable environmental requirements as detailed by NWPA and NEPA.

DESCRIPTION OF WORK: All efforts required to:

- o review, analyze, and interpret NEPA requirements to provide guidance to Project activities that integrate NEPA concerns and the needs of the Project
- o review, analyze, and interpret State and local environmental regulations
- o identify all permitting requirements, including those required for the exploratory shaft and the repository
- o prepare documents required to comply with NWPA and NEPA, including environmental assessments and environmental impact statements
- o provide for peer review of environmental compliance activities.

WBS: 2.5.3.1

TITLE: Environmental Assessment

OBJECTIVE: To assure that the NNWSI Project develops an Environmental Assessment document that conforms with the DOE Siting Guidelines and other appropriate regulatory guidelines.

DESCRIPTION OF WORK: All efforts required to:

- o develop an Environmental Assessment for the NNWSI Project in accordance with appropriate guidelines
- o ensure that all appropriate NNWSI Project actions, decisions, and documentation are included in the EA Document and are in accordance with applicable environmental requirements of responsible agencies, the NWPA, geologic repository program requirements, support data, analysis, and conclusions.

WBS: 2.5.3.1.A

TITLE: Environmental Assessment

PARTICIPANT: Los Alamos National Laboratory

OBJECTIVE: To assure that the NNWSI Project develops an Environmental Assessment document that conforms with the DOE Siting Guidelines and other appropriate regulatory guidelines.

DESCRIPTION OF WORK: All efforts required to:

- o develop the appropriate format and level of detail in order to merge the LANL data base with the technical and system guidelines set forth in the siting guidelines
- o develop a method to ensure that all references that are cited will be published for release prior to or concurrently with the EA.

WBS: 2.5.3.1.G

TITLE: Environmental Assessment

PARTICIPANT: United States Geological Survey

OBJECTIVE: To assure that the NNWSI Project develops an Environmental Assessment document that conforms with the DOE Siting Guidelines and other appropriate regulatory guidelines.

DESCRIPTION OF WORK: All efforts required to:

- o develop the appropriate format and level of detail in order to merge the USGS data base with the technical and system guidelines set forth in the siting guidelines
- o develop a method to ensure that all references that are cited will be published for release prior to or concurrently with the EA.

WBS: 2.5.3.1.L

TITLE: Environmental Assessment

PARTICIPANT: Lawrence Livermore National Laboratory

OBJECTIVE: To assure that the NNWSI Project develops an Environmental Assessment document that conforms with the DOE Siting Guidelines and other appropriate regulatory guidelines.

DESCRIPTION OF WORK: All efforts required to:

- develop the appropriate format and level of detail in order to merge the LLNL data base with the technical and system guidelines set forth in the siting guidelines
- develop a method to ensure that all references that are cited will be published for release prior to or concurrently with the EA.

WBS: 2.5.3.1.S

TITLE: Environmental Assessment

PARTICIPANT: Sandia National Laboratories

OBJECTIVE: To assure that the NNWSI Project develops an Environmental Assessment document that conforms with the DOE Siting Guidelines and other appropriate regulatory guidelines.

DESCRIPTION OF WORK: All efforts required to:

- o develop the appropriate format and level of detail in order to merge the SNL data base with the technical and system guidelines set forth in the siting guidelines
- o develop a method to ensure that all references that are cited will be published for release prior to or concurrently with the EA.

WBS: 2.5.3.3.T

TITLE: Environmental Regulatory Interactions

PARTICIPANT: Science Applications International Corporation

OBJECTIVE: To review, analyze, and interpret Federal, State, and local environmental regulations; to provide guidance to Project activities that integrate NEPA concerns and the needs of the Project; and to review existing environmental data in regards to applicable regulatory requirements and Project needs.

DESCRIPTION OF WORK: All efforts required to:

- review, analyze, and interpret Federal, State, and local environmental regulations
- provide guidance to Project activities that integrate NEPA concerns and the needs of the Project
- review existing environmental data in regards to applicable regulatory requirements
- interact with regulatory agencies as directed by YMPO
- determine environmental permits and permit requirements.

WBS: 2.5.4

TITLE: Communication and Liaison

OBJECTIVE: To inform the public and coordinate appropriate NNWSI Project activities with the affected community and government institutions.

DESCRIPTION OF WORK: All efforts required to:

- collect and disseminate relevant information and coordinate activities with affected States, local governments, affected Indian tribes, and the general public
- coordinate information meetings, public presentations, exhibits, films, and other public information activities including support of such activities with preparation, reproduction, and collection of audio-visual materials
- conduct workshops to enhance communications with the public that may be affected by the program
- prepare and negotiate consultation and cooperation agreements with affected states and Indian tribes
- consult, cooperate with, and provide support to affect states and Indian tribes
- provide media skills training to Project participants
- conduct public hearings.

WBS: 2.5.4.1

TITLE: Institutional Studies

OBJECTIVE: To inform the public and coordinate appropriate NNWSI Project activities with the affected community and government institutions.

DESCRIPTION OF WORK: All efforts required to:

- o provide support and liaison to State and local government institutions
- o collect and coordinate dissemination of relevant information to the State, local communities, and general public
- o coordinate information meetings, public presentations, exhibits, films, and public information activities
- o conduct workshops to enhance communication with the citizens of Nevada.

WBS: 2.5.4.1.S

TITLE: Institutional Studies

PARTICIPANT: Sandia Naional Laboratories

OBJECTIVE: To support the NNWSI Project in the preparation of factual data for use in publications and presentations to citizens, elected officials, and other groups interested in the potential siting of a high-level nuclear waste repository in Yucca Mountian.

DESCRIPTION OF WORK: All efforts required to prepare public information material that will explain the issues of principal concern to public officials and other residents of the State.

WBS: 2.5.4.1.T

TITLE: Institutional Studies

PARTICIPANT: Science Applications International Corporation

OBJECTIVE: To support the NNWSI Project in the preparation of factual data for use in publications and presentations to citizens, elected officials, and other groups interested in the potential siting of a high-level nuclear waste repository in Yucca Mountain.

DESCRIPTION OF WORK: All efforts required to prepare public information material that will explain the issues of principal concern to public officials and other residents of the State.

WBS: 2.5.5

TITLE: Financial/Technical Assistance

OBJECTIVE: To provide assistance to the states and affected Indian Tribes

DESCRIPTION OF WORK: All efforts required to:

- o provide grants in accordance with NWPA for document review/monitoring, information transfer, and commenting on statutory documents
- o provide grants-in-lieu-of-taxes in accordance with NWPA
- o provide impact mitigation grants in accordance with NWPA.

WBS: 2.6

TITLE: Exploratory Shaft Investigations

OBJECTIVE: To provide access to a selected underground tuff horizon and surrounding strata in the unsaturated zone; to provide the ability to safely and effectively acquire geotechnical data from the selected underground tuff horizon and surrounding strata; and to demonstrate the constructibility of a large diameter shaft and underground openings (drifts and waste package emplacement holes) in the selected horizon.

DESCRIPTION OF WORK: All efforts required to:

- design and construct facilities
- conduct observations, measurements and tests required to make a determination regarding the suitability of the Yucca Mountain site for containment of a nuclear waste repository
- maintain and operate the facility
- provide project planning and design review
- design and install an Integrated Data System.

WBS: 2.6.0

TITLE: Decommissioning

OBJECTIVE: To decommission and seal the Exploratory Shafts.

DESCRIPTION OF WORK: All efforts required to:

- prepare plans for the decommissioning and sealing of the Exploratory Shafts
- perform actual decommissioning and sealing of the Exploratory Shafts.

WBS: 2.6.1

TITLE: Management and Integration

OBJECTIVE: To provide for management and integration of the Exploratory Shaft activities and to implement QA program procedures for ES activities.

DESCRIPTION OF WORK: All efforts required to:

- o provide for the overall management of Exploratory Shaft activities including planning, scheduling, budgeting, controlling, and reporting; the project management for support activities performed by the architect-engineer and the construction manager; the preparation of the integrated Exploratory Shaft facility design; the conduct of safety analyses associated with the Exploratory Shaft facility; and obtaining the permits for Exploratory Shaft construction

- o provide for interaction with other OCRWM program participants on Exploratory Shaft activities (e.g., participation in the Underground Testing Coordinating Group)

- o prepare and implement QA program procedures for Exploratory Shaft activities.

WBS: 2.6.1.1

TITLE: Exploratory Shaft Management, Planning, and Design Review

OBJECTIVE: To provide overall management of Exploratory Shaft (ES) activities.

DESCRIPTION OF WORK: All efforts required to:

- organize, plan, schedule, budget, monitor, control, and report Exploratory Shaft work
- identify and define interfaces between the Exploratory Shaft elements
- integrate the Exploratory Shaft elements and integrate site activities and test plans with design efforts
- recommend solutions to major Exploratory Shaft issues that affect the overall project
- support Exploratory Shaft technical and programmatic decisions
- develop Functional Design Criteria (FDC), Exploratory Shaft Project Management Plan (ESPMP), and the Conceptual Design Criteria (CDC).
- provide project management for support activities performed by the architect-engineer and the construction manager including design reviews
- provide technical direction to the ES Project
- review and approve the ESF schedules.

WBS: 2.6.1.1.A

TITLE: Exploratory Shaft Management, Planning, and Design Review

PARTICIPANT: Los Alamos National Laboratory

OBJECTIVE: To provide overall management of Exploratory Shaft activities.

DESCRIPTION OF WORK: All efforts required to:

- organize, plan, schedule, budget, monitor, control, and report Exploratory Shaft work
- identify and define interfaces between the Exploratory Shaft elements
- integrate the Exploratory Shaft elements with related site, repository, test, and other elements including integration of site activities and test plans with design efforts
- recommend solutions to major Exploratory Shaft issues that affect the overall project
- support Exploratory Shaft technical and programmatic decisions
- develop input to Conceptual Design Report (CDR), Exploratory Shaft Project Management Plan (PMP), and the Functional Design Criteria (FDC).
- review and approve engineering designs to assure compatibility with project technical requirements
- provide technical direction to Exploratory Shaft Project
- review and approve the Exploratory Shaft Facilities network schedules produced by the T&MSS contractor.

WBS: 2.6.1.1.F

TITLE: Exploratory Shaft Management, Planning, and Design Review

PARTICIPANT: Fenix and Scisson

OBJECTIVE: To provide design reviews and analyses, budgets and schedules for subsurface activities.

DESCRIPTION OF WORK: All efforts required to:

- o provide cost estimates, schedules, and progress reporting on subsurface Exploratory Shaft activities
- o participate in internal and project design reviews.

WBS: 2.6.1.1.G

TITLE: Exploratory Shaft Management, Planning, and Design Review

PARTICIPANT: United States Geological Survey.

OBJECTIVE: To provide the management, planning, and design review for the USGS portion of the Exploratory Shaft activities.

DESCRIPTION OF WORK: All efforts required to:

- o provide input for planning and management of Exploratory Shaft testing
- o provide management of the USGS portion of the Exploratory Shaft activities including planning, scheduling, budgeting, controlling, and reporting
- o participate in management design reviews of the shaft facility design
- o interaction with other NNWSI Project participants and OCRWM program participants on Exploratory Shaft activities.

WBS: 2.6.1.1.H

TITLE: Exploratory Shaft Management, Planning, and Design Review

PARTICIPANT: Holmes and Narver

OBJECTIVE: To provide design reviews and analyses, budgets, and schedules for activities associated with the surface portion of the Exploratory Shaft.

DESCRIPTION OF WORK: All efforts required to:

- o provide cost estimates, schedules, and progress reporting on surface Exploratory Shaft activities
- o participate in internal and project design reviews.

WBS: 2.6.1.1.L

TITLE: Exploratory Shaft Management, Planning, and Design Review

PARTICIPANT: Lawrence Livermore National Laboratory

OBJECTIVE: To provide the management, planning, and design review for the LLNL portion of the Exploratory Shaft activities.

DESCRIPTION OF WORK: All efforts required to:

- o provide management of the LLNL portion of the Exploratory Shaft activities including planning, scheduling, budgeting, controlling, and reporting
- o perform management design reviews of the shaft facility design
- o interact with other NNWSI Project participants and OCRWM program participants on Exploratory Shaft activities.

WBS: 2.6.1.1.R

TITLE: Exploratory Shaft Management, Planning, and Design Review

PARTICIPANT: Reynolds Electrical and Engineering Co., Inc.

OBJECTIVE: To provide design reviews and analyses, budgets, and schedules.

DESCRIPTION OF WORK: All efforts required to:

- o provide cost estimates, schedules, and progress reporting for Exploratory Shaft operations
- o prepare and let the subcontractor bid package for shaft construction
- o hold internal and project design reviews
- o provide support as the construction manager.

WBS: 2.6.1.1.S

TITLE: Exploratory Shaft Management, Planning, and Design Review

PARTICIPANT: Sandia National Laboratories

OBJECTIVE: To provide the management, planning, and design review for the SNL portion of the Exploratory Shaft activities.

DESCRIPTION OF WORK: All efforts required to:

- o provide management of the SNL portion of the Exploratory Shaft activities
- o perform management design reviews of the shaft facility design
- o interact with other NNWSI Project participants and OCRWM program participants on Exploratory Shaft activities.

WBS: 2.6.1.2

TITLE: Safety and Quality Assurance

OBJECTIVE: To develop ES project safety procedures and a Quality Assurance Program Plan (QAPP).

DESCRIPTION OF WORK: All efforts required to:

- o develop proper safety procedures
- o implement safety standards
- o develop and implement a QAPP and supporting procedures in accordance with NNWSI Project QA Plan NVO-196-17
- o insure that all quality assurance standards meet NQA-1.

WBS: 2.6.1.2.A

TITLE: Safety and Quality Assurance

PARTICIPANT: Los Alamos National Laboratory .

OBJECTIVE: To produce a Quality Assurance Program Plan (QAPP) and supporting procedures for all LANL work associated with the Exploratory Shaft

DESCRIPTION OF WORK: All efforts required to:

- o produce an in-house QAPP and supporting procedures for LANL work associated with the Exploratory Shaft in accordance with the NNWSI Project QA Plan NVO-196-17
- o promote and maintain safe conditions according to the approved safety manuals and procedures of the various organizations involved in the ESF
- o document the accomplishment of all items and submit documentation to the NNWSI Project Records Center.

WBS: 2.6.6.R

TITLE: Subsurface Excavations

PARTICIPANT: Reynolds Electrical and Engineering Co., Inc.

OBJECTIVE: Administer construction of underground openings to support in situ testing.

DESCRIPTION OF WORK: All efforts required to:

- serve as construction manager for mining of an upper Demonstration Breakout Room (DBR) and a lower Demonstration Breakout Room (LBR)
- mine the drifts that will be used for the primary testing efforts and alcoves for the subsurface power substation and the Integrated Data System
- mine a drill room at the bottom of the shaft
- reinforce all excavated surfaces as required with rock bolts, wire mesh, shotcrete, and fire walls as required
- provide construction services including standard mining crafts and materials procurement subcontracts.

WBS: 2.6.1.2.F

TITLE: Safety and Quality Assurance

PARTICIPANT: Fenix & Scisson

OBJECTIVE: To produce a Quality Assurance Program Plan (QAPP) and supporting procedures for all F&S work associated with the Exploratory Shaft.

DESCRIPTION OF WORK: All efforts required to:

- o develop and implement a QAPP and supporting procedures for F&S work in accordance with the NNWSI Project QA Plan NVO-196-17
- o develop and implement safety standards
- o document the accomplishment of all items and submit documentation to the NNWSI Project Records Center.

WBS: 2.6.1.2.G

TITLE: Safety and Quality Assurance

PARTICIPANT: United States Geological Survey

OBJECTIVE: To develop a Quality Assurance Program Plan (QAPP) and supporting procedures for all USGS work associated with the Exploratory Shaft.

DESCRIPTION OF WORK: All efforts required to:

- develop and implement a QAPP and supporting procedures for USGS work in accordance with the NNWSI Project QA Plan NVO-196-17
- develop and implement safety standards
- document the accomplishment of all items and submit documentation to the NNWSI Project Records Center.

WBS: 2.6.1.2.H

TITLE: Safety and Quality Assurance

PARTICIPANT: Holmes & Narver

OBJECTIVE: To develop a Quality Assurance Program Plan (QAPP) and supporting procedures for all H&N work associated with the Exploratory Shaft.

DESCRIPTION OF WORK: All efforts required to:

- o develop and implement a QAPP and supporting procedures for H&N work in accordance with the NNWSI Project QA Plan NVO-196-17
- o develop and implement safety standards
- o document the accomplishment of all items and submit documentation to the NNWSI Project Records Center.

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WBS: 2.6.1.2.L

TITLE: Safety and Quality Assurance

PARTICIPANT: Lawrence Livermore National Laboratory

OBJECTIVE: To develop a Quality Assurance Program Plan (QAPP) and supporting procedures for all LLNL work associated with the Exploratory Shaft.

DESCRIPTION OF WORK: All efforts required to:

- o develop and implement a QAPP and supporting procedures for LLNL work in accordance with the NNWSI Project QA Plan NVO-196-17
- o develop and implement safety standards
- o document the accomplishment of all items and submit documentation to the NNWSI Project Records Center.

WBS: 2.6.1.2.R

TITLE: Safety and Quality Assurance

PARTICIPANT: Reynolds Electrical & Engineering Co., Inc.

OBJECTIVE: To develop a Quality Assurance Program Plan (QAPP) and supporting procedures for all REECo work associated with the Exploratory Shaft.

DESCRIPTION OF WORK: All efforts required to:

- o develop and implement a QAPP and supporting procedures for REECo work in accordance with the NNWSI Project QA Plan NVO-196-17
- o develop and implement safety standards
- o document the accomplishment of all items and submit documentation to the NNWSI Project Records Center.

WBS: 2.6.1.2.S

TITLE: Safety and Quality Assurance

PARTICIPANT: Sandia National Laboratories

OBJECTIVE: To develop a Quality Assurance Program Plan (QAPP) and supporting procedures for all SNL work associated with the Exploratory Shaft.

DESCRIPTION OF WORK: All efforts required to:

- conduct analysis of safety associated with the Exploratory Shaft
- develop and implement a QAPP and supporting procedures for SNL work in accordance with the NNWSI Project QA Plan NVO-196-17
- develop and implement safety standards
- document the accomplishment of all items and submit documentation to the NNWSI Project Records Center.

WBS: 2.6.1.2.T

TITLE: Safety and Quality Assurance

PARTICIPANT: Science Applications International Corporation

OBJECTIVE: To provide WMPO/NV with assistance in the performance of QA surveillance.

DESCRIPTION OF WORK: All efforts required to:

- o provide surveillance of Exploratory Shaft activities at the NTS
- o document the accomplishment of all items and submit documentation to the NNWSI Project Records Center.

WBS: 2.6.2

TITLE: Site Preparation

OBJECTIVE: To design and develop site and road access, utilities, and communication systems.

DESCRIPTION OF WORK: All efforts required to:

- o provide all necessary engineering labor to produce design calculations and drawings for all site, surface utilities, and communication systems and the materials testing laboratory
- o provide all the necessary labor and construction services for site, road, sewage and surface facilities, and communication systems
- o provide for surveys and maps, and the demolition and removal of structures that are unusable
- o provide general civil improvements, including clearing, grading, excavating, filling, parking, installation of drainage systems, and muck storage pads as required
- o construct new and relocate or refurbish existing roads, power systems, water supply, communications, and sewage treatment for the site, including provision for road and rail access to the site, as required.

WBS: 2.6.2.1

TITLE: Site and Roads

OBJECTIVE: To prepare site and roads for access to the shaft.

DESCRIPTION OF WORK: All efforts required to:

- o provide engineering for surveying, design drawings, and for the preparation of site and roads
- o provide construction services for all the site and road activity.

WBS: 2.6.2.1.H

TITLE: Site and Roads

PARTICIPANT: Holmes & Narver

OBJECTIVE: To provide design drawings, technical specifications, and engineering expertise.

DESCRIPTION OF WORK: All efforts required to:

- perform field surveying
- provide design calculations and design drawings
- provide cost estimates of site work
- provide for project engineering
- provide for Title III inspection.

WBS: 2.6.2.1.R

TITLE: Site and Roads

PARTICIPANT: Reynolds Electrical & Engineering Co., Inc.

OBJECTIVE: To prepare site and roads for access to the shaft.

DESCRIPTION OF WORK: All efforts required to:

- o provide construction services for all efforts including labor
- o provide materials procurement and subcontracted earthworking equipment rentals
- o improve the existing dirt road grading, widening, and applying a double oil and chip surface treatment
- o clear, grade, and stabilize an approximate by 20-acre contiguous site area to include drainage provisions and access control fencing
- o construct a pad to support the construction effort
- o install a sewage tank and construct seepage pits
- o grade a water tank service road and water tank pad area.

WBS: 2.6.2.2

TITLE: Utilities and Communications Systems

OBJECTIVE: To provide engineering and construction labor for the surface utilities and communication systems.

DESCRIPTION OF WORK: All efforts required to:

- o provide the engineering to produce design calculations and drawings for surface utilities and communication systems (including a primary power system, secondary power system, emergency power system, water supply, sewage collection system)
- o provide labor and equipment to construct and install the utilities and communications systems.

WBS: 2.6.2.2.H

TITLE: Utilities and Communication Systems

PARTICIPANT: Holmes & Narver

OBJECTIVE: To provide engineering for surface utilities and communications systems.

DESCRIPTION OF WORK: All efforts required to:

- o provide field surveying
- o provide design calculations and drawings
- o provide cost estimates of the systems
- o provide technical specifications
- o provide Title III inspection.

WBS: 2.6.2.2.R

TITLE: Utilities and Communications System

PARTICIPANT: Reynolds Electrical & Engineering Co., Inc.

OBJECTIVE: To provide all power, a water supply system, and a sewage collection system necessary to support surface and subsurface operations, and to provide surface and subsurface communications equipment as well as fire protection system monitoring.

DESCRIPTION OF WORK: All efforts required to:

- provide construction services for listed efforts including labor of standard construction crafts (laborers, teamsters, operating engineers, electricians, plumbers, carpenters, etc.,)
- provide materials and equipment procurement subcontractors
- construct an overhead power transmission line
- construct a substation with primary transformer and associated panels, switches, and conductors
- construct an electrical distribution system with secondary transformers and associated panels, switches, conduit, and conductors, as necessary
- install an emergency generator system with automatic transfer switches for connection to hoists, area lighting system, and ventilation fans
- construct an underground water line to include pumping station(s), storage tank, and distribution system throughout the surface facility
- install a buried sanitary waste collection piping system
- install solar-powered microwave communication system to accommodate at least 30 phone sets and a digital communication link for fire protection system monitoring.

WBS: 2.6.3

TITLE: Surface Facilities

OBJECTIVE: To design and develop the Exploratory Shaft surface facilities buildings.

DESCRIPTION OF WORK: All efforts required to:

- o develop the surface facility buildings at the Exploratory Shaft site including all storage buildings or fenced storage areas
- o provide all shop facilities, both fabrication and maintenance
- o provide buildings to house engineering, scientific, and administrative personnel, first aid services, safety and emergency equipment and personnel, environmental monitoring system, etc.

WBS: 2.6.3.1

TITLE: Buildings

OBJECTIVE: To provide all necessary support for design and construction of site buildings.

DESCRIPTION OF WORK: All efforts required to:

- o provide engineering for site surveying and building designs
- o provide construction services to construct the site buildings.

WBS: 2.6.3.1.H

TITLE: Buildings

PARTICIPANT: Holmes & Narver

OBJECTIVE: To provide design drawings and field survey for all site buildings.

DESCRIPTION OF WORK: All efforts required to:

- perform necessary field surveying
- prepare design drawings and design calculations
- prepare technical specifications and provide project engineering
- provide Title III inspection
- provide materials testing service, as required.

WBS: 2.6.3.1.R

TITLE: Buildings

PARTICIPANT: Reynolds Electrical & Engineering Co., Inc.

OBJECTIVE: To provide concrete building foundations and trailer pads for all site buildings and trailers; to erect a shop and warehouse, complete with utilities; to procure and erect pre-engineered office trailers and change-house trailers.

DESCRIPTION OF WORK: All efforts required to:

- o provide construction services including labor of standard construction crafts
- o construct concrete building foundations and graded trailer pads for prefabricated metal buildings and trailers (this does not include the pads for the hoists)
- o erect one ES-1 hoist house, one ES-2 hoist house, one shop, one visitors' center, and one warehouse, complete with utilities (this does not include the erection of the hoists or headframes)
- o set and connect office/laboratory trailers and change house trailers (this does not includes the IDS trailer)
- o grade and form power pads for generators and compressors.

WBS: 2.6.4

TITLE: First Shaft

OBJECTIVE: To provide technical and design support as well as labor support for construction of the ES-1 shaft, liner, hoist and headframe.

DESCRIPTION OF WORK: All efforts required to:

- o provide design calculations, drawings, materials, surveying, and labor for construction of the hoists, liner, foreshaft, shaft, and collar
- o design shaft, including hoist, headframe, and supports required for service systems
- o perform engineering studies in support of design
- o excavate the shaft
- o line the shaft, including installation of supports for service systems
- o seal the shaft liner.

WBS: 2.6.4.1

TITLE: Shaft and Liner

OBJECTIVE: To provide technical and design support as well as labor support for construction of the ES-1 shaft and liner.

DESCRIPTION OF WORK: All efforts required to provide design calculations, drawings, surveying, materials, and labor for construction of the ES-1 shaft and liner.

WBS: 2.6.4.1.F

TITLE: Shaft and Liner

PARTICIPANT: Fenix & Scisson

OBJECTIVE: To provide technical design support for the ES-1 shaft and liner.

DESCRIPTION OF WORK: All efforts required to:

- o provide engineering for design calculation, design drawings, technical specification preparation, and project engineering for the ES-1 shaft and liner (including shaft collar and foreshaft)
- o provide Title III inspection.

WBS: 2.6.4.1.H

TITLE: Shaft and Liner

PARTICIPANT: Holmes and Narver

OBJECTIVE: Provide survey support during construction of the ES-1 shaft and liner

DESCRIPTION OF WORK: All efforts required to:

- o conduct surveys to assure correct alignment of the ES-1 shaft to a minimum neat line diameter of 14 ft and a finished inside diameter of 12 ft
- o provide Title III inspection, surveying, and Materials Testing Laboratory.

WBS: 2.6.4.1.R

TITLE: Shaft and Liner

PARTICIPANT: Reynolds Electrical & Engineering Co., Inc.

OBJECTIVE: To administer construction of the ES-1 shaft and liner to support in situ testing and provide government-furnished equipment and materials.

DESCRIPTION OF WORK: All efforts required to:

- serve as construction manager for construction of the ES-1 shaft and liner (including shaft collar and foreshaft), all of which will be performed by the shaft-sinking subcontractor
- provide construction services under a major subcontract to include labor of standard mining crafts, associated supervisory personnel, materials (exclusive of sand and aggregate for concrete which will be government furnished through REECo procurement), and mining equipment.

WBS: 2.6.4.2

TITLE: Hoists and Headframe

OBJECTIVE: To provide technical, design, and labor support for construction of the Exploratory Shaft hoists and headframe.

DESCRIPTION OF WORK: All efforts required to provide design calculations, drawings, design specifications, materials, and labor for construction and installation of the ES-1 hoists and headframe.

WBS: 2.6.4.2.F

TITLE: Hoists and Headframe

PARTICIPANT: Fenix and Scisson

OBJECTIVE: To provide design specifications for the ES-1 hoists and headframe.

DESCRIPTION OF WORK: All efforts required to:

- o provide the specifications on the hoists and headframe necessary for design and procurement
- o provide Title III inspection.

WBS: 2.6.4.2.H

TITLE: Hoists and Headframe

PARTICIPANT: Holmes and Narver

OBJECTIVE: To provide technical design support for the ES-1 hoists and headframe.

DESCRIPTION OF WORK: All efforts required to provide engineering for design calculation, design drawings, technical specification preparation, and project engineering for the hoist foundation.

WBS: 2.6.4.2.R

TITLE: Hoists and Headframe

PARTICIPANT: Reynolds Electrical and Engineering Co., Inc.

OBJECTIVE: To install hosits and a headframe to support in situ testing.

DESCRIPTION OF WORK: All efforts required to:

- construct concrete pads for hoists and headframe and install hoists and headframe
- install a mine hoist signal system
- provide construction services including labor of standard construction crafts.

WBS: 2.6.5

TITLE: Second Shaft

OBJECTIVE: To provide technical, design, and labor support for construction of the ES-2 shaft, liner, hoist, and headframe.

DESCRIPTION OF WORK: All efforts required to:

- o provide design calculations, drawings, materials, surveying, and labor for construction of the hoist, headframe, shaft, and liner
- o design shaft, including hoist, headframe, and supports required for service systems
- o perform engineering studies in support of design
- o excavate the shaft
- o line the shaft, including installation of supports for service systems
- o seal the shaft liner.

WBS: 2.6.5.1

TITLE: Shaft and Liner

OBJECTIVE: To provide technical and design support as well as labor support for construction of the ES-2 shaft and liner.

DESCRIPTION OF WORK: All efforts required to provide design calculations, drawings, surveying, materials, and labor for construction of the ES-2 shaft and liner.

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WBS: 2.6.5.1.F

TITLE: Shaft and Liner

PARTICIPANT: Fenix & Scisson

OBJECTIVE: To provide technical design support for the ES-2 shaft, liner, and headframe.

DESCRIPTION OF WORK: All efforts required to:

- o provide engineering labor for design calculations, design drawings, technical specification preparation, and project engineering for ES-2 shaft and liner
- o provide Title III inspection.

WBS: 2.6.5.1.H

TITLE: Shaft and Liner

PARTICIPANT: Holmes and Narver

OBJECTIVE: To provide survey support during construction of ES-2 shaft and liner.

DESCRIPTION OF WORK: All efforts required to:

- conduct surveys to assure correct alignment of the shaft to a diameter of approximately 8 ft and a finished inside diameter of 6 ft
- provide Title III inspection, surveying, and Materials Testing Laboratory.

WBS: 2.6.5.1.R

TITLE: Shaft and Liner

PARTICIPANT: Reynolds Electrical & Engineering Co., Inc.

OBJECTIVE: To administer construction of ES-2 shaft and liner and to provide government furnished equipment and materials.

DESCRIPTION OF WORK: All efforts required to:

- o serve as manager for construction of the ES-2 shaft and liner which will be performed by the shaft-sinking subcontractor
- o provide construction services under a major subcontract to include labor of standard mining crafts, associated supervisory personnel, materials (exclusive of sand and aggregate for concrete which will be government furnished through REECo procurement), and mining equipment.

WBS: 2.6.5.2

TITLE: Hoist and Headframe

OBJECTIVE: To provide technical design support and labor support construction of the Exploratory Shaft ES-2 hoist and headframe.

DESCRIPTION OF WORK: All efforts required to provide design calculations, drawings, design specifications, materials, and labor construction of the ES-2 hoist and headframe.

WBS: 2.6.5.2.F

TITLE: Hoist and Headframe

PARTICIPANT: Fenix and Scisson

OBJECTIVE: To provide design specifications for the ES-2 hoist and headframe.

DESCRIPTION OF WORK: All efforts required to:

- o provide the specifications on the hoist and headframe necessary for design and procurement
- o provide Title III inspection.

WBS: 2.6.5.2.H

TITLE: Hoist and Headframe

PARTICIPANT: Holmes and Narver

OBJECTIVE: To provide technical design support for the ES-2 hoist and headframe.

DESCRIPTION OF WORK: All efforts required to:

- o provide engineering for design calculations, design, drawings, technical specification preparation, and project engineering for the ES-2 hoist foundation
- o provide Title III inspection and surveying.

WBS: 2.6.5.2.R

TITLE: Hoist and Headframe

PARTICIPANT: Reynolds Electrical and Engineering Co., Inc.

OBJECTIVE: To construct ES-2 hoist and headframe to support in situ testing and to provide government furnished equipment and materials.

DESCRIPTION OF WORK: All efforts required to:

- construct concrete pads for ES-2 hoist and install hoist and headframe
- provide construction services under a major subcontract to include labor of standard construction crafts.

WBS: 2.6.6

TITLE: Subsurface Excavations

OBJECTIVE: To provide technical, design, and labor support for the Exploratory Shaft underground openings.

DESCRIPTION OF WORK: All efforts required to:

- o provide all necessary design calculations, drawings, surveying, labor, and materials for the underground openings
- o design subsurface excavations, including required rock bolting and grading
- o excavate the subsurface working areas, including grading and installation of rock bolting, wire mesh, shotcrete, and fire wall as required.

WBS: 2.6.6.F

TITLE: Subsurface Excavations

PARTICIPANT: Fenix and Scisson

OBJECTIVE: To provide technical design support for the Exploratory Shaft subsurface excavation to satisfy the in situ testing requirements.

DESCRIPTION OF WORK: All efforts required to provide engineering for design calculations, design drawings, technical specification preparation, and project engineering for subsurface excavations.

WBS: 2.6.6.H

TITLE: Subsurface Excavations

PARTICIPANT: Holmes and Narver

OBJECTIVE: To provide survey support during construction of breakout rooms, drifts, and during the drilling of in situ test holes.

DESCRIPTION OF WORK: All efforts required to:

- o provide survey support to assure proper alignment of the breakout rooms, drifts, and drill rooms during construction of the shaft
- o provide Title III inspection, surveying, and Materials Testing Laboraory.

WBS: 2.6.7

TITLE: Underground Service Systems

OBJECTIVE: To provide technical and design support, design criteria, and labor for the Exploratory Shaft underground service systems.

DESCRIPTION OF WORK: All efforts required to:

- o provide design calculations, design criteria, and drawings for shaft internals and conveyances, conduits, water line, dewater line, compressed air line, ventilation ducts, and mine plant
- o provide the engineering support for the design of the concrete foundation for the mine plant equipment, the subsurface substations, electrical system, and communication system
- o provide all construction labor and materials in accordance with the design specifications provided by F&S and H&N.

WBS: 2.6.7.1

TITLE: Utilities and Communications

OBJECTIVE: To provide technical and design support, design criteria, and labor for Exploratory Shaft subsurface utilities and communications.

DESCRIPTION OF WORK: All efforts required to provide all necessary design criteria, design calculations, drawings, Title III inspection, labor and materials for the utilities and communications systems, including utilities and communications costs in both the shaft proper and the underground openings. (Surface Utilities and Communications systems are provided under WBS Element 2.6.2.2.)

WBS: 2.6.7.1.F

TITLE: Utilities and Communications

PARTICIPANT: Fenix and Scisson

OBJECTIVE: To provide technical design support for the Exploratory Shaft subsurface utilities and communications.

DESCRIPTION OF WORK: All efforts required to:

- o provide engineering for design calculations, design drawings, technical specification preparation, and project engineering for ventilation ducts, power and instrumentation conduits, water line, dewater line, and compressed air line for the Exploratory Shaft
- o provide Title III inspection.

WBS: 2.6.7.1.H

TITLE: Utilities and Communications

PARTICIPANT: Holmes and Narver

OBJECTIVE: To provide design criteria on the subsurface substation, communication system, and electrical system.

DESCRIPTION OF WORK: All efforts required to:

- o provide the engineering support for the design of the subsurface substation, the electrical system, including the distribution of the conduit, cables, and panels, and the communication system
- o provide Title III inspection, surveying, and Materials Testing Laboratory.

WBS: 2.6.7.1.R

TITLE: Utilities and Communications

PARTICIPANT: Reynolds Electrical and Engineering Co., Inc.

OBJECTIVE: To administer construction of utilities and communications to support in situ testing in the underground openings.

DESCRIPTION OF WORK: All efforts required to:

- serve as construction manager for installation of electrical tranformers, conduits, distribution panels, and conductor cable for power distribution and scientific instrumentation systems in the underground openings
- install ventilation ducts, compressed air lines, and waterlines in the underground openings
- install communication cables and telephone instruments as appropriate in the underground openings
- provide construction services under a major subcontract to include labor of standard construction crafts, and materials and equipment procurement subcontracts.

WBS: 2.6.7.2

TITLE: Mine Plant

OBJECTIVE: To provide the mine plant for the Exploratory Shaft including air compressors, ventilation air supply/exhaust fans, and surface duct work, as well as waste water pumps.

DESCRIPTION OF WORK: All efforts required to:

- o provide the design specifications for the purchase of air compressors, vent fans, and waste water pumps
- o provide engineering support for the design of the concrete foundation for the mine plant equipment, and specifications for the emergency power generators
- o provide all construction labor and materials.

WBS: 2.6.7.2.F

TITLE: Mine Plant

PARTICIPANT: Fenix & Scisson

OBJECTIVE: To provide design specifications for the mine plant equipment.

DESCRIPTION OF WORK: All efforts required to:

- o provide design specifications for surface ventilation ductwork, air supply/exhaust system fans, and air compressors
- o provide specifications for the waste water sumps, tanks, and pumps
- o provide Title III inspection.

WBS: 2.6.7.2.H

TITLE: Mine Plant

PARTICIPANT: Holmes & Narver

OBJECTIVE: To provide the engineering specifications to build the concrete pad for the Mine Plant equipment including a concrete pad for the emergency power motor-generators.

DESCRIPTION OF WORK: All efforts required to:

- o provide the engineering labor to produce the design specifications for the concrete building foundation for the mine plant equipment
- o provide Title III inspection, surveying, and Materials Testing Laboratory.

WBS: 2.6.7.2.R

TITLE: Mine Plant

PARTICIPANT: Reynolds Electrical & Engineering Co., Inc.

OBJECTIVE: To install the mine plant equipment, including waste water manifolds and pipelines, and ventilation ductwork and compressed air supply for the Exploratory Shaft.

DESCRIPTION OF WORK: All efforts required to:

- construct concrete foundations for mine plant equipment and erect ventilation ductwork and compressed air supply lines to the shaft collar
- provide construction services of REECo, including labor of standard construction crafts and materials and equipment procurement subcontracts, including those for ventilation and compressed air systems.

WBS: 2.6.7.3

TITLE: Shaft Internals and Conveyances - First Shaft

OBJECTIVES: To provide technical and design support and labor support for construction of the Exploratory Shaft ES-1 Internals and Conveyances.

DESCRIPTION OF WORK: All efforts required to provide design calculations, drawings, surveying, Title III inspection, materials and labor necessary to construct the shaft internals and conveyances.

WBS: 2.6.7.3.F

TITLE: Shaft Internals and Conveyances - First Shaft

PARTICIPANT: Fenix & Scisson

OBJECTIVE: To provide technical design support for the ES-1 Exploratory Shaft internals and conveyances.

DESCRIPTION OF WORK: All efforts required to:

- o provide engineering for design calculations, design drawings, technical specification preparation, cost estimating
- o provide Title III inspection
- o provide project engineering for shaft internals and conveyances.

WBS: 2.6.7.3.H

TITLE: Shaft Internal and Conveyances - First Shaft

PARTICIPANT: Holmes and Narver

OBJECTIVE: To provide survey support during installation of ES-1 shaft internals and conveyances.

DESCRIPTION OF WORK: All efforts required to:

- o conduct surveys to assure correct alignment of shaft internals and conveyances
- o provide Title III inspection.

WBS: 2.6.7.3.R

TITLE: Shaft Internals and Conveyances - First Shaft

PARTICIPANT: Reynolds Electrical & Engineering Co., Inc.

OBJECTIVE: To administer construction of shaft internals and conveyances to support in situ testing and to provide government-furnished equipment.

DESCRIPTION OF WORK: All efforts required to:

- oversee subcontractors installation of safety doors, buntons, vertical conveyances guides, and ladder-way
- install permanent shaft conveyances to include personnel and equipment cage(s) and muck transport skip
- provide construction services under a major subcontract to include labor of standard mining crafts, associated supervisory personnel, materials and equipment (exclusive of permanent conveyances which will be government furnished through REECo procurement).

WBS: 2.6.7.4

TITLE: Shaft Internals and Conveyances - Second Shaft

OBJECTIVE: To provide technical and design support and labor support for construction of the ES-2 shaft internals and conveyances.

DESCRIPTION OF WORK: All efforts required to provide design calculations, drawings, Title III inspection, material, and labor necessary to construct the ES-2 shaft internals and conveyances.

WBS: 2.6.7.4.F

TITLE: Shaft Internals and Conveyances - Second Shaft

PARTICIPANT: Fenix and Scisson

OBJECTIVE: To provide technical and design support for the ES-2 shaft internals and conveyances.

DESCRIPTION OF WORK: All efforts required to:

- o provide engineering for design calculations, design drawings, Title III inspection, technical specification preparation
- o provide project engineering for the ES-2 shaft internals and conveyances.

WBS: 2.6.7.4.H

TITLE: Shaft Internals and Conveyances - Second Shaft

OBJECTIVE: To provide survey support during installation of ES-2 shaft internals and conveyances.

DESCRIPTION OF WORK: All efforts required to:

- o conduct surveys to assure correct alignment of shaft internals and conveyances
- o provide Title III inspection.

WBS: 2.6.7.4.R

TITLE: Shaft Internals and Conveyances - Second Shaft

PARTICIPANT: Reynolds Electrical and Engineering Co., Inc.

OBJECTIVE: To administer construction of the ES-2 shaft internals and conveyances.

DESCRIPTION OF WORK: All efforts required to oversee subcontractor's installation of vertical conveyances guides.

WBS: 2.6.8

TITLE: Operations

OBJECTIVE: To maintain and operate the Exploratory Shaft Facility

DESCRIPTION OF WORK: All efforts required to:

- coordinate and manage all on-site construction, maintenance, and operations activities
- provide support to the experiment and test programs
- assure security, health and safety, environmental protection, and related activities
- provide necessary periodic maintenance on all government-owned equipment, the facilities, and the site in general, including the access road and primary power and water systems
- operate, maintain, inspect, and prepare operating and maintenance manuals for (1) the systems necessary to transport personnel and material onto the site, into the shaft, and into the underground workings such as includes the hoist, headframe, cage and other related equipment and (2) the systems necessary to remove excavated material from the underground workings to its storage pad
- operate, maintain, inspect system components, and prepare operating and maintenance manuals for shaft and subsurface ventilation, communications, instrumentation, plant utilities, and emergency systems.

WBS: 2.6.8.1.R

TITLE: Site and Equipment Maintenance

PARTICIPANT: Reynolds Electrical and Engineering Co., Inc.

OBJECTIVE: To assure that the site and equipment are maintained in proper working condition.

DESCRIPTION OF WORK: All efforts required to provide necessary periodic maintenance on all government-owned equipment, the facilities, and the site, including the access road and primary power and water systems.

WBS: 2.6.8.2.R

TITLE: Project Operations

PARTICIPANT: Reynolds Electrical and Engineering Co., Inc.

OBJECTIVE: To provide project operations support to LANL.

DESCRIPTION OF WORK: All efforts required to:

- o provide necessary operations services, including administrative and material support (REECo Project Office), metered electric power, and equipment operations personnel, to sustain the day-to-day operation of the facility and to maintain underground access for user personnel
- o support underground construction and testing activities and provide LANL logistical support.

WBS: 2.6.8.3.R

TITLE: Training

PARTICIPANT: Reynolds Electrical & Engineering Co., Inc.

OBJECTIVE: To provide necessary safety precautions for site and underground facilities and personnel.

DESCRIPTION OF WORK: All efforts required to provide services of the Operations and Maintenance Division consisting primarily of supervisory personnel who will provide necessary safety training, certification, and surveillance for personnel responsible for operational control of underground access.

WBS: 2.6.9

TITLE: Testing

OBJECTIVE: To prepare and conduct Exploratory Shaft test programs that will meet the information requirements for site characterization and a waste repository license application.

DESCRIPTION OF WORK: All efforts required to:

- o develop an Exploratory Shaft Test Plan (ESTP)
- o develop an Exploratory Shaft test implementation and control plan
- o conduct observations, measurements, experiments, and tests required to determine the suitability of the Yucca Mountain site for containment of a nuclear waste repository
- o prepare technical and management reports
- o develop, design, procure, install, and operate test equipment (including data collection systems)
- o conduct the test program, reduce data, prepare reports, and provide results to the waste package, repository, and site tasks.

WBS: 2.6.9.1

TITLE: Exploratory Shaft Test Plan

OBJECTIVE: To coordinate and prepare Exploratory Shaft Test Plans and develop and to prepare the Draft Implementation and Control Plan for ES testing.

DESCRIPTION OF WORK: All efforts required to:

- develop the initial Exploratory Shaft Test Plan (ESTP)
- coordinate updates and revisions of the ESTP as required
- participate in ESTP Committee meetings
- prepare the Draft Implementation and Control Plan
- coordinate ESTP peer review.

WBS: 2.6.9.1.A

TITLE: Exploratory Shaft Test Plan

PARTICIPANT: Los Alamos National Laboratory

OBJECTIVE: To participate in the development of the Test Plans for the ES in support of NNWSI Project issues and to participate in the development of the Draft Implementation Plan and Control for ES testing.

DESCRIPTION OF WORK: All efforts required to:

- design and develop Test Plans that answer the issues associated with the feasibility of a repository
- conduct reviews with WMPO, TPO's, contractors, peers, QA, and NRC
- participate in ESTP Committee meetings
- prepare the Draft Implementation and Control Plan.

WBS: 2.6.9.1.G

TITLE: Exploratory Shaft Test Plan

PARTICIPANT: United States Geological Survey.

OBJECTIVE: To provide special technical support along with other NNWSI Project participants to develop a detailed plan for testing activities during and after construction of the Exploratory Shaft.

DESCRIPTION OF WORK: All efforts required to:

- o develop and produce detailed plans for testing activities that will help determine the suitability of the site for the development of a repository
- o participate in ESTP meetings
- o participate in peer reviews
- o participate in the development of the Draft Implementation and Control Plan.

WBS: 2.6.9.1.L

TITLE: Exploratory Shaft Test Plan

PARTICIPANT: Lawrence Livermore National Laboratory

OBJECTIVE: To provide special technical support along with other NNWSI Project participants to develop a detailed plan for testing activities during and after construction of the Exploratory Shaft and to participate in the development of the Draft Implementation and Control Plan.

DESCRIPTION OF WORK: All efforts required to:

- o develop and produce detailed plans for testing activities that will help determine the suitability of the site for the development of a repository
- o participate in ESTP meetings
- o participate in peer reviews
- o participate in the development of the Draft Implementation and Control Plan.

WBS: 2.6.9.1.S

TITLE: Exploratory Shaft Test Plan

PARTICIPANT: Sandia National Laboratories

OBJECTIVE: To provide special technical support along with other NNWSI Project participants to develop a detailed plan for testing activities during and after construction of the Exploratory Shaft.

DESCRIPTION OF WORK: All efforts required to:

- develop and produce detailed plans for testing activities that will help determine the suitability of the site for the development of a repository
- participate in ESTP meetings
- participate in peer reviews
- participate in the development of the Draft Implementation and Control Plan.

WBS: 2.6.9.2

TITLE: Exploratory Shaft Testing

OBJECTIVE: To conduct and evaluate the Exploratory Shaft experiment and test programs including the test planning and sequencing necessary to characterize the site's suitability for the development of a repository.

DESCRIPTION OF WORK: All efforts required to:

- conduct observations, measurements, and tests, to including shaft wall fracture mapping and photography, rock sample collection and analyses, shaft wall deformation measurements, in situ stress measurements (strain-relief overcore), and hydrologic sample analyses during shaft sinking and in situ tests and experiments after shaft sinking to acquire the geotechnical data required to make determinations regarding the suitability of the Yucca Mountain site for containment of a nuclear waste repository

- perform field inspection and laboratory tests of constructions to determine conformance with design and assure quality of workmanship and materials

- prepare technical reports describing the results of geotechnical and construction data analyses with respect to meeting the information requirements for site characterization and waste repository license application as identified in 10CFR60 and quality assurance requirements identified in 10CFR50, Appendix B

- prepare management reports describing the degree of achievement of cost and schedule objectives and making recommendations for future similar projects

- provide Title III engineering, materials, testing laboratory services, drilling specialist services, and survey costs associated with verification of shaft alignment and special survey costs for maintaining deviation control of long coreholes

- provide scientific and technical labor costs of USGS, LANL, LLNL, and SNL personnel for field and laboratory efforts necessary to perform data acquisition and analyses and labor costs of F&S geologic personnel for data acquisition

- provide engineering, scientific, and technical labor of USGS, LANL, LLNL, and SNL personnel for preparation of technical reports which document the results of geotechnical and construction data analysis.

WBS: 2.6.9.2.1

TITLE: Geologic Testing

OBJECTIVE: To conduct and evaluate Exploratory Shaft geologic tests and experiments to help characterize the site's suitability for the development of a repository.

DESCRIPTION OF WORK: All efforts required to:

- perform needed prototype testing, acquire testing materials, hardware, and instrumentation, and provide training for installing test equipment
- monitor tests during operation and modify tests as conditions dictate
- implement quality assurance procedures
- prepare technical reports describing results of tests and issue management reports describing achievements and costs
- provide support to the Exploratory Shaft testing program.

WBS: 2.6.9.2.1.F

TITLE: Geologic Testing

PARTICIPANT: Fenix and Scisson

OBJECTIVE: To support the Exploratory Shaft testing programs necessary to characterize the site's suitability for the development of a repository.

DESCRIPTION OF WORK: All efforts required to:

- o assist in gathering data during the Exploratory Shaft testing program as per individual test plans
- o provide drilling specialist services
- o provide Title III design effort for subsurface facilities
- o provide Title III inspection for both surface and subsurface facilities.

WBS: 2.6.9.2.1.G

TITLE: Geologic Testing

PARTICIPANT: United States Geological Survey

OBJECTIVE: To conduct and evaluate Exploratory Shaft tests and experiments to help characterize the site's suitability for the development of a repository.

DESCRIPTION OF WORK: All efforts required to:

- acquire testing materials, hardware, and instrumentation (exclusive of the Integrated Data System)
- perform prototype testing and validation of test designs excluding equipment and associated labor which is needed for development of experimental concepts
- provide training and technical guidance for installing test equipment in the ESF
- monitor tests during ESF operation
- modify tests as conditions and/or early results warrant to assure the validity and timeliness of acquired data
- implement technical quality assurance procedures, controls, and documentation per the NNWSI Project QA/QC guidelines and procedures
- perform field inspection and laboratory tests of the construction and preparation of the test area to determine conformance with design and assure quality of workmanship and materials
- prepare technical reports describing the results of geotechnical and construction data analyses with respect to meeting the information requirements for site characterization and waste repository license application as identified in 10CFR60 and quality assurance requirements
- conduct laboratory tests and analysis on ESF materials in conjunction with the individual tests and prepare technical reports from the data gathered
- conduct in situ testing at depth as one means of determining the suitability of the site for a geologic repository.

WBS: 2.5.3.1.T

TITLE: Environmental Assessment

PARTICIPANT: Science Applications International Corporation

OBJECTIVE: To ensure that all appropriate NNWSI Project actions, decisions, and documentation are reflected in the EA and are in accordance with applicable environmental requirements of responsible agencies, the Nuclear Waste Policy Act (NWPA), geologic repository requirements, support data, analysis, and conclusions; and to coordinate the definition of EA data and referenced documents that are to be provided by each Project participant.

DESCRIPTION OF WORK: All efforts required to:

- assume lead role and responsibility for production of the EA
- review and revise Project participant input
- prepare EA input and supporting documents as requested by WMPO
- compile, edit, and distribute the EA document and associated references as necessary.

WBS: 2.5.3.2

TITLE: Environmental Impact Statement

OBJECTIVE: To assure that the NNWSI Project develops an Environmental Impact Statment that conforms with the DOE Siting Guidelines and other appropriate regulatory guidelines.

DESCRIPTION OF WORK: All efforts required to:

- o develop an EIS for the NNWSI Project in accordance with appropriate guidelines
- o ensure that all appropriate NNWSI Project actions, decisions, and documentation are included in the EIS and are in accordance with applicable environmental requirements of responsible agencies, the NWPA, geologic repository program requirements, support data, analysis, and conclusions.

WBS: 2.6.9.2.1.H

TITLE: Geologic Testing

PARTICIPANT: Holmes & Narver

OBJECTIVE: To provide support for the Exploratory Shaft testing programs necessary to characterize the site's suitability for the development of a repository.

DESCRIPTION OF WORK: All efforts required to:

- o provide survey services for verification of shaft alignment and for maintaining deviation control of long coreholes
- o provide Title III design and inspection for surface facilities and materials-testing laboratory services for both surface and subsurface facilities.

WBS: 2.6.9.2.1.P

TITLE: Geologic Testing

PARTICIPANT: Pan Am

OBJECTIVE: To provide support for the Exploratory Shaft testing programs necessary to characterize the site's suitability for the development of a repository.

DESCRIPTION OF WORK: All efforts required to:

- o provide labor to assist during photography of shaft walls and drifts
- o provide necessary equipment to develop and process film used in shaft and drift wall mapping.

WBS: 2.6.9.2.1.R

TITLE: Geologic Testing

PARTICIPANT: Reynolds Electrical & Engineering Co., Inc.

OBJECTIVE: To provide support for the Exploratory Shaft testing programs necessary to characterize the site's suitability for the development of a repository.

DESCRIPTION OF WORK: All efforts required to provide labor, materials, and services of miners and standard construction crafts as required to support mining and core drilling operations directly associated with installation of test hardware.

WBS: 2.6.9.2.2

TITLE: Hydrologic Testing

OBJECTIVE: To conduct and evaluate Exploratory Shaft hydrologic tests and experiments to help characterize the site's suitability for the development of a repository.

DESCRIPTION OF WORK: All efforts required to:

- perform needed prototype testing, acquire testing materials, hardware, and instrumentation, and provide training for installing test equipment
- monitor tests during operation and modify tests as conditions dictate
- implement quality assurance procedures
- prepare technical reports describing results of tests and issue management reports describing achievements and costs
- provide support to the Exploratory Shaft testing program.

WBS: 2.6.9.2.2.F

TITLE: Hydrologic Testing

PARTICIPANT: Fenix & Scisson

OBJECTIVE: To support the Exploratory Shaft testing programs necessary to characterize the site's suitability for the development of a repository.

DESCRIPTION OF WORK: All efforts required to:

- o assist in gathering data during the Exploratory Shaft testing program as per individual test plans
- o provide drilling specialist services
- o provide Title III design for subsurface facilities
- o provide Title III inspection for both surface and subsurface facilities.

WBS: 2.6.9.2.2.G

TITLE: Hydrologic Testing

PARTICIPANT: United States Geological Survey

OBJECTIVE: To conduct and evaluate Exploratory Shaft tests and experiments to help characterize the site's suitability for the development of a repository.

DESCRIPTION OF WORK: All efforts required to:

- o provide testing materials, hardware, and instrumentation (exclusive of the Integrated Data System)
- o perform prototype testing and validation of test designs, excluding equipment and associated labor which is needed for development of experimental concepts
- o provide training and technical guidance for installing test equipment in the ESF
- o monitor tests during ESF operation
- o modify tests as conditions and/or early results warrant to assure the validity and timeliness of acquired data
- o implement technical quality assurance procedures, controls, and documentation per the NNWSI Project QA/QC guidelines and procedures
- o perform field inspection and laboratory tests of the construction and preparation of the test area to determine conformance with design and assure quality of workmanship and materials
- o prepare technical reports describing the results of geotechnical and construction data analyses with respect to meeting the information requirements for site characterization and waste repository license application as identified in 10CFR60 and quality assurance requirements
- o conduct laboratory tests and analysis on ESF materials in conjunction with the individual tests and prepare technical reports from the data gathered
- o conduct in situ testing at depth as one means of determining the suitability of the site for a geologic repository.

WBS: 2.6.9.2.2.H

TITLE: Hydrologic Testing

PARTICIPANT: Holmes & Narver

OBJECTIVE: To provide support for the Exploratory Shaft testing programs necessary to characterize the site's suitability for the development of a repository.

DESCRIPTION OF WORK: All efforts required to:

- o provide survey services for verification of shaft alignment and for maintaining deviation control of long coreholes
- o provide Title III design and inspection for surface facilities and materials testing laboratory services for both surface and subsurface facilities.

WBS: 2.6.9.2.2.R

TITLE: Hydrologic Testing

PARTICIPANT: Reynolds Electrical & Engineering Co., Inc.

OBJECTIVE: To provide support for the Exploratory Shaft testing programs necessary to characterize the site's stability for the development of a repository.

DESCRIPTION OF WORK: All efforts required to provide labor, materials, and services of miners and standard construction crafts as required to support mining and core drilling operations directly associated with installation of test hardware.

WBS: 2.6.9.2.3

TITLE: Geomechanical Testing

OBJECTIVE: To conduct and evaluate Exploratory Shaft geomechanical tests and experiments to help characterize the site's suitability for the development of a repository.

DESCRIPTION OF WORK: All efforts required to:

- perform needed prototype testing, acquire testing materials, hardware, and instrumentation, and provide training for installing test equipment
- monitor tests during operation and modify tests as conditions dictate
- implement quality assurance procedures
- prepare technical reports describing results of tests and issue management reports describing achievements and costs
- provide support to the Exploratory Shaft testing program.

WBS: 2.6.9.2.3.F

TITLE: Geomechanical Testing

PARTICIPANT: Fenix & Scisson

OBJECTIVE: To support the Exploratory Shaft testing programs necessary to characterize the site's suitability for the development of a repository.

DESCRIPTION OF WORK: All efforts required to:

- o provide assistance in gathering data during the Exploratory Shaft testing program as per individual test plans
- o provide drilling specialist services
- o provide Title III inspection for both surface and subsurface facilities.

WBS: 2.6.9.2.3.G

TITLE: Geomechanical Testing

PARTICIPANT: United States Geological Survey.

OBJECTIVE: To conduct and evaluate Exploratory Shaft tests and experiments to help characterize the site's suitability for the development of a repository.

DESCRIPTION OF WORK: All efforts required to:

- acquire testing materials, hardware, and instrumentation (exclusive of the Integrated Data System)
- perform prototype testing and validation of test designs, excluding equipment and associated labor which is needed for development of experimental concepts
- provide training and technical guidance for installing test equipment in the ESF
- monitor tests during ESF operation
- modify tests as conditions and/or early results warrant to assure the validity and timeliness of acquired data
- implement technical quality assurance procedures, controls, and documentation per the NNWSI Project QA/QC guidelines and procedures
- perform field inspection and laboratory tests of the construction and preparation of the test area to determine conformance with design and assure quality of workmanship and materials
- prepare technical reports describing the results of geotechnical and construction data analyses with respect to meeting the information requirements for site characterization and waste repository license application as identified in 10CFR60 and quality assurance requirements
- conduct laboratory tests and analysis on ESF materials in conjunction with the individual tests and prepare technical reports from the data gathered
- conduct in situ testing at depth as one means of determining the suitability of the site for a geologic repository.

WBS: 2.6.9.2.3.H

TITLE: Geomechanical Testing

PARTICIPANT: Holmes & Narver

OBJECTIVE: To provide support for the Exploratory Shaft testing programs necessary to characterize the site's suitability for the development of a repository.

DESCRIPTION OF WORK: All efforts required to:

- o provide survey services for verification of shaft alignment and for maintaining devation control of long coreholes
- o provide Title III designs and inspection for surface facilities and materials testing laboratory services for both surface and subsurface facilities.

WBS: 2.6.9.2.3.R

TITLE: Geomechanical Testing

PARTICIPANT: Reynolds Electrical & Engineering Co., Inc.

OBJECTIVE: To provide support for the Exploratory Shaft testing programs necessary to characterize the site's suitability for the development of a repository.

DESCRIPTION OF WORK: All efforts required to provide labor, materials, and services of miners and standard construction crafts as required to support mining and core drilling operations directly associated with installation of test hardware.

WBS: 2.6.9.2.3.S

TITLE: Geomechanical Testing

PARTICIPANT: Sandia National Laboratories

OBJECTIVE: To conduct and evaluate Exploratory Shaft tests and experiments to help characterize the site's suitability for the development of a repository.

DESCRIPTION OF WORK: All efforts required to:

- acquire testing materials, hardware, and instrumentation (exclusive of the Integrated Data System)
- perform prototype testing and validation of test designs, excluding equipment and associated labor which is needed for development of experimental concepts
- provide training and technical guidance for installing test equipment in the ESF
- monitor tests during ESF operation
- modify tests as conditions and/or early results warrant to assure the validity and timeliness of acquired data
- implement technical quality assurance procedures, controls, and documentation per the NNWSI Project QA/QC guidelines and procedures
- perform field inspection and laboratory tests of the construction and preparation of the test area to determine conformance with design and assure quality of workmanship and materials
- prepare technical reports describing the results of geotechnical and construction data analyses with respect to meeting the information requirements for site characterization and waste repository license application as identified in 10CFR60 and quality assurance requirements
- conduct laboratory tests and analysis on ESF materials in conjunction with the individual tests and prepare technical reports from the data gathered
- conduct in situ testing at depth as one means of determining the suitability of the site for a geologic repository.

WBS: 2.6.9.2.4

TITLE: Geochemical Testing

OBJECTIVE: To conduct and evaluate Exploratory Shaft geochemical tests and experiments to help characterize the site's suitability for the development of a repository.

DESCRIPTION OF WORK: All efforts required to:

- perform needed prototype testing, acquire testing materials, hardware, and instrumentation, and provide training for installing test equipment
- monitor tests during operation and modify tests as conditions dictate
- implement quality assurance procedures
- prepare technical reports describing results of tests and issue management reports describing achievements and costs
- provide support to the Exploratory Shaft testing program.

WBS: 2.6.9.2.4.A

TITLE: Geochemical Testing

PARTICIPANT: Los Alamos National Laboratory

OBJECTIVE: To conduct and evaluate Exploratory Shaft tests and experiments to help characterize the site's suitability for the development of a repository.

DESCRIPTION OF WORK: All efforts required to:

- o provide testing materials, hardware, and instrumentation (exclusive of the Integrated Data System)
- o perform prototype testing and validation of test designs, excluding equipment and associated labor which is needed for development of experimental concepts
- o provide training and technical guidance for installing test equipment in the ESF
- o monitor tests during ESF operation
- o modify tests as conditions and/or early results warrant to assure the validity and timeliness of acquired data
- o implement technical quality assurance procedures, controls, and documentation per the NNWSI Project QA/QC guidelines and procedures
- o perform field inspection and laboratory tests of the construction and preparation of the test area to determine conformance with design and assure quality of workmanship and materials
- o prepare technical reports describing the results of geotechnical and construction data analyses with respect to meeting the information requirements for site characterization and waste repository license application as identified in 10CFR60 and quality assurance requirements
- o conduct laboratory tests and analysis on ESF materials in conjunction with the individual tests and prepare technical reports from the data gathered
- o conduct in situ testing at depth as one means of determining the suitability of the site for a geologic repository.

WBS: 2.6.9.2.4.F

TITLE: Geochemical Testing

PARTICIPANT: Fenix & Scisson

OBJECTIVE: To support the Exploratory Shaft testing programs necessary to characterize the site's suitability for the development of a repository.

DESCRIPTION OF WORK: All efforts required to:

- o assist in gathering data during the Exploratory Shaft testing program as per individual test plans
- o provide drilling specialist services
- o provide Title III design effort for subsurface facilities
- o provide Title III inspection for both surface and subsurface facilities.

WBS: 2.6.9.2.4.G

TITLE: Geochemical Testing

PARTICIPANT: United States Geological Survey

OBJECTIVE: To conduct and evaluate Exploratory Shaft tests and experiments to help characterize the site's suitability for the development of a repository.

DESCRIPTION OF WORK: All efforts required to:

- o provide testing materials, hardware, and instrumentation (exclusive of the Integrated Data System)
- o perform prototype testing and validation of test designs; this does not include equipment and associated labor which is needed for development of experimental concepts
- o provide training and technical guidance for installing test equipment in the ESF
- o monitor tests during ESF operation
- o modify tests as conditions and/or early results warrant to assure the validity and timeliness of acquired data
- o implement technical quality assurance procedures, controls, and documentation per the project QA/QC guidelines and procedures
- o perform field inspection and laboratory tests of construction and preparation of test area to determine conformance with design and assure quality of workmanship and materials
- o prepare technical reports describing the results of geotechnical and construction data analyses with respect to meeting the information requirements for site characterization and waste repository license application as identified in 10CFR60 and quality assurance requirements
- o conduct laboratory tests and analysis on ESF materials in conjunction with the individual tests and prepare technical reports from the data gathered
- o conduct in situ testing at depth as one of the means of determining the suitability of the site for a geologic repository.

WBS: 2.6.9.2.4.H

TITLE: Geochemical Testing

PARTICIPANT: Holmes & Narver

OBJECTIVE: To provide support for the Exploratory Shaft testing programs necessary to characterize the site's suitability for the development of a repository.

DESCRIPTION OF WORK: All efforts required to:

- o provide survey services for verification of shaft alignment and for maintaining deviation control of long coreholes
- o provide Title III design and inspection for surface facilities and materials testing laboratory services for both surface and subsurface facilities.

WBS: 2.6.9.2.4.R

TITLE: Geochemical Testing

PARTICIPANT: Reynolds Electrical & Engineering Co., Inc.

OBJECTIVE: To provide support for the Exploratory Shaft testing programs necessary to characterize the site's suitability for the development of a repository.

DESCRIPTION OF WORK: All efforts required to provide labor, materials, and services of miners and standard construction crafts as required to support mining and core drilling operations directly associated with installation of test hardware.

WBS: 2.6.9.2.4.S

TITLE: Geochemical Testing

PARTICIPANT: Sandia National Laboratories

OBJECTIVE: To conduct and evaluate Exploratory Shaft tests and experiments to help characterize the site's suitability for the development of a repository.

DESCRIPTION OF WORK: All efforts required to:

- o provide testing materials, hardware, and instrumentation (exclusive of the Integrated Data System)
- o perform prototype testing and validation of test designs, excluding equipment and associated labor which is needed for development of experimental concepts
- o provide training and technical guidance for installing test equipment in the ESF
- o monitor tests during ESF operation
- o modify tests as conditions and/or early results warrant to assure the validity and timeliness of acquired data
- o implement technical quality assurance procedures, controls, and documentation per the NNWSI Project QA/QC guidelines and procedures
- o perform field inspection and laboratory tests of the construction and preparation of the test area to determine conformance with design and assure quality of workmanship and materials
- o prepare technical reports describing the results of geotechnical and construction data analyses with respect to meeting the information requirements for site characterization and waste repository license application as identified in 10CFR60 and quality assurance requirements
- o conduct laboratory tests and analysis on ESF materials in conjunction with the individual tests and prepare technical reports from the data gathered
- o conduct in situ testing at depth as one means of determining the suitability of the site for a geologic repository.

WBS: 2.6.9.2.5

TITLE: Engineered Barrier Design Testing

OBJECTIVE: To conduct and evaluate Exploratory Shaft engineered barrier tests and experiments to help characterize the site's suitability for the development of a repository.

DESCRIPTION OF WORK: All efforts required to:

- perform needed prototype testing, acquire testing materials, hardware, and instrumentation, and provide training for installing test equipment
- monitor tests during operation and modify tests as conditions dictate
- implement quality assurance procedures
- prepare technical reports describing results of tests and issue management reports describing achievements and costs
- provide support to the Exploratory Shaft testing program.

WBS: 2.6.9.2.5.F

TITLE: Engineered Barrier Design Testing

PARTICIPANT: Fenix & Scisson

OBJECTIVE: To support the Exploratory Shaft testing program necessary to characterize the site' suitability for the development of a repository.

DESCRIPTION OF WORK: All efforts required to:

- o assist in gathering data during the Exploratory Shaft testing program as per individual test plans
- o provide drilling specialists services
- o provide Title III design effort for subsurface facilities
- o provide Title III inspection for both surface and subsurface facilities.

WBS: 2.6.9.2.5.H

TITLE: Engineered Barrier Design Testing

PARTICIPANT: Holmes & Narver

OBJECTIVE: To provide support for the Exploratory Shaft testing programs necessary to characterize the site's suitability for the development of a repository.

DESCRIPTION OF WORK: All efforts required to:

- o provide survey services for verification of shaft alignment and for maintaining deviation control of long coreholes
- o provide Title III design and inspection for surface facilities and materials testing laboratory services for both surface and subsurface facilities.

WBS: 2.6.9.2.5.L

TITLE: Engineered Barrier Design Testing

PARTICIPANTS: Lawrence Livermore National Laboratory

OBJECTIVE: To conduct and evaluate Exploratory Shaft tests and experiments to help characterize the site's suitability for the development of a repository.

DESCRIPTION OF WORK: All efforts required to:

- o provide testing materials, hardware, and instrumentation (exclusive of the Integrated Data System)
- o perform prototype testing and validation of test designs, excluding equipment and associated labor which is needed for development of experimental concepts
- o provide training and technical guidance for installing test equipment in the ESF
- o monitor tests during ESF operation
- o modify tests as conditions and/or early results warrant to assure the validity and timeliness of acquired data
- o implement technical quality assurance procedures, controls, and documentation per the NNWSI Project QA/QC guidelines and procedures
- o perform field inspection and laboratory tests of the construction and preparation of the test area to determine conformance with design and assure quality of workmanship and materials
- o prepare technical reports describing the results of geotechnical and construction data analyses with respect to meeting the information requirements for site characterization and waste repository license application as identified in 10CFR60 and quality assurance requirements
- o conduct laboratory tests and analysis on ESF materials in conjunction with the individual tests and prepare technical reports from the data gathered
- o conduct in situ testing at depth as one means of determining the suitability of the site for a geologic repository.

WBS: 2.6.9.2.5.R

TITLE: Engineered Barrier Design Testing

PARTICIPANT: Reynolds Electrical and Engineering Co., Inc.

OBJECTIVE: To provide support for the Exploratory Shaft testing programs necessary to characterize the site's suitability for the development of a repository.

DESCRIPTION OF WORK: All efforts required to provide labor, materials, and services of miners and standard construction crafts as required to support mining and core drilling operations directly associated with installation of test hardware.

WBS: 2.6.9.3

TITLE: Integrated Data Systems (IDS)

OBJECTIVE: To provide an Integrated Data System (IDS) to automatically record, control, store, and transfer data acquired during ES tests.

DESCRIPTION OF WORK: All efforts required to:

- o develop, design, procure, install, and operate data collection equipment
- o support the test program, including training and prototype testing, data reduction, and report generation
- o provide data to Performance Assessment, Waste Package, Site, and Repository Tasks.

WBS: 2.6.9.3.A

TITLE: Integrated Data Systems (IDS)

PARTICIPANT: Los Alamos National Laboratory

OBJECTIVE: To provide an Integrated Data System (IDS) to automatically record, control, store, and transfer data acquired during ES tests

DESCRIPTION OF WORK: All efforts required to:

- o provide technical and administrative services of LANL personnel for analysis, integration, and design of the IDS system.
- o design, implement, and support an automated data acquisition system
- o participate in and support the NNWSI ES Project Test Plan Committee
- o define, design, and specify the system in accordance with requirements of testing organizations
- o select and procure hardware
- o design, develop, test, document, and control software
- o install and integrate hardware and software
- o connect to signal lines, continually acquire electronic measurements as specified by experimenters, store data, and provide data at 4-week intervals on computer readable media; includes provision of advice, assistance, and prototyping capability for experimenters, and advice and assistance to facility designers
- o include hardware necessary for development plus surface and drift-space control locations and 17 acquisition locations equipped with required data scanners, voltmeters, excitation supplies, and ancillary equipment
- o operate and maintain the system and provide required initial and periodic calibrations and performance tests
- o provide an ES master timing system, monitoring and alarm functions, and data communications technical control

WBS: 2.6.9.3.A (Continued)

- o provide user-interface work stations as required at user work locations
- o support shaft and drift mapping as required with graphical input/output
- o provide an uninterruptable power supply (UPS) to the IDS.

WBS: 2.6.9.3.H

TITLE: Integrated Data System (IDS)

PARTICIPANT: Holmes and Narver

OBJECTIVE: To provide an Integrated Data System (IDS) to automatically record, control, store, and transfer data acquired during ES tests.

DESCRIPTION OF WORK: All efforts required to:

- o provide design drawings, and specifications for wiring from the junction boxes to the IDS
- o generate and maintain all necessary wiring lists for the IDS
- o provide design drawings and specifications for the underground IDS enclosure
- o provide design drawings and specifications for the above ground IDS trailer
- o provide Title III inspection, surveying, and materials testing laboratory.

WBS: 2.6.9.3.R

TITLE: Integrated Data System (IDS)

PARTICIPANT: Reynolds Electrical and Engineering Co., Inc.

OBJECTIVE: To provide an Integrated Data System (IDS) to automatically record, control, store, and transfer data acquired during ES tests.

DESCRIPTION OF WORK: All efforts required to provide labor, materials, and services of standard construction crafts as required to support construction of the IDS enclosure and the IDS surface trailer, and to install the wiring from the PIs junction box to the junction box in the data alcove.

WBS: 2.7.1

TITLE: Management and Integration

OBJECTIVE: To provide the overall management of test facilities.

DESCRIPTION OF WORK: All efforts required to:

- o provide overall management of test facilities, including planning, scheduling, budgeting, controlling, and reporting
- o perform analyses of existing facilities and potential new facilities, identify optimum support facilities
- o prepare and implement QA program procedures for test facilities.

WBS: 2.7.1.F

TITLE: Management and Integration

PARTICIPANT: Fenix & Scisson

OBJECTIVE: To provide management and integration of the F&S engineering activities associated with geologic characterization, material sampling and field testing.

DESCRIPTION OF WORK: All efforts required to:

- o provide management controls including planning, scheduling, budgeting, controlling, and reporting of contracted engineering activity
- o manage drilling programs, produce as-built drawings and related activity
- o develop and implement proper procedures for geological management during construction and drilling
- o manage the production of design drawings, calculations, and related estimates.

WBS: 2.7.1.H

TITLE: Management and Integration

PARTICIPANT: Holmes & Narver

OBJECTIVE: To provide management and integration of the H&N support activities associated with civil engineering, Non-Destruction Testing (NDT), and quality assurance.

DESCRIPTION OF WORK: All efforts required to:

- provide management controls including planning, scheduling, budgeting, controlling and reporting of contracted engineering activity
- manage all aspects of civil engineering work
- manage the production of design drawings, calculations and related estimate
- manage quality assurance test documentation, Non-Destructive Testing, and certification requirements.

WBS: 2.7.1.R

TITLE: Management and Integration

PARTICIPANT: Reynolds Electrical & Engineering Co., Inc.

OBJECTIVE: To provide management and integration of the REECo support activities associated with drilling services, coreholes, and related construction.

DESCRIPTION OF WORK: All efforts required to:

- o provide management controls including planning, scheduling, budgeting, controlling, and reporting of contracted engineering activity
- o manage the production of design drawings, calculations and related estimates
- o develop and implement proper procedures for drilling, materials handling, and safety related requirements
- o manage drilling programs, produce as-built drawings and related activity.

WBS: 2.7.2

TITLE: Testing

OBJECTIVE: To provide for the operation and maintenance of domestic test facilities including the Assemine, URL, STRIPA, NSTF, Avery Island.

DESCRIPTION OF WORK: All efforts required to:

- operate and maintain the Climax Test and Facility
- ensure the availability and readiness of the E-MAD Facility and G-Tunnel to meet programmatic needs
- maintain and develop the capabilities to meet programmatic requirements
- operate and maintain similar facilities as directed.

WBS: 2.7.2.1

TITLE: Spent Fuel Test-Climax

OBJECTIVE: To provide the support services needed to operate and maintain the Spent Fuel Test - Climax facility (SFT-C)

DESCRIPTION OF WORK: All efforts required to:

- o provide access for completion of testing in the facility
- o provide for public tours as scheduled by DOE/NV
- o check and calibrate instrumentation used to take data to assure that data are accurate
- o provide for the formal evaluation of extensive test data (10 million data points)
- o measure in situ rock properties and stresses for calculation of rock response and model development
- o conduct the material sampling and testing necessary to measure and document the nature of thermal and radiation effects on granite
- o perform the thermal and thermomechanical calculations required to validate codes used to calculate effects on hard brittle rock using data from SFT-C and document where current calculations are insufficient.

WBS: 2.7.2.1.F

TITLE: Spent Fuel Test - Climax

PARTICIPANT: Fenix & Scisson

OBJECTIVE: To provide engineering support needed for geologic characterization and material sampling.

DESCRIPTION OF WORK: All efforts required to:

- o develop drilling programs for exploratory drilling, rock mechanics drilling, and implantation drilling
- o develop as-built drawings
- o design excavation openings and stations
- o provide on-going inspection of drilling and sampling.

WBS: 2.7.2.1.H

TITLE: Spent Fuel Test - Climax

PARTICIPANT: Holmes & Narver

OBJECTIVE: To provide engineering support for core hole drilling; and to provide quality assurance and testing documentation upon completion of the Project.

DESCRIPTION OF WORK: All efforts required to:

- o provide engineering support necessary fore corehole survey, layout, and as-built drawings
- o provide quality assurance and testing documentation upon completion of the Project.

WBS: 2.7.2.1.L

TITLE: Spent Fuel Test - Climax

PARTICIPANT: Lawrence Livermore National Laboratory

OBJECTIVE: To demonstrate the feasibility of short-term storage and retrieval of spent unreprocessed fuel; to measure the response of a crystalline rock mass to simulated repository conditions and use these data to validate thermal and thermomechanical models; and to compare the effects of heat alone and heat in combination with intense ionizing radiation on a crystalline rock mass.

DESCRIPTION OF WORK: All efforts required to:

- document displacements and stress changes in the rock comprising the pillars between the central and side drifts due to the mechanical disturbance of mining the central drift
- compare that response to the results of existing computational modeling to assess the validity of those models in terms of mechanical effects alone
- document the temperature and radiation dose in the close-in heated zone to infer both the total power level of the spent-fuel assemblies and the proportion of that power transported out of the canisters by nuclear radiation, as opposed to thermal processes
- document displacement and stress effects in the intermediate heated zone caused by the thermal disturbance of the fuel and heaters
- compare measured thermomechanical responses with computational modeling to assess the validity of those thermomechanical models
- document the amount of heat removed by ventilation
- document the thermal field (both close-in and intermediate) and compare with calculational models
- document the relative effect of existing fractures on rock response by duplication of all mechanical measurements in regions which are either fractured or relatively unfractured, and by direct instrumentation of selected, prominent geologic features
- evaluate displacement and stress instrumentation under simulated repository conditions.

WBS: 2.7.2.1.R

TITLE: Climax

PARTICIPANT: Reynolds Electrical & Engineering Company, Inc.

OBJECTIVE: To provide support and drilling services for the Climax Test Facility.

DESCRIPTION OF WORK: All efforts required to:

- o provide access for completion of testing in the facility
- o provide labor and materials for exploratory drilling, rock mechanics drilling, and implementatation drilling program.

WBS: 2.7.2.2

TITLE: E-MAD

OBJECTIVE: To ensure that the E-MAD Facility is maintained and available for nuclear materials handling, packaging, and testing.

DESCRIPTION OF WORK: All efforts required to:

- conduct nuclear materials handling, packaging, data gathering analysis, and other related tasks
- perform interim storage tests and other waste packaging and handling experiments as requested
- provide non-destructive testing (NDT)
- maintain capability to ship spent fuel per NRC requirements.

WBS: 2.7.2.2.H

TITLE: E-MAD

PARTICIPANT: Holmes & Narver

OBJECTIVE: To provide engineering and certification support as requested.

DESCRIPTION OF WORK: All efforts required to:

- o provide Non-Destructive Testing (NDT) and certification of testing when requested
- o provide quality assurance and related documentation upon completion of this work.

WBS: 2.7.2.2.R

TITLE: E-MAD

PARTICIPANT: Reynolds Electrical and Engineering Co., Inc.

OBJECTIVE: To provide support for E-MAD facility operation.

DESCRIPTION OF WORK: All efforts required to provide labor and materials for the core hole activity required for the E-MAD Facility.

WBS: 2.7.2.2.W

TITLE: E-MAD

PARTICIPANT: Westinghouse

OBJECTIVE: To ensure the availability and readiness of the E-MAD Facility to meet programmatic needs and to maintain and develop the capabilities to meet programmatic requirements.

DESCRIPTION OF WORK: All efforts required to:

- conduct nuclear materials handling, packaging, data gathering, analysis, and other related tasks.
- maintain capability to ship spent fuel off NTS in a licensed cask, per NRC requirements.

WBS: 2.7.2.3

TITLE: G-Tunnel

ISSUE: 3.4

OBJECTIVE: To develop and implement test plans for determining and evaluating the in situ physical, chemical, and simulated repository conditions.

DESCRIPTION OF WORK: All efforts required to:

- perform field rock mechanics tests and conduct rock-mass evaluation tests considered to be essential by NRC as input into understanding how subsurface structures will respond
- develop experiments for the evaluation of models used in predictive calculations necessary for the early performance evaluation of a proposed repository
- develop generic data and testing experience in welded tuff using thermal loads representative of the canister-scale environment to verify reference repository conditions to support conceptual design activities
- develop techniques for making geotechnical measurements in welded tuff, and to allow rapid deployment of in situ experiments when at-depth testing is possible.

WBS: 2.7.2.3.F

TITLE: G-Tunnel

PARTICIPANT: Fenix & Scisson

OBJECTIVE: To provide technical expertise for Tuff Rock Properties Field Testing.

DESCRIPTION OF WORK: All efforts required to:

- o provide a geologist during construction and drilling to ensure proper procedures are followed
- o provide underground design drawings and calculations, cost estimates, and drilling programs.

WBS: 2.7.2.3.H

TITLE: G-Tunnel

PARTICIPANT: Holmes & Narver

OBJECTIVE: To provide technical and planning expertise for Tuff Rock Properties Field Testing.

DESCRIPTION OF WORK: All efforts required to:

- o provide site surveying for potential drilling locations
- o prepare work orders and authorization
- o prepare design drawings and cost estimates.

WBS: 2.7.2.3.R

TITLE: G-Tunnel

PARTICIPANT: Reynolds Electrical & Engineering Co., Inc.

OBJECTIVE: To provide technical expertise for Tuff Rock Properties Field Testing.

DESCRIPTION OF WORK: All efforts required to provide the necessary labor and materials needed to perform the drilling and construction associated with Tuff Rock Properties Field Testing.

WBS: 2.7.3

TITLE: New Facility Acquisition

OBJECTIVE: To provide for the acquisition of new field facilities, including costs for lease, acquisition, design, and construction.

WBS: 2.8

TITLE: Land Acquisition

OBJECTIVE: To acquire land for possible future use as a repository site.

DESCRIPTION OF WORK: All efforts required to:

- o submit paperwork to BLM requesting land withdrawal to protect that portion of site under their jurisdiction
- o prepare a land acquisition plan for siting a commercial high-level waste repository on the NRDA and/or contiguous Nellis AFB and BLM land.

WBS: 2.9

TITLE: Project Management

OBJECTIVE: To direct and assure implementation and coordination of all activities to fulfill the goals and objectives of the NNWSI Project.

DESCRIPTION OF WORK: All efforts required to:

- o provide overall management of the NNWSI Project
- o provide for interaction with other OCRWM Program participants
- o provide management support for cost, schedule and performance measurement
- o provide identification of interfaces among all project elements including their integration
- o establish and implement a QA program.

WBS: 2.9.1

TITLE: Management and Integration

OBJECTIVE: To provide overall management of the NNWSI Project and to provide for interaction with other OCRWM Program participants on project management activities (e.g., participant in the Project Management Coordinating Group).

DESCRIPTION OF WORK: All efforts required to:

- o provide overall management of the project including strategic planning and analyses
- o support HQ activities such as Mission Plan preparation
- o provide budgeting and financial analysis
- o provide computer support services
- o provide progress reporting
- o provide procurement and subcontract administration
- o provide legal services
- o provide administrative and audit services
- o provide administrative services including printing, graphic services, photo services, and library operations
- o conduct overall project peer reviews
- o identify interfaces among all project elements and the integration of all project elements.

WBS: 2.9.1.1

TITLE: Management

OBJECTIVE: To direct and assure coordination of all NNWSI Project activities necessary to fulfill the goals and objectives of the Project and to coordinate this Project with the NNWSI overall program.

DESCRIPTION OF WORK: All efforts required to manage and coordinate all activities to be consistent with the goals and objectives of the overall DOE NNWSI Project, including planning, technical direction, cost, and schedule control.

WBS: 2.9.1.1.A

TITLE: Management

PARTICIPANT: Los Alamos National Laboratory

OBJECTIVE: To manage and coordinate LANL activities to be consistent with the goals and objectives of the overall DOE NNWSI Project, including planning, technical direction, cost, and schedule control.

DESCRIPTION OF WORK: All efforts required to:

- To represent Los Alamos at PM/TPO meetings and in communications with other NNWSI Project participants
- track deliverables and milestones established by the NNWSI Project to ensure implementation of program goals at Los Alamos
- arrange and maintain technical interfaces between the NNWSI Project and other Geologic Repository Program projects as directed
- support ad hoc committees established within the program
- prepare comments on DOE, NRC, and EPA reports as requested by the DOE/WMPO.

WBS: 2.9.1.1.G

TITLE: Management

PARTICIPANT: United States Geological Survey

OBJECTIVE: To manage and coordinate the USGS activities to be consistent with the goals and objectives of the overall DOE NNWSI Project, including planning, technical direction, cost, and schedule control.

DESCRIPTION OF WORK: All efforts required to:

- o direct all USGS NNWSI Project activities
- o coordinate the USGS with the overall NNWSI Project.

WBS: 2.9.1.1.I

TITLE: Management

PARTICIPANTS: Wackenhut Services, Inc.

OBJECTIVE: To direct and assure coordination of all appropriate NNWSI Project activities as they apply to security at NTS and DOE/NV.

DESCRIPTION OF WORK: All efforts required to provide security assistance as may be required.

WBS: 2.9.1.1.L

TITLE: Management

PARTICIPANT: Lawrence Livermore National Laboratory

OBJECTIVE: To direct and assure coordination of all LLNL NNWSI Project activities.

DESCRIPTION OF WORK: All efforts required to manage and coordinate the LLNL activities to be consistent with the goals and objectives of the overall DOE NNWSI Project, including planning, technical direction, cost, and schedule control.

WBS: 2.9.1.1.R

TITLE: Management

PARTICIPANT: Reynolds Electrical Engineering Co., Inc.

OBJECTIVE: To direct and assure coordination of all REECo NNWSI Project activities.

DESCRIPTION OF WORK: All efforts required to manage and coordinate the REECo activities to be consistent with the goals and objectives of the overall DOE NNWSI Project, including planning, technical direction, cost, and schedule control.

WBS: 2.9.1.1.S

TITLE: Management

PARTICIPANT: Sandia National Laboratories

OBJECTIVE: To direct and assure coordination of all SNL NNWSI Project activities.

DESCRIPTION OF WORK: All efforts required to manage and coordinate the SNL activities to be consistent with the goals and objectives of the NNWSI Project, including planning, technical direction, cost, and schedule control.

WBS: 2.9.1.1.T

TITLE: Management

PARTICIPANT: Science Applications International Corporation

OBJECTIVE: To provide management and administrative support to the Waste Management Project Office for effective planning and execution of the NNWSI Project.

DESCRIPTION OF WORK: All efforts required to:

- prepare NNWSI Project Management Plan and Annual Project Plans for WMPO/NV. These Plans shall be revised and updated as required from input provided by all Project participants

- assist DOE in the organization of meetings, development and dissemination of appropriate information, and preparation of meeting records including, but not be limited to, Project Control Meetings, Project Manager's Meetings, and Project Midyear and End-of-Year Review Meetings

- develop and maintain a NNWSI Project-wide Administrative Procedures Manual defining a uniform set of systematic procedures for all participants to follow in the conduct of Project activities

- prepare reports such as the UCRS Monthly Report, Weekly Highlights Report, Informal Project Weekly Report, MSA Report, and Quarterly Technical Report

- perform internal Project management and control necessary to plan, organize, and direct technical and administrative activities of the contract, including short- and long-range planning, secretarial and word processing staff and facilities, financial analysis and periodic contract reporting, contract management, procurement, general office management, administration, and on-the-job training

- provide graphic support services as requested by WMPO/NV to provide visual aids for Project and public presentations or documents

- develop and prepare material for speeches, other presentations made by WMPO/NV personnel, and public information material for the general public, news media, and others. Preparation includes supporting background material collection, data research documentation, and post-presentation analysis and documentation.

WBS: 2.9.1.2

TITLE: Interface Activities

OBJECTIVE: To conduct OCRWM interface activities.

DESCRIPTION OF WORK: All efforts required to coordinate interfaces between the Geologic Repository Program and the other OCRWM Program elements. This is accomplished by waste- isolation interface coordination groups. Coordination groups are formed to represent the various technical elements of the waste-isolation system (e.g. waste-package, repository, etc.) with members representing technical participants of the OCRWM Program.

WBS: 2.9.1.2.A

TITLE: Interface Activities

PARTICIPANT: Los Alamos National Laboratory

OBJECTIVE: To conduct OCRWM interface activities.

DESCRIPTION OF WORK: All efforts required to coordinate interfaces between and the other OCRWM Program elements. This is accomplished by Waste Isolation Interface Coordination groups. Coordination groups are formed to represent the various technical elements of the waste-isolation system (e.g. waste-package, repository, etc.) with members representing technical participants of the OCRWM Program.

WBS: 2.9.1.2.G

TITLE: Interface Activities

PARTICIPANT: United States Geological Survey

OBJECTIVE: To conduct OCRWM interface activities.

DESCRIPTION OF WORK: All efforts required to participate in the coordination of interfaces between the Geologic Repository Program and other OCRWM Program elements through various Waste Isolation Interface Coordination Groups that are formed to represent technical elements of the waste-isolation system and members representing the various elements of the OCRWM Program.

WBS: 2.9.1.2.S

TITLE: Interface Activities

PARTICIPANT: Sandia National Laboratories

OBJECTIVE: To conduct OCRWM interface activities.

DESCRIPTION OF WORK: All efforts required to coordinate interfaces between Geologic Repository Program and the other OCRWM Program elements. This is accomplished by Waste Isolation Interface coordination groups. Coordination groups are formed to represent the various technical elements of the waste-isolation system (e.g. waste-package, repository, etc.) with members representing technical participants of the Program to achieve OCRWM Program.

WBS: 2.9.1.2.L

TITLE: Interface Activities

PARTICIPANT: Lawrence Livermore National Laboratory

OBJECTIVE: To conduct OCRWM interface activities.

DESCRIPTION OF WORK: All efforts required to coordinate interfaces between the Geologic Repository Program and the other OCRWM Program elements. This is accomplished by Waste Isolation Interface coordination groups. Coordination groups are formed to represent the various technical elements of the waste-isolation system (e.g. waste-package, repository, etc.) with members representing technical participants of the OCRWM Program.

WBS: 2.9.1.2.T

TITLE: Interface Activities

PARTICIPANTS: Science Applications International Corporation

OBJECTIVE: To conduct OCRWM interface activities.

DESCRIPTION OF WORK: All efforts required to coordinate interfaces between the Geologic Repository Program and the other OCRWM Program elements. This is accomplished by Waste Isolation Interface coordination groups. Coordination groups are formed to represent the various technical elements of the waste-isolation system (e.g. waste-package, repository, etc.) with members representing technical participants of the OCRWM Program.

WBS: 2.9.1.3

TITLE: Geologic Repository Program Support

OBJECTIVE: To provide for interaction with other OGR program participants on Project management activities (e.g., participation in the Project Management Coordinating Group).

DESCRIPTION OF WORK: All efforts required to:

- o work with other GR Program participants and/or contractors preparing or reviewing documents
- o review major documents, plans, or criteria prepared by other Projects within the Program
- o attend and participate in Program meetings and discussions, including meetings between the DOE and other Federal agencies
- o participate in workshops, etc., in support of the GR Program efforts.

WBS: 2.9.1.3.A

TITLE: Geologic Repository Program Support

PARTICIPANT: Los Alamos National Laboratory

OBJECTIVE: To provide special technical support to the Geologic Repository Program.

DESCRIPTION OF WORK: All efforts required:

- o work with other GR Program participants and/or contractors preparing or reviewing documents
- o review major documents, plans, or criteria prepared by other Projects within the Program
- o attend and participate in Program meetings and discussions, including meetings between the DOE and other Federal agencies
- o participate in workshops, etc., in support of the GR Program efforts.

WBS: 2.9.1.3.G

TITLE: Geologic Repository Program Support

PARTICIPANT: United States Geological Survey

OBJECTIVE: To provide special technical support to the Geologic Repository Program.

DESCRIPTION OF WORK: All efforts required to:

- o work with other GR Program participants and/or contractors preparing or reviewing documents
- o review major documents, plans, or criteria prepared by other Projects within the Program
- o attend and participate in Program meetings and discussions, including meetings between the DOE and other Federal agencies
- o participate in workshops, etc., in support of the GR Program effort.

WBS: 2.9.1.3.L

TITLE: Geologic Repository Program Support

PARTICIPANT: Lawrence Livermore National Laboratory

OBJECTIVE: To provide special technical support to the Geologic Repository Program.

DESCRIPTION OF WORK: All efforts required to:

- o work with other GR Program participants and/or contractors preparing or reviewing documents
- o review major documents, plans, or criteria prepared by other Projects within the Program
- o attend and participate in Program meetings and discussions, including meetings between the DOE and other Federal agencies
- o participate in workshops, etc., in support of the GR Program effort.

WBS: 2.9.1.3.S

TITLE: Geologic Repository Program Support

PARTICIPANT: Sandia National Laboratories

OBJECTIVE: To provide special technical support to the Geologic Repository Program.

DESCRIPTION OF WORK: All efforts required:

- work with other GR Program participants and/or contractors preparing or reviewing documents
- review major documents, plans, or criteria prepared by other Projects within the Program
- attend and participate in Program meetings and discussions, including meetings between the DOE and other Federal agencies
- participate in workshops, etc., in support of the GR Program effort.

WBS: 2.9.1.3.T

TITLE: Geologic Repository Program Support

PARTICIPANTS: Science Applications International Corporation

OBJECTIVE: To provide special technical support to the Geologic Repository Program.

DESCRIPTION OF WORK: All efforts required to:

- work with other GR Program participants and/or contractors preparing or reviewing documents
- review major documents, plans, or criteria prepared by other Projects within the Program
- attend and participate in Program meetings and discussions, including meetings between the DOE and other Federal agencies
- participate in workshops, etc., in support of the GR Program effort.

WBS: 2.9.2

TITLE: Project Control

OBJECTIVE: To provide project management support in the areas of cost and schedule planning and control.

DESCRIPTION OF WORK: All efforts required to:

- o provide project management support to DOE/NV in the areas of cost and schedule planning and control, development of management practice and procedures, and management information systems
- o provide valid, timely, nad auditable performance measurement information
- o collect project management planning and control data; develop, implement and maintain computerized cost, schedule, and technical milestone data bases; and develop strategies to meet management information requirements
- o establish and maintain a change control board
- o establish and maintain network charts for all WBS elements.

WBS: 2.9.2.A

TITLE: Project Control

PARTICIPANT: Los Alamos National Laboratory

OBJECTIVE: To monitor the fiscal and technical accomplishments of the LANL participation in the NNWSI Project.

DESCRIPTION OF WORK: All efforts required to:

- ensure that the schedule, milestones, and deliverables are maintained within the approved fiscal year budget
- provide required performance measurement information.

WBS: 2.9.2.G

TITLE: Project Control

PARTICIPANT: United States Geological Survey

OBJECTIVE: To monitor the fiscal and technical accomplishments of the USGS participation in the NNWSI Project.

DESCRIPTION OF WORK: All efforts required to:

- To ensure that the schedule, milestones, and deliverables are maintained within the approved fiscal year budget
- provide performance measurement information.

WBS: 2.9.2.L

TITLE: Project Control

PARTICIPANT: Lawrence Livermore National Laboratory

OBJECTIVE: To monitor the fiscal and technical accomplishments of the LLNL participation in the NNWSI Project.

DESCRIPTION OF WORK: All efforts required to:

- To ensure that the schedule, milestones, and deliverables are maintained within the approved fiscal year budget
- provide performance measurement information.

WBS: 2.9.2.S

TITLE: Project Control

PARTICIPANT: Sandia National Laboratories

OBJECTIVE: To monitor the fiscal and technical accomplishments of the SNL participation in the NNWSI Project.

DESCRIPTION OF WORK: All efforts required to:

- To ensure that the schedule, milestones, and deliverables are maintained within the approved fiscal year budget
- provide performance measurement information.

WBS: 2.9.2.T

TITLE: Project Control

PARTICIPANT: Science Applications International Corporation

OBJECTIVE: To provide systems and methods to execute Project planning, scheduling, and cost reporting procedures in accordance with DOE orders.

DESCRIPTION OF WORK: All efforts required to:

- o provide PMS-related information required by the NNWSI Project to make periodic reports specified by the Office of Management and Budgets (OMB) for Major Systems Acquisitions (MSA)
- o maintain the NNWSI Project work breakdown structure in accordance with OGR direction
- o provide procedures for the implementation by all participants of a uniform method of organizing and planning work elements
- o analyze variances in schedule and cost
- o maintain the NNWSI Project Change Control Board records which includes development of a log of required and approved changes
- o prepare performance measurement data to support NNWSI Project reporting.

WBS: 2.9.3

TITLE: Quality Assurance - NNWSI Project

OBJECTIVE: To establish and implement a NNWSI Project QA Plan (QAP) based on the requirements contained in NV Order 5700.6A; 10 CFR 60, Subpart G; 10 CFR 50, Appendix B; and ANSI/ASME NQA-1 (1983) with modifications as directed by the OCRWM to assure that NNWSI Project activities are conducted to high standards, are verifiable, and are adequately documented. The QAP describes the quality assurance requirements to be applied to NNWSI Project activities/items by the WMPO, individual Participating Organizations, and NTS Support Contractors. WMPO is responsible for assuring that the plan is adequately implemented.

DESCRIPTION OF WORK: All efforts by WMPO required to:

- establish an overall NNWSI Project Quality Assurance Plan (QAP) and specific Project QA Standard Operating Procedures (NNWSI-SOPs)
- establish individual NNWSI Project Quality Assurance Program Plans and implementing procedures to be established by WMPO, participating organizations, and NTS support contractors
- perform independent verification and assessment of QA program effectiveness through audits, management reviews, and surveillance activities
- review plans, procedures, technical specifications, and other key documents to assure that appropriate quality requirements have been incorporated
- provide training to assure that technical proficiency and QA awareness is maintained
- assure that appropriate records are prepared and maintained that will permit verification of work activities
- establish and implement a non-conformance reporting system that includes methods for dispositioning, corrective action follow-up, and trend analysis.

WBS: 2.9.3.A

TITLE: Quality Assurance

PARTICIPANTS: Los Alamos National Laboratory

OBJECTIVE: To establish, implement, and maintain a Quality Assurance Program Plan in accordance with requirements set forth in the NNWSI Project QA Plan, NVO-196-17, and the Project-wide Standard Operating Procedures.

DESCRIPTION OF WORK: All efforts required to:

- establish appropriate levels of quality for all NNWSI Project items/activities in accordance with NNWSI-SOP-02-02
- apply appropriate QA requirements to NNWSI Project activities/items depending on the quality level assigned and submit to WMPO for approval
- provide personnel training to maintain an awareness of QA requirements and to maintain technical proficiency
- perform independent verification and assessment of QA program effectiveness through audits, surveillances, and management reviews.

WBS: 2.9.3.F

TITLE: Quality Assurance

PARTICIPANT: Fenix & Scisson

OBJECTIVE: To establish, implement, and maintain a Quality Assurance Program Plan in accordance with requirements set forth in the NNWSI Project QA Plan, NVO-196-17, and the Project-wide Standard Operating Procedures.

DESCRIPTION OF WORK: All efforts required to:

- establish appropriate levels of quality for all NNWSI Project items/activities in accordance with NNWSI-SOP-02-02
- provide personnel training to maintain an awareness of QA requirements and to maintain technical proficiency
- perform independent verification and assessment of QA program effectiveness through audits, surveillances, and management reviews.

WBS: 2.9.3.G

TITLE: Quality Assurance

PARTICIPANTS: United States Geological Survey

OBJECTIVE: To establish, implement, and maintain a Quality Assurance Program Plan in accordance with requirements set forth in the NNWSI Project QA Plan, NVO-196-17, and the Project-wide Standard Operating Procedures.

DESCRIPTION OF WORK: All efforts required to:

- establish appropriate levels of quality for all NNWSI Project items/activities in accordance with NNWSI-SOP-02-02
- apply appropriate QA requirements to NNWSI Project activities/items depending on the quality level assigned and submit to WMPO for approval
- provide personnel training to maintain an awareness of QA requirements and to maintain technical proficiency
- perform independent verification and assessment of QA program effectiveness through audits, surveillances, and management reviews.

WBS: 2.9.3.H

TITLE: Quality Assurance

PARTICIPANT: Holmes & Narver

OBJECTIVE: To establish, implement, and maintain a Quality Assurance Program Plan in accordance with requirements set forth in the NNWSI Project QA Plan, NVO-196-17, and the Project-wide Standard Operating Procedures.

DESCRIPTION OF WORK: All efforts required to:

- establish appropriate levels of quality for all NNWSI Project items/activities in accordance with NNWSI-SOP-02-02
- provide personnel training to maintain an awareness of QA requirements and to maintain technical proficiency
- perform independent verification and assessment of QA program effectiveness through audits, surveillances, and management reviews.

WBS: 2.9.3.L

TITLE: Quality Assurance

PARTICIPANTS: Lawrence Livermore National Laboratory

OBJECTIVE: To establish, implement, and maintain a Quality Assurance Program Plan in accordance with requirements set forth in the NNWSI Project QA Plan, NVO-196-17, and the Project-wide Standard Operating Procedures.

DESCRIPTION OF WORK: All efforts required to:

- establish appropriate levels of quality for all NNWSI Project items/activities in accordance with NNWSI-SOP-02-02
- apply appropriate QA requirements to NNWSI Project activities/items depending on the quality level assigned and submit to WMPO for approval
- provide personnel training to maintain an awareness of QA requirements and to maintain technical proficiency
- perform independent verification and assessment of QA program effectiveness through audits, surveillances, and management reviews.

WBS: 2.9.3.R

TITLE: Quality Assurance

PARTICIPANTS: Reynolds Electrical & Engineering Company

OBJECTIVE: To establish, implement, and maintain a Quality Assurance Program Plan in accordance with requirements set forth in the NNWSI Project QA Plan, NVO-196-17, and the Project-wide Standard Operating Procedures.

DESCRIPTION OF WORK: All efforts required to:

- establish appropriate levels of quality for all NNWSI Project items/activities in accordance with NNWSI-SOP-02-02
- provide personnel training to maintain an awareness of QA requirements and to maintain technical proficiency
- perform independent verification and assessment of QA program effectiveness through audits, surveillances, and management reviews.

WBS: 2.9.3.S

TITLE: Quality Assurance

PARTICIPANTS: Sandia National Laboratories

OBJECTIVE: To establish, implement, and maintain a Quality Assurance Program Plan in accordance with requirements set forth in the NNWSI Project QA Plan, NVO-196-17, and the Project-wide Standard Operating Procedures.

DESCRIPTION OF WORK: All efforts required to:

- establish appropriate levels of quality for all NNWSI Project items/activities in accordance with NNWSI-SOP-02-02
- apply appropriate QA requirements to NNWSI Project activities/items depending on the quality level assigned and submit to WMPO for approval
- provide personnel training to maintain an awareness of QA requirements and to maintain technical proficiency
- perform independent verification and assessment of QA program effectiveness through audits, surveillances, and management reviews.

WBS: 2.9.3.T

TITLE: NNWSI Quality Assurance

PARTICIPANTS: Science Applications International Corporation

OBJECTIVE: To establish, implement, and maintain a Quality Assurance Program Plan in accordance with requirements set forth in the NNWSI Project QA Plan, NVO-196-17, and the Project-wide Standard Operating Procedures.

DESCRIPTION OF WORK: All efforts required to:

- establish appropriate levels of quality for all NNWSI Project items/activities in accordance with NNWSI-SOP-02-02
- apply appropriate QA requirements to NNWSI Project activities/items depending on the quality level assigned and submit to WMPO for approval
- provide personnel training to maintain an awareness of QA requirements and to maintain technical proficiency
- perform independent verification and assessment of QA program effectiveness through audits, surveillances, and management reviews.

NNWSI WORK BREAKDOWN STRUCTURE DICTIONARY

APPENDIX A

NNWSI Issues Hierarchy

KEY ISSUE 1.0 The quantity of waste radionuclides released from a repository at Yucca Mountain under current conditions and processes must be small enough and transport time to the accessible environment long enough to meet the radiation release limits specified by EPA and [illegible]

ISSUE 1.1 What period and degree of radionuclide containment will be provided by a waste package designed for use in a repository at Yucca Mountain?

1.1.1 Estimates of and bounds on the flow of steam, air, and water in the waste package emplacement environment

1.1.2 Estimates of and bounds on the chemical characteristics of steam, air, and water in the horizon and waste packages

1.1.3 Material properties relevant to design specifications for waste form, and estimates of and bounds on the leaching of the waste form during repository storage [illegible]

1.1.4 Material properties relevant to design specifications for canister and/or overpack composition, thickness, fabrication, and filling

1.1.5 Performance characteristics for backfill, and material properties relevant to design specifications for backfill composition and amount, if required

1.1.6 Calculated estimates of bounds on the release initiation time (period of containment) and the release rates (degree of containment) from the waste package subsystem

ISSUE 1.2 What hydrologic flow paths, fluxes, water velocities, and travel times will arise within the repository and between the repository and accessible environment?

1.2.1 Estimates of and bounds on the geologic framework of the site, including the locations of any stratigraphic or structural constraints on the depth and lateral extent of the waste-emplacement horizon

1.2.2 Definition of boundaries of the accessible environment

1.2.3 Estimates of and bounds on hydrologic flow paths, fluxes, water velocities, and travel times in the unsaturated zone

1.2.4 Estimates of and bounds on hydrologic flow paths, fluxes, groundwater velocities, and travel times in the saturated zone between the repository area and the accessible environment

1.2.5 Estimates of and bounds on the effects of the repository-induced thermal pulse and rock excavations on rock mass properties and the resulting effects on the permeability and degree of saturation in the unsaturated and saturated zones

1.2.6 Calculated estimates of and bounds on the directions, fluxes, velocities, and travel times of water flow for both the perturbed and unperturbed conditions of the unsaturated and saturated zones within the repository and between the repository and the accessible environment

ISSUE 1.3 What degree of radionuclide retardation may be provided by geochemical and physical processes within the repository and between the repository and the accessible environment?

1.3.1 Estimates of and bounds on radionuclide retardation by sorption processes

1.3.2 Estimates of and bounds on retardation by precipitation processes

1.3.3 Bounds on effective retardation in dispersive/diffusive/advective transport processes

1.3.4 Calculated estimates of and bounds on radionuclide retardation along the hydrologic flow paths within the repository and between the repository and the accessible environment

ISSUE 1.4 To what extent will the rates and concentrations of radionuclides released from the repository and to the accessible environment be in compliance with NRC and EPA criteria based on an integrated performance assessment?

1.4.1 Definition of boundaries of the waste package, engineered barrier system, disturbed zone, and accessible environment

1.4.2 Calculated estimates of and bounds on the performance of the total waste isolation system, including waste package release rates, groundwater travel time, retardation of radionuclides, and the integrated release of radionuclides to the accessible environment as a function of time

ISSUE 1.5 What are the consequences associated with predicted radionuclide release rates and concentrations?

1.5.1 Assessments of demographic projections or estimates that apply to the short- and long-term future

1.5.2 Assessments of food chain, hydrologic, and atmospheric dispersal models that are appropriate

1.5.3 Calculated estimates of and bounds on the consequences associated with the predicted releases of radionuclides to the accessible environment

KEY ISSUE 2.0 Changes from current conditions and processes (Key Issue 1) in the waste isolation environment that have reasonable potential of occurring must not adversely and significantly affect capability of a repository and its surrounding to contain and isolate radioactive waste consistent with NRC and EPA requirements.

ISSUE 2.1 Do any natural processes or events provide reasonable potential for physical disruption of the repository and release of radionuclides to the surface?

2.1.1 Calculated estimates of and bounds on the probability of igneous extrusion through the repository, and the distribution and concentrations of radionuclides in material extruded at the land surface

2.1.2 Calculated estimates of and bounds on future climatic and fluvial conditions

2.1.3 Calculated estimates of and bounds on anticipated rate of tectonism

2.1.4 Calculated estimates of and bounds on future depths of erosion

2.1.5 Calculated estimates of and bounds on the direct radionuclide releases at the land surface associated with reasonably likely tectonic, climatic, and erosional conditions

ISSUE 2.2 Do any natural processes or events provide reasonable potential for changing the hydrologic system so as to increase the rates or concentrations of radionuclide releases from the repository to the accessible environment?

2.2.1 Calculated estimates of and bounds on future climatic and fluvial conditions (same as 2.1.2)

2.2.2 Calculated estimates of and bounds on future rates of tectonism and their hydrogeologic effects at or near the site

2.2.3 Calculated estimates of and bounds on future changes in recharge patterns and rates due to anticipated tectonic and climatic conditions

2.2.4 Calculated estimates of and bounds on the effects of tectonic and climatic conditions that have reasonable potential of occurring on hydrologic flow paths, hydraulic properties, and retardation potential within the repository block and between the repository and the accessible environment

2.2.5 Calculated estimates of and bounds on the rates and concentrations of radionuclide releases from the repository to the accessible environment resulting from future climatic conditions and tectonism

ISSUE 2.3 Do any human-induced processes or events provide reasonable potential for increasing the rates or concentrations of radionuclide releases to the accessible environment?

2.3.1 Estimates of and bounds on the potential effects of groundwater withdrawal from nearby aquifers on the hydrologic flow paths and rates; and the resulting impact on rates and concentrations of radionuclide releases to the accessible environment

2.3.2 Estimates of and bounds on the potential effects of exploratory drilling or mine development for resources or other human perturbations on the rates and concentrations of radionuclide releases to the accessible environment

2.3.3 Estimates of and bounds on the potential effects of site characterization on hydrologic flow paths and rates and geochemical retardation mechanisms and the resulting impact on the rates and concentrations of radionuclide releases to the accessible environment

KEY ISSUE 3.0 Construction, operation, and decommissioning of a repository must be timely, safe, economic, and environmentally acceptable.

ISSUE 3.1 Will the waste package designed for use at Yucca Mountain be cost effective and compatible with the regulatory requirements for safe transportation, handling, emplacement, and retrieval?

3.1.1 Summary of all the regulatory requirements affecting a waste package, including transportation, handling, emplacement, containment, release control, and retrieval

3.1.2 Designs and specifications developed to meet regulatory requirements and cost effectiveness goals

3.1.3 Technical analyses showing that the proposed waste package designs and specifications are compatible with the regulatory requirements

3.1.4 Economic analyses of waste package and related repository systems showing that the chosen designs and specifications are most cost effective

ISSUE 3.2 Will local surface conditions at Yucca Mountain lead to significant cost increases or safety concerns for construction, operation, and decommissioning of a repository?

3.2.1 Impact of surface topography on surface facility location and design

3.2.2 Impact of soil mechanics properties on surface facility location and foundation design

3.2.3 Impact of local meteorological conditions on surface facility location and foundation design

3.2.4 Identification of suitable locations for surface facilities and assessment of soil mechanics and meteorological requirements on design

ISSUE 3.3 Will local subsurface conditions at Yucca Mountain lead to significant cost increases or safety concerns for construction, operation, and decommissioning of a repository?

3.3.1 Impact of target horizon continuity and local geologic structure and hydrology on repository layout

3.3.2 Impact of in situ stress and rock mass mechanical properties on size, shape, orientation, and stability of mined openings

3.3.3 Development of the natural and man-made seismicity design criteria for surface and subsurface facilities

3.3.4 Impact of in situ temperature, thermal gradient, and rock mass thermal properties on subsurface facility location and design

3.3.5 Impact of unexpected geologic and hydrologic conditions on location and design of subsurface facilities

3.3.6 Define the impact of local subsurface conditions on repository design

ISSUE 3.4 Will surface and subsurface facilities designed for use at Yucca Mountain be cost effective and compatible with the regulatory requirements for safe transportation, emplacement, and retrieval of waste?

3.4.1 Definition of the surface and subsurface boundaries of the repository block

3.4.2 Definition of the allowable gross thermal load in the repository

3.4.3 Definition of the basic design parameters for the receiving and waste packaging facilities

3.4.4 Definition of the method of waste emplacement and retrieval

3.4.5 Definition of the plan for grouping of wastes by type and underground layout

3.4.6 Definitions of the method of backfilling and sealing boreholes, drifts, and shafts

3.4.7 Estimates of and bounds on the releases resulting from possible accidents during the operation period, and the consequences of such releases

3.4.8 Designs and specifications developed to meet the regulatory requirements in a cost-effective manner

ISSUE 3.5 Will short-term and long-term effects of the repository exploration, construction, operation, and decommissioning comply with environmental regulations?

3.5.1 Assessment of natural environmental baseline conditions (energy and mineral resources, groundwater resources, ecological system, and air quality) and impacts and identification of mitigation strategies

3.5.2 Assessment of human environmental baseline conditions (socioeconomic, cultural resources, and transportation system) and impacts and identification of mitigation strategies

3.5.3 Assessment of hazardous (chemical) and process radiological waste disposal requirements

3.5.4 Assessment of current radiological background and meteorological dispersion characteristics and impacts of routine operational releases

LLNL NNWSI Program

List of Planned Field and Laboratory Tests

Waste Package Program - WBS 2.2

The following list of field and laboratory experiments are in support of the LLNL Waste Package Program, WBS 2.2. The list includes experiments which are complete, in progress, and planned for each major subtask within the Waste Package Program.

WBS 2.2.2 L - Waste Package Environment

P.I. - V. M. Oversby

A. Tests related to water chemistry and hydrothermal alteration products

In progress:

1. Dickson-type gold-cell rocking autoclave tests.

   DB12 - G-1 core wafer, J-13 water, 90°C, 365 day duration Scheduled termination April 1985.

   DB13 - G-1 core wafer, J-13 water, 150°C, 365 day duration Scheduled termination April 1985.

   DB16- G-1 wafer, distilled water, 90°C, 64 day duration Scheduled termination November 19, 1984.

   DB17 - G-1 wafer, distilled water, 150°C, 64 day duration Scheduled termination November 19, 1984.

2. Single mineral dissolution kinetics experiments.

   FTQ3 - Quartz, various pH buffers, 75°C, 35 ml/day flow rate Scheduled termination November 9, 1984.

   CFTF - Plagioclase, various pH buffers, 70°C, 10, 35, and 100 ml/day Scheduled termination November 9, 1984.

Planned:

1. Dickson-type gold-cell rocking autoclave tests.

   DB18 - J-13 water, 90°C, 30 days. December 1984.

   DB19 - J-13 water, 150°C, 30 days. December 1984.

   DB20 - Tpt vitrophyre polished wafer, J-13 water, 90°C, 64 days, January 1985 start.

   DB21 - Tpt vitrophyre polished wafer, J-13 water, 150°C, 64 days, January 1985 start.

DB22 - Tpt vitrophyre polished wafer, J-13 water, 250°C, 64 days, April 1985 start.

DB23 - Tpt zeolite polished wafer, J-13 water, 90°C, 64 days, April 1985 start.

DB24 - as DB23, but 150°C, July 1985 start.

DB25 - as DB23, but 250°C, July 1985 start.

2. Single phase dissolution kinetics

FTCr - cristobalite, various pH buffers, 35 ml/day flow rate, 70°C. Start January 1985, finish March 1985.

3. Parr bomb experiments

Lithium distribution between solution and core wafers of Tpt at 90°C. Start November 1984, finish February 1985.

4. Hydrothermal alteration in a radiation field

Polished core wafers of Tpt will be included in some of the metallurgy experiments that are to be conducted in a gamma radiation field. See WBS 2.2.3.2 for schedule.

B. Experiments to determine the transport properties of liquid and vapor phases in core samples of Topopah Spring tuff. This is a developmental activity. As such, the experiments are planned to determine the sequence of activities but are not conducted according to detailed written procedures. Procedures that are used during the execution of the experiments are documented at the conclusion of each experiment.

In progress:

Dehydration and rehydration of a core sample of Tpt containing a natural fracture. System run under isothermal conditions. Planned completion April 1985.

Planned:

Experiments to determine the dehydration and rehydration behavior of Tpt intact and fractured core samples when held in a temperature gradient. Scheduled start January 1985. Expected duration, six months.

WBS 2.2.3 - Waste Form

WBS 2.2.3.1 L - Waste form testing

A. Spent fuel dissolution studies.

P.I. - V. M. Oversby

In progress:

Series 2A - H. B. Robinson fuel (bare fuel, 5" segment with no cladding defect, 5" segment with laser puncture, 5" segment with machined slit defect) in J-13 water, ambient hot cell temperature. Scheduled to finish in June 1985. Actual finish date will depend on experimental results, which may indicate extension of the experiments is desirable.

Series 2B - Turkey Point fuel segments. All conditions are as for series 2A.

Planned: Series 3 tests at higher temperature (probably 70°C); otherwise, conditions as for series 2 tests. Planned to start June 1985. Approximate duration 1 year.

B. Zircaloy cladding corrosion tests.

P.I. - V. M. Oversby

In progress:

Electrochemical scoping experiment consisting of a bundle of irradiated Zircaloy (defueled) segments wrapped in a stainless steel sheath. Test temperature is 90°C. Test durations: 2, 6, and 12 months. The two month test is completed. The series will be completed by August 1985.

Planned:

Testing of fueled H. B. Robinson segments is deionized water at 170°C and 100 psi to simulate a breached, water-logged fuel pin inside an intact waste package container. Scheduled to start in April 1985. Planned duration 6 months.

C. Spent fuel oxidation studies.

P.I. - V. M. Oversby

In progress:

Thermogravimetric analysis of spent fuel oxidation under controlled atmosphere conditions at temperatures from 100 to 250°C. These are a series of related experiments, each of which lasts one to two months. They will continue throughout 1985.

Planned:

Furnace or hot bath oxidation studies at 100 to 150°C. These experiments will involve larger samples than the TGA studies and will provide the starting material for leaching studies of oxidized spent fuel. (The leaching studies are tentatively planned for FY86). The furnace oxidation work will begin in April 1985.

D. Glass Waste form testing under unsaturated conditions.

P.I. - V. M. Oversby

In progress:

A test series of one year duration using the unsaturated test method. Termination expected in July 1985. This series is using DWPF 165 frit glass.

Planned:

A test series using PNL 76-68 glass using the unsaturated test method. Planned start - late 1985.

E. Parametric Testing of glass waste forms.

P.I. - V. M. Oversby

In progress:

Test series using actinide-doped PNL 76-68 glass and procedure patterned after MCC-1 test. Matrix includes 7, 14, 28, 56, 91, and 182 day tests with deionized water, J-13 water, J-13 + tuff, and J-13 + tuff + stainless steel, all at 90°C and SA/V = 0.3 cm^{-1}.

Test series using U-doped PNL 76-68 glass with SA/V = 0.5 cm^{-1}. Other conditions as above.

Both series are planned to finish in April 1985.

Planned:

Test series using an "aged" actinide-doped glass with composition equivalent to that which would be present 300 years after disposal. Test conditions as for actinide-doped 76-68 glass. Planned start date February 1985.

Testing in gamma radiation field at dose rates of approximately 10^4 rad/hr. Planned for late FY85, depending on availability of funds.

F. Testing in rock reaction vessels.

P.I. - V. M. Oversby

In progress:

Test series using actinide doped PNL 76-68 glass in J-13 water in tuff reaction vessels. Test duration - 1, 3, and 6 months. Planned to finish in January 1985.

No further tests in rock reaction vessels planned as of present.

WBS 2.2.3.2 Metal Barriers Selection and Testing

The majority of experiments underway at LLNL are on-going. Data are generated by periodic removal, observation, and measurement of test specimens with frequent re-emplacement of the test specimens in the experimental apparatus to accumulate additional exposure time. Instructions and operational details for the experiments performed at LLNL can be found in the front of the appropriate laboratory notebook for the particular experiment. In most cases, these instructions are based on standardized ASTM test procedures. For the experiments performed at PNL, ASTM procedures are generally followed with the special modifications of these as the EMP-TUF series available from PNL.

P.I. - R. D. McCright

EXPERIMENT 11 4/83 - 9/87

Determination of general corrosion rates and tendencies for 304L, 316L, 321 stainless steels, as well as Incoloy 825 in TUFF saturated J-13 well water 50°C, 70°C, 80°C, 90°C, and 100°C.

EXPERIMENT 13 5/83 - 9/83

Electrochemical determination of corrosion rates and tendencies for 304L, 316L, 321, and I 825 in TUFF saturated J-13 well water at 50°C, 70°C, 80°C, 90°C, and 100°C.

EXPERIMENT 15 4/83 - 9/87

Corrosion rate study of 304, 304L, 316, 316L, 321, 317L, I-825, 347, and 409 stainless in various chloride concentrations added to J-13 well water.

EXPERIMENT 17 3/83 - 9/87

Corrosion rate study of cast iron, 1020 carbon steel, and 9 Cr-1 Mo in TUFF saturated J-13 well water under four-point load bent-beam stress conditions.

EXPERIMENT 18 12/82 - 9/87

Radiation corrosion exposure of annealed and sensitized 304L stainless steel in gamma pit environment at ambient temperature.

EXPERIMENT 20 12/83 - 9/87

Corrosion rates 304L and 316L alloys heated as vessels from the inside (using liquid metal) to 150°C in J-13 well water.

EXPERIMENT 21 9/83 - 9/87

Upset resistance welded specimens of 304L stainless for stress corrosion testing.

EXPERIMENT 22 8/83 - 9/87

The continuation of experiment 12: corrosion rates of 1020 carbon steel, A-36, 9 Cr-1 Mo, 409, 304L, 316L, 317L, 321, 347, and I-825 in TUFF saturated J-13 well water and steam (100°C).

EXPERIMENT 23 9/83 - 9/87

Stress corrosion determination of 304, 304L, 316, and 321 in 100°C J-13 well water and steam. Procedure requires four-point load bent-beam survey.

EXPERIMENT 24 10/83 - 9/87

Electrochemical parallel to experiment 22: corrosion rates of 304, 409, 321, F9, 347, 1020 carbon steel, 317L, A36, 316L and I-825 in 100°C J-13 well water.

EXPERIMENT 26 8/83 - 9/87

Electrochemical polarization behavior of 304L in J-13 well water with various chloride and nitride additions at 2°C below boiling temperature.

EXPERIMENT 27 6/84 - 9/87

Corrosion testing of 1020 carbon steel, A36, 9 Cr-1 Mo, 409, 304, 304L, 316L, 317L, 321, 347, and I-825 in controlled humidity environments above 100°C.

EXPERIMENT 28 12/83 - 9/87

Corrosion of 304 stainless steel in J-13 well water at elevated temperatures with applied current over an extended time period.

EXPERIMENT 30 4/84 - 9/87

Gamma electrochemical evaluation of 304L, 304, 316L, and 316 stainless in J-13 well water at various temperatures.

EXPERIMENT 31 3/84 - 9/87

Corrosion rate determination of electrolytic tough pitch copper, 90/10 Cupronickel, and 70/30 Cupronickel in 100°C J-13 well water and steam.

EXPERIMENT 32 3/84 - 9/87

Electrochemical parallel to experiment 31.

EXPERIMENT 33 7/84 - 9/87

Corrosion rate determination of 304, 304L, 316L, and 321 suspended in a humidity chamber at 150°C using deionized water. Samples are sensitized four-point bend alloys.

EXPERIMENT 35 5/84 - 9/87

Electrochemical study on the effects of high temperature air-formed oxide films formed on 304L and 316L stainless samples.

EXPERIMENT 36 5/84 - 9/87

Crevice corrosion experiment on 304, 304L, 316L, 321, 347, and I-825 in gamma pit environment.

EXPERIMENT 37 5/84 - 9/87

Weight loss experiment on 304L in gamma environment. 50% of all samples will be immersed in J-13 TUFF saturated water.

EXPERIMENT 38 7/84 - 9/87

Gleeble experiment (controlling time and temperature) using 304, 304L, 316L, and 321. These alloys will be used: as received, sensitized (heat treated), cold rolled, and welded.

EXPERIMENT 38-A 7/84 - 9/87

Four-point bend, weight loss, and electrochemical studies of sensitized stainless 304L-CSO, 321-CSO, 316L-CSO, and 304-CSO on Gleeble.

EXPERIMENT 41 7/84 - 9/87

Crevice corrosion behavior of 304, 304L, 316, 316L, 321, 347, and I-825 in J-13 well water at 90°C.

List of experiments conducted under sub-contract to Pacific Northwest Laboratory

P.I. and Tech. Contact. - R. E. Westerman
Program Mgr. - R. D. McCright

EXPERIMENT 1 (PNL) 5/84 - present

General survey of corrosion of candidate stainless steels in solutions of J-13 well water whose ionic content is concentrated by alternate wetting and drying cycles. Test conducted in autoclave at 200°C. U-bend specimens examined for weight loss, evidence of localized corrosion attack, evidence of stress corrosion cracking. Procedures followed: ASTM G-1; ASTM G-31; ASTM G-39; PNL-EMP-TUF-1; PNL-EMP-TUF-3.

EXPERIMENT 2 (PNL) 4/83 - present

Irradiation corrosion testing of candidate stainless steels in J-13 water and water vapor at 50 and at 90°C. Environments sparged with air. U-bend specimens examined periodically for weight loss, evidence of localized corrosion attack, evidence of stress corrosion cracking. Some specimens heat treated to effect a sensitized microstructure. Procedures followed: ASTM G-1; ASTM G-30; ASTM G-31; ASTM G-39; PNL-EMP-TUF-1.

EXPERIMENT 3 (PNL) 6/83 - present

Slow stain rate testing of candidate stainless steels in J-13 water to determine susceptibility to stress corrosion cracking. Some specimens heat treated to effect sensitized microstructure. Test conducted at different temperatures and different strain rates. Procedure used: PNL-EMP-TUF-2. Also, ASTM STP 665 gives overall guidance on the slow strain rate technique.

Experiments planned for the near future

P.I. - R. D. McCright

1. Localized corrosion susceptibility of candidate stainless steels in specially fabricated crevice cell. Planned start date, January 1985.

2. Bent beam stress corrosion cracking experiments with electrochemical potential measurement and control. Planned start date, July 1985.

3. Electrochemical corrosion potential determination of candidate stainless steels at different temperatures in irradiated environments. Planned start date, December 1984

4. Electrochemical corrosion potential determination of candidate copper alloys at different temperatures in irradiated environments. Planned start date, December 1984.

5. Corrosion survey experiments (general, localized, stress) of copper and copper-base alloys in irradiated J-13 water and water vapor environments. Planned start date, January 1985.

6. Determination of general corrosion rates and localized corrosion susceptibilities of candidate stainless steels in moist atmospheres by AC impedance techniques. Planned start date, April 1985.

7. Determination of general corrosion rates and localized corrosion susceptibilities of candidate copper alloys in moist atmospheres by AC impedance techniques. Planned start date, August 1985.

8. Determination of the stress corrosion susceptibility of copper and copper-base alloys in J-13 water by the slow strain rate technique. Planned start date, August 1985.

9. Determination of the crack growth rates in stress corrosion cracking susceptible austenitic stainless steels. Planned start date, June 1985.

10. Corrosion survey tests of copper and copper-base alloys in radiation simulated environments by chemical and electrochemical means. Planned start date, September 1985.

WBS 2.2.3.3 L - Other Materials

P.I. - V. M. Oversby

In progress:

Permeability of Topopah Spring tuff in a temperature gradient. This is baseline data for future measurements on packing material samples. Experiments are complete; work is being documented at present. Expected completion, February 1985.

Fabrication trials of packing material samples consisting of crushed Topopah Spring tuff and silica gel mixtures (5% and 10% gel). Expected completion, January 1985.

Planned:

Fabricate two larger size samples of tuff plus silica gel mixture to be used for experiments below. Expected to occur in February 1985.

Measure thermal conductivity of packing material sample as a function of temperature to 200°C. Expected start March 1985.

Measure permeability of packing material sample in a temperature gradient. Start March 1985, complete August 1985.

WBS 2.2.4 - Package Design, Fabrication, and Testing

No field or laboratory testing is planned for the Waste Package design subtask for FY85 or early in FY86.

Exploratory Shaft - WBS 2.6

WBS 2.6.9.2.5

A. Exploratory Shaft Tests

P.I. - J. Yow

In progress:

None.

Planned:

Three tests of the waste package environment are planned to begin in drifts in the exploratory shaft in 1988, with a scheduled duration yet to be determined. The tests will be conducted in accord with written procedures that are under development. These procedures will be modified during the tests; the final procedures will be documented at the conclusion of the tests.

B I BLANCHARD WMPO RAMSPOTT 26 Nov 84 [redacted] WGB 11-27-84

[redacted] WMPO LLNL

Status: OPEN [redacted] Director's Input Required: Y

Description: TRANSMIT LLNL NWWSI PROGRAM'S PLANNED FIELD AND LABORATORY TESTS TO NRC

Remarks:

LLNL NNWSI PROGRAM

CATALOG OF DATA

January 1985

Contents

LLNL DATA CATALOG

NNWSI - WASTE PACKAGE TASK WBS 2.2

Waste Package Environment - WBS 2.2.2

Rock-Water Interaction Tests

File Location: T1456, Rm 1001 and T1478, Rm 116,
Lawrence Livermore National Laboratory

	Category	Description
1.	Bullfrog Tuff + J-13 water at 90 and 150°C	Crushed rock and rock wafers reacted with J-13 water in Parr bombs. Solution analyses. Pre- and post-test petrologic characterization. Details contained in UCRL-53470, UCRL-53521, and UCRL-53442. Data acquired during FY82-83 at LLNL.
2.	Topopah Spring tuff + J-13 water (outcrop samples)	Crushed rock reacted with J-13 water in Parr bombs at 90, 120, and 150°C. Solution analyses. Details contained in UCRL-53552 and UCRL-53574. Data acquired during FY83-84 at LLNL.
3.	Topopah Spring tuff + J-13 water (core samples)	Crushed rock reacted with J-13 water in Parr bombs at 150°C. Times to 72 days. Solution analyses. Test procedure same as #2 above. Data acquired during FY83-84 at LLNL.
4.	Topopah Spring tuff + J-13 water Long term tests.	Crushed rock, J-13 water, Parr bombs. Times to 300 days at 90°C and 180 days at 150°C. Solution analyses. Test procedure same as #2 above. Data acquired during FY84 at LLNL.
5.	Topopah Spring tuff + deionized water.	Crushed rock, DIW, Parr bombs, 150°C. Times to 48 days. Solution analyses. Test procedure same as #2 above. Data acquired Oct-Dec, 1984 at LLNL.

LLNL DATA CATALOG

NNWSI - WASTE PACKAGE TASK WBS 2.2

Waste Package Environment - WBS 2.2.2

Rock-Water Interaction Tests

File Location: T1478, Rm 116 and Bldg 281, Rm 1159,
Lawrence Livermore National Laboratory

	Category	Description
6.	Topopah Spring tuff + J-13 water (outcrop samples)	Rock wafers reacted at 150°C with J-13 water in Parr bombs. Solution analyses. Pre- and post-test characterization of solids. Details contained in UCRL-53558 and UCRL-53576. Data acquired during FY83 at LLNL.
7.	Topopah Spring tuff + J-13 water (crushed tuff)	Crushed tuff from either outcrop or drillcore reacted for up to 82 days with J-13 water at 90°C, 150°C, and 250°C in Dickson-type, gold-cell, rocking autoclaves (Dickson bombs). Solution analyses. Pre- and post-test characterization of solids. Data acquired during FY84-85 at LLNL.
8.	Topopah Spring tuff (rock wafers)	Rock wafers from either outcrop or drillcore reacted for up to 66 days with either J-13 or deionized water at 90°C, 150°C, and 250°C in Dickson bombs. J-13 water alone (no rock) run under identical conditions. Solution analyses. Pre- and post-test characterization of solids. Data acquired during FY84-85 at LLNL.
9.	Topopah Spring tuff + J-13 water (long term)	Rock wafers from drillcore reacted for up to 300 days with J-13 water at 90°C and 150°C in Dickson bombs. Solution analyses. Post-test characterization of solids. Data acquired during FY84-85.
10.	Topopah Spring tuff + Li-doped J-13 water	Rock wafers from outcrop reacted for 60 days with J-13 water doped with 1, 10, and 20 ppm Li at 90°C in Parr bombs. Solution analyses. Post-test characterization of solids. Data acquired during FY85.
11.	Single mineral dissolution kinetics	Crushed pure quartz and feldspar reacted for 50 days with buffers ranging from pH1 through pH13 at 70°C with volume flow velocities ranging from 10 to 100 ml/day in single-pass, flow-through cells. Solution analyses. Pre- and post-test characterization of solids. Data acquired during FY84-85.

LLNL DATA CATALOG

NNWSI - WASTE PACKAGE TASK WBS 2.2

Waste Package Environment - WBS 2.2.2

Transport Properties of Topopah Spring Tuff

File Location: Bldg 243 and the Central Mass Storage, Computer Center, Lawrence Livermore National Laboratory

	Category	Description
1.	Topopah Spring tuff + J-13 water to 140°C (outcrop sample)	Intact core 2.54 cm diameter, 10 cm long. Permeability, electrical resistivity, and ultrasonic P-wave velocity were determined. The sample went through three dehydration and rehydration cycles, to 140°C. Details are contained in UCRL-53602. Data acquired from June to September, 1983, at LLNL.
2.	Topopah Spring tuff + J-13 water to 140°C (core sample)	Fractured core 2.54 cm diameter, 10 cm long. Test procedures same as #1 above. Details are contained in UCRL-53602. Data acquired from October, 1983 to February, 1984, at LLNL.
3.	Topopah Spring tuff + J-13 water to 140°C (core sample)	Fractured core 2.54 cm diameter, 10 cm long. Measurements same as #1 above. The sample was kept saturated constantly to 140°C. Data details are contained in UCRL-53602. Data acquired from April to June, 1984, at LLNL.

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NNWSI - WASTE PACKAGE TASK WBS 2.2

Waste Form Testing - WBS 2.2.3.1

NNWSI Waste Form Performance Test

File Location: Bldg 205, Rms Y-132, C-239, G-138,
Argonne National Laboratory

	Category	Description
1.	Unsaturated test matrix with DWPF 165 glass	Selected waste package components reacted with EJ-13 using unsaturated conditions. Times to 365 days in progress. Solution analyses. Pre- and post-test component characterization. Details contained in ANL 84-81 and in ANL Nuclear Technology Programs Quarterly Progress Reports beginning April-June 1983, ANL 83-78. Data acquired during FY83-84 at ANL.
2.	Parametric and analog testing of DWPF 165 glass in unsaturated conditions	Selected waste package components reacted with EJ-13 water using unsaturated conditions. Times to 365 days in progress. Solution analyses. Pre- and post-test component characterization. Details contained in ANL 84-81 and in ANL Nuclear Technology Programs Quarterly Progress Reports beginning April-June 1983, ANL 83-78. Data acquired during FY83-84 at ANL.
3.	Parametric testing of nonirradiated fuel	Nonirradiated fuel and selected waste package components reacted with EJ-13 water using unsaturated conditions. Times to 90 days in progress. Solution analyses. Details contained in ANL Nuclear Technology Programs Quarterly Progress Report October-December 1984. Data acquired during FY85 at ANL.
4.	Gamma-irradiation testing of DWPF 165 and PNL 76-68 glass in saturated conditions	Doped DWPF 165 and PNL 76-68 glass reacted with EJ-13 in a gamma field of intensity 2×10^5 R/h. Total submersion using monolithic and crushed glass samples combined with 304L stainless steel and crushed tuff. 90°C for times of 7, 14, 28, and 56 days with SA/V (monolith) of 0.3 cm^{-1} and (crushed) 1.0 cm^{-1}. Solution analyses. Pre- and post-test component characterization. Details contained in ANL 84-91. Data acquired during FY84 at ANL.

LLNL DATA CATALOG

NNWSI - WASTE PACKAGE TASK WBS 2.2

Waste Form Testing - WBS 2.2.3.1

Glass Dissolution/Leaching

File Location: Bldg 151, Rms 2128, Rm 2131, Rm 2136,
Lawrence Livermore National Laboratory

	Category	Description
1.	DWPG glass at 90°C a. with DI water: SA/V= 0.1, 0.3, 0.5, 1.0 cm^{-1} b. with J-13 water; SA/V=0.3, 0.5 cm^{-1} c. with J-13 water + tuff; SA/V=0.1, 0.3 cm^{-1} d. with J-13 water + tuff + stainless steel; SA/V=0.3, 0.5 cm^{-1}	Monoliths and crushed glass reacted with DI water and J-13 water for leaching times from 1 to 182 days using MCC-1-like procedures. Leachants analyzed by ICP. Data acquired in 1983 and 1984. Results are contained in UCRL-53606.
2.	U-doped PNL 76-68 glass at 90°C. Same series of tests as above, but only at SA/V=0.5 cm^{-1}	Discs reacted with DI water and J-13 water for leaching times from 3 to 182 days using MCC-1-like procedures. Data acquired in 1984. Results are being calculated.
3.	Actinide-doped PNL 76-68 glass at 90°C. Same series as above. SA/V=0.3 cm^{-1}	Discs and crushed glass reacted with DI water and J-13 water for leaching times from 7 to 182 days, using MCC-1-like procedures. Tests still in progress.
4.	Actinide-doped PNL 76-68 glass at 90°C. Tests include glass with J-13 water in tuff reaction vessels at SA/V=0.3 cm^{-1}	Discs reacted with J-13 water for 30, 90, and 180 days. Still in progress. Planned to finish in 1985.

LLNL DATA CATALOG

NNWSI - WASTE PACKAGE TASK WBS 2.2

Waste Form Testing - WBS 2.2.3.1

Zircaloy Cladding Corrosion Degradation

File Location: Bldg 325, Rm 706, HEDL-N-3280 Controlled Notebook
Bldg 326, Rm 19C, HEDL-N-3281 Controlled Notebook
Rm 25A, Log SEM
Bldg 327, Canyon Offices, Photo Log
Hanford Engineering Development Laboratory,
Richland, WA

	Category	Description
1.	Spent fuel cladding bundles + J-13 water in equilibrium with tuff at 90°C	Cladding bundles reacted with J-13 for 2, 6 and 12 months. pH, °C, conductivity monitored. Solution analyses. Evaluation of cladding sections for corrosion via electron optics. Details contained in HEDL-TC-2562 and HEDL 7455, Rev. 1 Data acquired FY84-85 at HEDL.

Spent Fuel Oxidation Studies

File Location: Bldg 326, Rm 17C and Bldg 308, Rm 28,
Hanford Engineering Development Laboratory,
Richland, WA

	Category	Description
1.	Preliminary TGA tests, 200-225°C and sample examinations	Irradiation Turkey Point Fuel oxidized for up to 800 hours. Weight gain, XRD, microprobe, SEM data. Details in TUF/OX-1 and HEDL-N-3327. Data acquired FY84-85 at WHC.

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NNWSI - WASTE PACKAGE TASK WBS 2.2

Waste Form Testing - WBS 2.2.3.1

Spent Fuel Leaching/Dissolution Tests

File Location: Bldg 325, Rms 200 and 310, Bldg 326, Rms 34B and 5B; Bldg 327, Hanford Engineering Development Laboratory, Richland, WA

	Category	Description
1.	Spent fuel specimen preparation data	Records preparation of Series 1 and Series 2 test specimens. General methods description in HEDL TC-2353-2 and HEDL-TC-2353-3.
2.	SAL hot cell notes	Notes on actual running of tests and sample in Bldg 325 SAL hot cells.
3.	Radiochemical laboratory data	Sample preparation and counting data. Instrument calibration records.
4.	Microstructural data	Post-test microstructural data, specimen data and negatives in Bldg 327.
5.	Central data, spent fuel in deionized and J-13 water	Reported radiochemical results, Lotus 1-2-3 files, principal investigator's notebooks and general project files (Bldg 326). Final Series 1 data reported in HEDL-TME-84-30. Data acquired FY83 to 85 at HEDL.

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NNWSI - WASTE PACKAGE TASK WBS 2.2

Metal Barrier Testing - WBS 2.2.3.2

General and Localized Corrosion Rates from Weight Loss Coupons

File Location: Bldg 241, Rm 1878, Library
Lawrence Livermore National Laboratory

	Category	Description
1.	General and localized corrosion rates of 304L, 316L, 317L, 321, 347, and 825 in tuff-conditioned J-13 water at 50, 70, 80, 90, and 100°C.	General corrosion data acquired by ASTM G-1, G-31 procedures; localized corrosion data acquired by ASTM G-46 procedures. Data obtained after approximately 3500, 5000, 7500, and 10,000 exposure hours over period April 1983 to present. Tests scheduled to continue to September 1987. Data reported in UCID-20174. Files retained in notebook labeled "Experiment 11."
2.	General and localized corrosion rates of 304L annealed and "sensitized" in room temperature irradiated J-13 water.	Companion determination in non-irradiated J-13 water. Same procedures used as in #1 above. Data obtained after a year of exposure over period December 1982 to December 1983. Data reported in UCRL-91804. Tests scheduled to continue until September 1987. Files retained in notebook labeled "Experiment 18."
3.	General and localized corrosion rates of 1020 carbon steel, A-36, F-9, 409 stainless steel, 304L, 316L, 317L, 321, 347, and 825 in tuff-conditioned J-13 water at 100°C and in steam at 100°C.	General corrosion data acquired by ASTM G-1, G-31 procedures; localized corrosion data acquired by ASTM G-46 procedures. Data obtained after approximately 3500, 5000, 7500, and 10,000 exposure hours over period August 1983 to present. Tests scheduled to continue to September 1987. Data reported in UCRL-90875 and UCRL-91804. Files retained in notebook labeled "Experiment 22." An earlier similar experiment was terminated after 1000 hours (March-May 1982). These data were reported in UCRL-89988. Files are retained in notebook labeled "Experiment 12."

	Category	Description
4.	General and localized rates of 1020 carbon steel, A-36, F-9, 409SS, 304L, 316L, 317L, 321, 347, and 825 in "dry" steam at 150°C, atmospheric pressure.	Tests conducted in Bemco controlled humidity chamber. Same procedures as in #3 above. Data obtained after approximately 3000 hours with planned future interval determinations. Data acquired over period beginning June 1984 and continuing to present; test planned to continue until September 1987. Data set not yet published. Files retained in notebook labeled "Experiment 27."
5.	General and localized corrosion rates of electrolytic tough pitch copper, 90/10 and 70/30 cupronickel, and Monel 400 in 100°C J-13 water.	Test procedures as in #3 above. Data acquired since March 1984 and continuing to present; test schedule to continue until September 1987. Data set not yet published. Files retained in notebook labeled "Experiment 31."
6.	General and localized corrosion rates of 304L which have undergone different thermal-mechanical treatment and exposed to irradiated J-13 water and vapor above the water.	Test procedure same as in #2 above. Data acquired since May 1984 but not yet published. Test scheduled to continue until September 1987. File retained in notebook labeled "Experiment 37."
7.	General and localized corrosion rates of carbon steel, Cr-Mo alloy steels, and cast iron in Topopah Spring tuff conditioned J-13 water at 50, 70, 80, 90, and 100°C with sparging by different laboratory gases - air, oxygen, nitrogen, CO_2.	Test procedures same as in #1 above. Data acquired between January and May 1983. Data reported in UCRL-90875. File retained in notebook labeled "Experiment 9."
8.	General and localized corrosion rates of carbon steel, Cr-Mo alloy steels, and cast iron in tuff-conditioned J-13 water at 50, 70, 80, 90, and 100°C in contact with air; no gas sparging.	Same procedures as in #7 above. Data acquired between April and June 1983. Data published in UCRL-90875. File retained in notebook labeled as "Experiment 10."

	Category	Description
9.	General and localized corrosion rates of carbon steel, Cr-Mo alloy steels, and cast iron in water made up from deionized water conditioned by contact with ground Bullfrog tuff rock at 50, 70, 80, 90, and 100°C with sparging by different laboratory gases - air, oxygen, nitrogen, CO_2.	Test procedures same as in #1 above. Data acquired between April 1982 and July 1982. Data set not published. File retained in notebook labeled "Experiment 1."
10.	General and localized corrosion rates of carbon steel, Cr-Mo alloy steels, and cast iron in Bullfrog tuff conditioned J-13 water at 50, 70, 80, 90, and 100°C with air sparging.	Test procedure same as in #1 above. Data acquired between July and October 1982. Data not published. File retained in notebook labeled "Experiment 5."

LLNL DATA CATALOG

NNWSI - WASTE PACKAGE TASK WBS 2.2

Metal Barrier Testing - WBS 2.2.3.2

Stress Corrosion Testing Using the Four-Point Load Bent-Beam Configuration

File Location: Bldg 241, Rm 1878, Library
Lawrence Livermore National Laboratory

	Category	Description
1.	Stress corrosion susceptibility of welded beams of ductile cast iron, 1020 carbon steel, and 9 Cr-1 Mo alloy steel exposed to tuff-conditioned J-13 water at 90°C.	Test procedure follows ASTM G-39. Data acquired over period beginning March 1983 and continuing until present. Test scheduled to continue until September 1987. Data reported in UCRL-90875. File retained in notebook labeled, "Experiment 17."
2.	Stress corrosion susceptibility of upset resistance welded 304L stainless steel specimens, exposed to 90°C tuff-conditioned J-13 water.	Test procedure follows ASTM G-39. Data acquired over period beginning September 1983; test planned to continue until September 1987. Data is unpublished. File retained in notebook labeled, "Experiment 21."
3.	Stress corrosion susceptibility of 304, 304L, 316L, and 321 stainless steel specimens with different mechanical, thermal, and welding histories.	Some specimens given "sensitizing" heat treatments. Test procedure follows ASTM G-39. Data acquired over period beginning September 1983 and continuing until present. Test scheduled to continue until September 1987. Data reported in UCRL-91804. File retained in notebook labeled, "Experiment 23."
4.	Stress corrosion susceptibility of 304, 304L, 316, and 321 stainless steel specimens with different thermal histories.	Specimens exposed in humidity chamber to 150°C "dry" steam and air. Test procedure ASTM G-39 used. Data acquired since July 1984 but not published. Test planned to continue until September 1987. File retained in notebook labeled, "Experiment 33."
5.	Stress corrosion susceptibility of 304, 304L, 316L, and 321 stainless steel specimens prepared according to different time-temperature-strain cycles on a Gleeble.	Specimens exposed to 100°C J-13 water and "wet" steam. Data acquired since July 1984 but not published. Test planned to continue until September 1987. File retained in notebook labeled, "Experiment 38."

	Category	Description
6.	Stress corrosion susceptibility of 304, 304L, 316L, and 321 stainless steel specimens prepared from plate with different thermal and mechanical treatments.	Some plates given lengthy heat treatments to effect a continuously sensitized or sigma-phase structure. Test procedure ASTM G-39 used for stress configuration; test ASTM A262 used for sensitization determination. Data acquired since July 1984 but not published. Test scheduled to continue until September 1987. File retained in notebook labeled, "Experiment 38-A."

LLNL DATA CATALOG

NNWSI - WASTE PACKAGE TASK WBS 2.2

Metal Barrier Testing - WBS 2.2.3.2

Electrochemical Determination of Corrosion Behavior

File Location: Bldg 241, Rm 1896
Lawrence Livermore National Laboratory

	Category	Description
1.	Electrochemical determination of corrosion rates and corrosion attack patterns of 304L, 316L, 321, and 825 in J-13 water at different temperatures (50-100°C).	Test procedures follow ASTM G-5 and other recognized published electrochemical test procedures. Data acquired in period May-September 1983. Data published in UCID-20174. File retained in notebook labeled, "Experiment 13."
2.	Electrochemical determination of corrosion rates and corrosion attack patterns of the same candidate alloys plus 304, 316, 317L, 347, and 409 with different previous thermal-mechanical treatments.	Some work with special purities and formulations of these alloys. Polarization tests performed in J-13 water at different stainless steels with and without different chemical additions. Test procedures as in #1 above. Data acquired since April 1983 to the present time; tests will continue until September 1987. Data published in report in UCID-20174. File retained in notebook labeled, "Experiment 15."
3.	Electrochemical determination of corrosion rates and corrosion attack patterns of 304L, 316L, 321, and 825 in J-13 water with chemical additions to simulate radiation effects.	Test procedures follow ASTM G-5 and other recognized published electrochemical test procedures. Data acquired since August 1983 to present time; tests will continue until September 1987. Data published in part in UCID-20174. File retained in notebook labeled, "Experiment 26."
4.	Electrochemical determination of corrosion rates and corrosion attack patterns of 304L, 316L, 321, and 825 in 100°C J-13 water at different exposure times to the solution.	Test procedures follow ASTM G-5 and other recognized published electrochemical test procedures. Tests begun in October 1983. Tests will continue until September 1987. Data reported in UCID-20174. File retained in notebook labeled, "Experiment 24."

	Category	Description
5.	Determination of corrosion currents and corrosion potentials for candidate stainless steels in J-13 under gamma irradiation at different temperatures.	Some tests performed on special grades of stainless steel. Tests follow ASTM G-5 calibration. Tests begun in April 1984. Tests will continue until September 1987. Data not yet published. File retained in notebook labeled, "Experiment 30."
6.	Electrochemical determination of corrosion rates and corrosion attack patterns of different copper-base materials in J-13 water.	Parallel study to Experiment 31. Test procedures follow ASTM G-5 and other recognized published electrochemical test procedures. Data acquired since March 1984. Tests plan to continue until September 1987. Data not yet published. File retained in notebook labeled, "Experiment 32."
7.	Electrochemical determination of corrosion rates and corrosion attack patterns on 304L and 316L stainless steel with thermally grown oxides.	Test procedures follow ASTM G-5 and other recognized published electrochemical test procedures. Data acquired since May 1984, but not yet published. Tests to continue until September 1987. File retained in notebook labeled, "Experiment 35."

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NNWSI - WASTE PACKAGE TASK WBS 2.2

Metal Barrier Testing - WBS 2.2.3.2

Crevice Corrosion Testing

File Location: Bldg 241, Rm 1896
Lawrence Livermore National Laboratory

	Category	Description
1.	Crevice corrosion testing of austenitic stainless steels and alloys 304, 304L, 316, 316L, 321, 347, and 825 in J-13 water at different temperatures.	Tests are designed for long-term exposure of bolted plate specimens. Data acquired since July 1984. Data not yet published. Tests expected to continue until September 1987. File retained in notebook labeled, "Experiment 41."
2.	Crevice corrosion testing of austenitic stainless steel and alloys 304, 304L, 316, 316L, 321, 347, and 825 under gamma irradiation conditions, but for shorter exposure periods than in #1 above.	Data acquired since May 1984. Data not yet published. Tests planned to continue until September 1987. File retained in notebook labeled, "Experiment 36."

Slow Strain Rate Stress Corrosion Testing

File Location: PSL Bldg, Room 414
Pacific Northwest Laboratory
Richland, WA

	Category	Description
1.	Stress corrosion susceptibility testing of 304 and 304L stainless steels with different thermal-mechanical histories.	Strain rates are in the range 10^{-6} to 10^{-4}/sec. Specimens are tested in J-13 water at different temperatures. Mechanical properties in the test environment are compared to those obtained in air. Fractured surfaces are examined to determine the nature of the cracking. ASTM STP 665 and PNL-EMP-TUF-2 test procedures are followed. Data acquired since June 1983; tests are planned to continue until September 1987 and include other alloys. Data published in UCRL-89988 and UCRL-91804.

LLNL DATA CATALOG

NNWSI - WASTE PACKAGE TASK WBS 2.2

Metal Barrier Testing - WBS 2.2.3.2

Irradiation Corrosion Testing

File Location: PSL Bldg, Room 1122
Pacific Northwest Laboratory
Richland, WA

	Category	Description
1.	Irradiation corrosion testing of candidate stainless steels in J-13 water and water vapor at 50 and 90°C in the PNL gamma pits.	U-bend specimens exposed to determine general, localized, and stress corrosion susceptibilities. Some specimens given heat treatments to form "sensitized" microstructures. ASTM G-1, G-30, G-31 procedures followed. Data collected since April 1983; test planned to continue until September 1987. Data published in UCRL-89988 and UCRL-91804.
2.	Irradiation corrosion testing of carbon, alloy, and stainless steels in J-13 water at 105 and 150°C in the PNL gamma pit.	Weight loss coupons exposed to determine general corrosion rates (ASTM G-1 and G-31). Stainless steel specimens heat treated to annealed and sensitized microstructures. Data collected in period October 1982 to April 1983. Data reported in UCRL-89988.

Corrosion Testing Under Alternating Wetting and Drying

File Location: Bldg. 3720, Room 113
Pacific Northwest Laboratory
Richland, WA

	Category	Description
1.	Corrosion survey testing of stressed U-bend specimens of 304 and 304L stainless steels in 200°C J-13 water in autoclave.	Alternate wetting and drying cycles in autoclave to allow ionic species in water to concentrate. General, localized, stress corrosion susceptibilities of stainless steels determined. ASTM G-1, G-30, G-31 and PNL-EMP-TUF-1 and 3 procedures used. Data acquired since May 1984; tests planned to continue until September 1985. Data not yet published.

LLNL DATA CATALOG

NNWSI - WASTE PACKAGE TASK WBS 2.2

Other Materials - WBS 2.2.3.3.L

Permeability of Tuff Samples in a Temperature Gradient

File Location: Bldg 9, Rms B04 and B05
USGS, 275 Middlefield Rd., Menlo Park, CA

	Category	Description
1.	Bullfrog tuff samples	Permeability and pore fluid chemistry. Details of procedure and results contained in USGS Open File Report 83-475. Data acquired during FY83 at USGS.
2.	Topopah Spring tuff samples	Permeability and pore fluid chemistry. Details of procedure and results contained in USGS Open File Report 84-273 (also available as UCRL-15620. Data acquired during FY83-84 at USGS Menlo Park.

Fabrication of Packing Materials

File Location: Bldg 1456, Rm 1001
Lawrence Livermore National Laboratory

	Category	Description
1.	Results of fabrication trials	Description of starting materials, density, thermal conductivity of pressed samples. Data acquired during FY83 through FY85 at LLNL.

LLNL DATA CATALOG

NNWSI - WASTE PACKAGE TASK WBS 2.2

Exploratory Shaft Testing - WBS 2.6.9

Waste Package Environment Field Testing

File Location: T1401, Rm 1101
Lawrence Livermore National Laboratory

	Category	Description
1.	Field trials of high frequency electromagnetic (HFEM) geotomography	HFEM signal attenuation measurements made during FY84 in fractured, welded tuff before and after water injection. Procedures covered in UCID-20289.