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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

December 2, 1993

Dr. Fred J. Molz
Department of Civil Engineering
Auburn University
Auburn, AL 36849

SUBJECT: TRANSMITTAL OF INFORMATION FOR CNWRA RESEARCH REVIEW

Dear Dr. Molz:

In preparation for your participation, as a member of the waste management subcommittee of NRC's Nuclear Safety Research Review Committee, in the December 16 - 17, 1993, review of NRC-supported research on high-level radioactive waste disposal at the Center for Nuclear Waste Regulatory Analyses (CNWRA), I am enclosing the following documents for your information.

- o Current personnel roster for CNWRA (first attachment to Patrick-to-Sege letter).
- o List of CNWRA reports and conference publications (second attachment to Patrick-to-Sege letter).
- o List of peer-reviewed publications produced by CNWRA (third attachment to Patrick-to-Sege letter).
- o List of presentations by CNWRA personnel (fourth attachment to Patrick-to-Sege letter).
- o Copy of the CNWRA report, "NRC High-Level Radioactive Waste Research at CNWRA, January - June 1993."
- o Copy of the CNWRA report, "The Role of Natural Analogs in Geologic Disposal of High-Level Nuclear Waste."

If you have questions on the enclosed material, please contact me at 301 492-3873 (voice) or 301 492-3696 (fax).

Sincerely,

John D. Randall

John D. Randall
Research Program Element Manager
Waste Management Branch
Division of Regulatory Applications
Office of Nuclear Regulatory Research

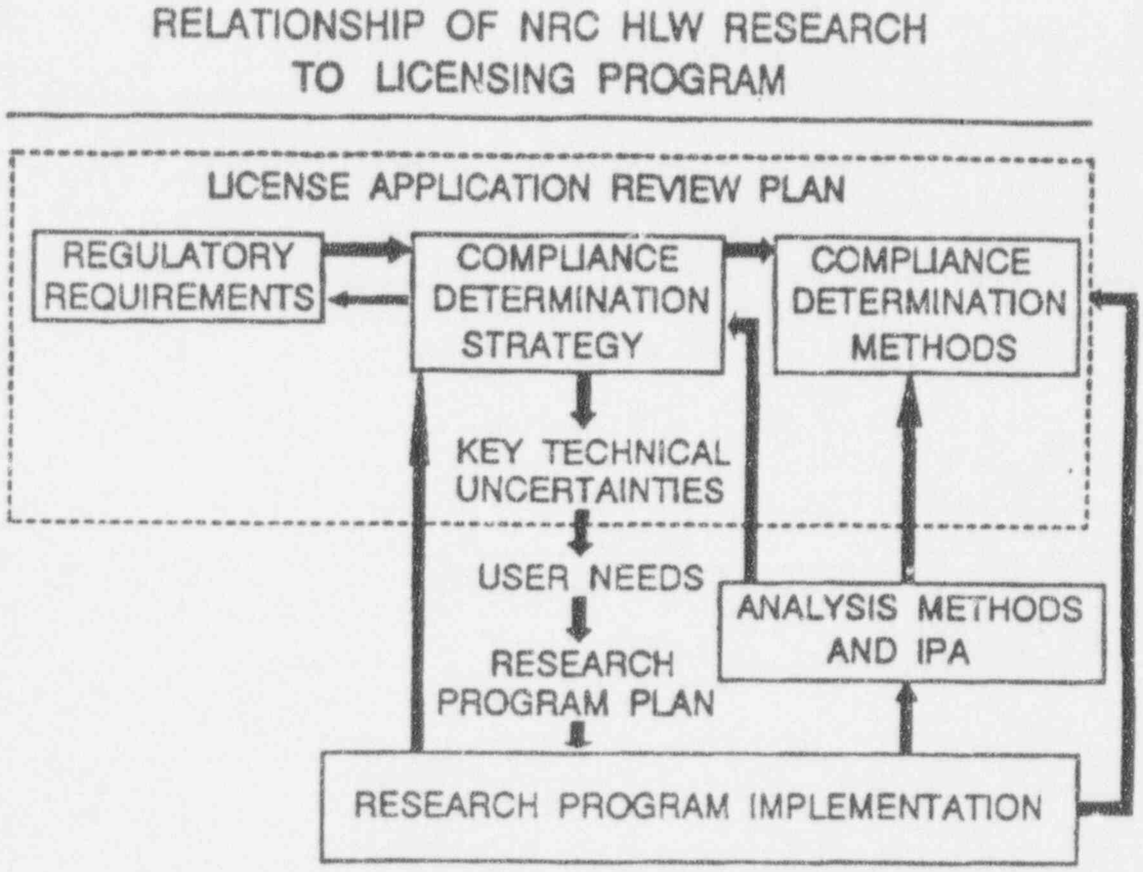
RELATIONSHIP OF NRC HLW RESEARCH
TO LICENSING PROGRAM
LICENSE APPLICATION REVIEW PLAN
REGULATORY REQUIREMENTS
COMPLIANCE DETERMINATION STRATEGY
COMPLIANCE DETERMINATION METHODS
KEY TECHNICAL UNCERTAINTIES
USER NEEDS
ANALYSIS METHODS AND IPA
RESEARCH PROGRAM PLAN
RESEARCH PROGRAM IMPLEMENTATION

FIGURE 1

CNWRA ORGANIZATIONAL CHART

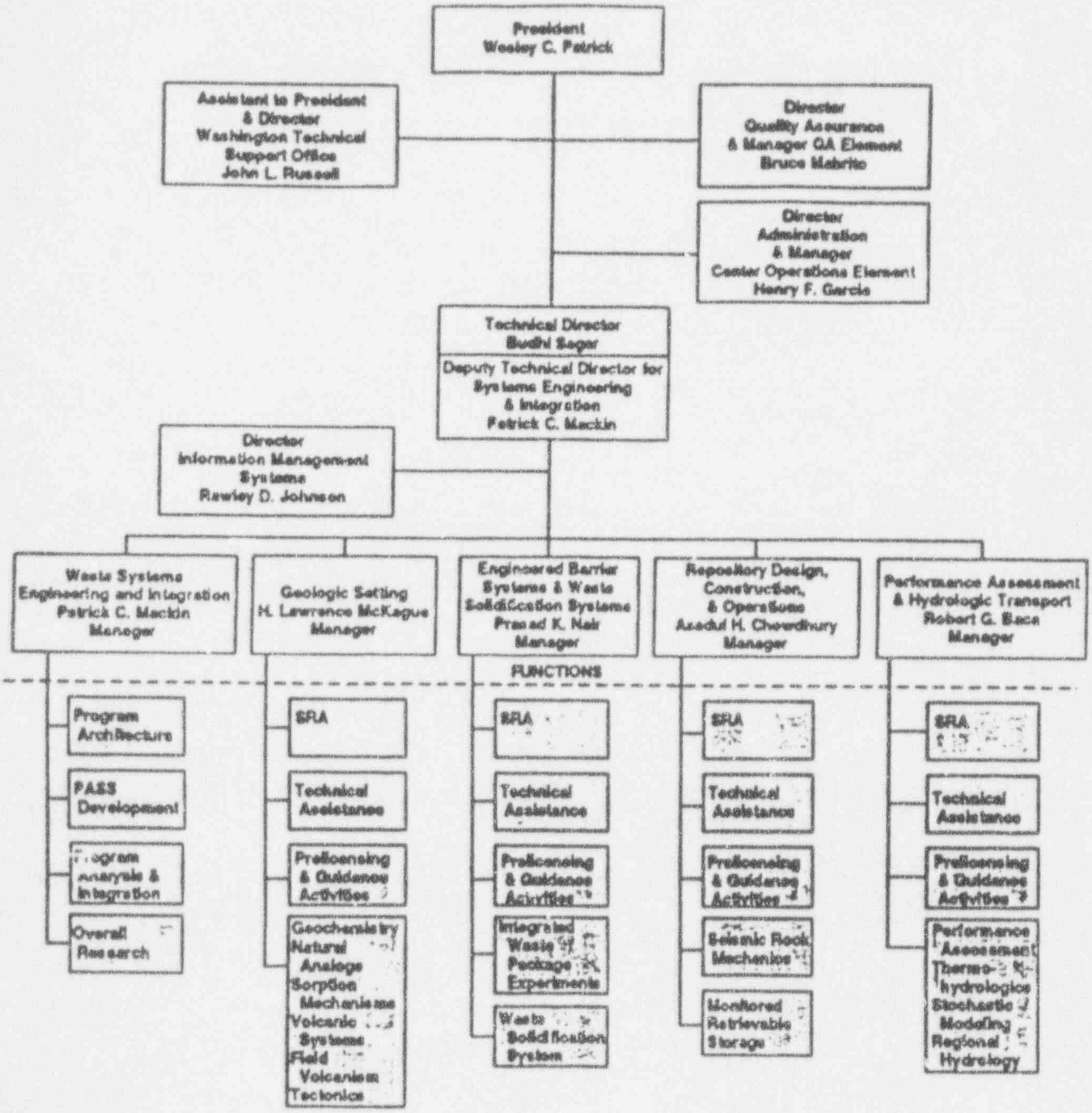

FIGURE 2

PERFORMANCE ASSESSMENT RESEARCH

Generic Outline for PA:

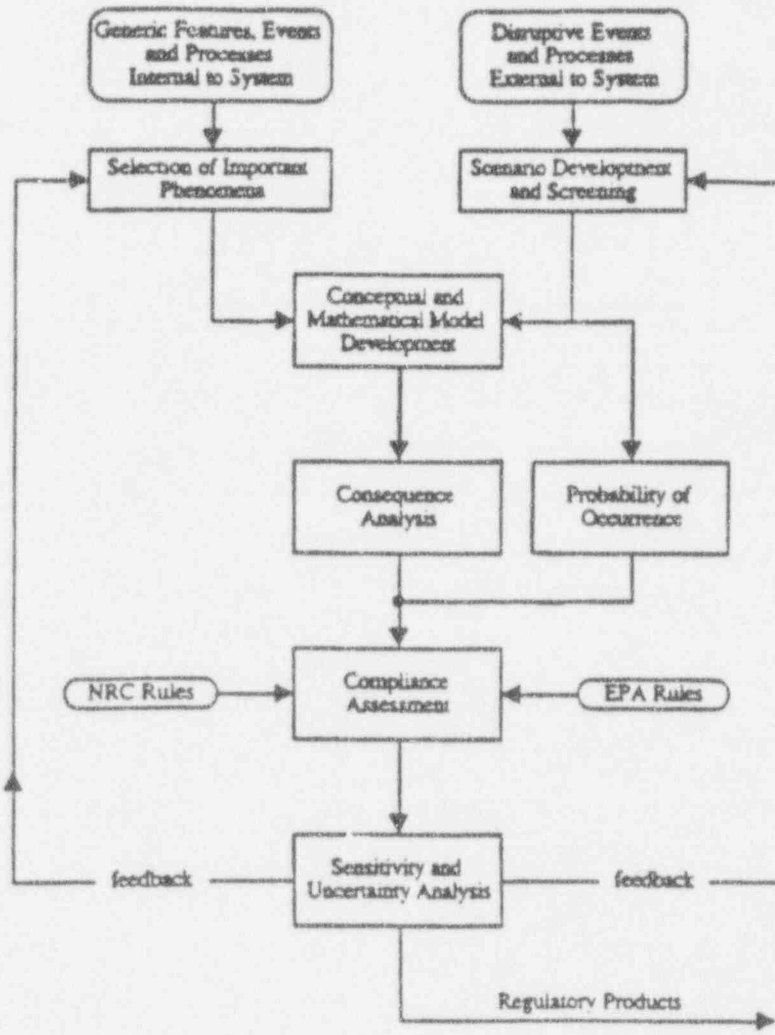

FIGURE 3

SUMMARY OF BUDGETS FOR HL RESEARCH
CONDUCTED AT THE
CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES,
THE NRC/RES AND OTHER LOCATIONS

PROJECT NAME	($K) CNWRA	($K) NRC/RES
Overall Research	161K	230K
Geochemistry (Unsaturated Transport)	85K	300K
Thermohydrology	377K	380K
Seismic Rock Mechanics	508K	500K
Integrated Waste Package Experiments	603K	600K
Stochastic Flow and Transport	172K	300K
Geochemical Natural Analogs	470K	475K
Sorption Mechanisms	459K	475K
Performance Assessment Research	513K	520K
Volcanism of the Basin and Range	340K	350K
Field Volcanism	389K	400K
Tectonics of the Basin and Range	392K	450K
Regional Hydrology	278K	200K
Geochronology	0	250K
Modeling of Mantel Dynamics	0	270K

PROJECT NAME	LOCATION	FUNDING
Validation of Flow & Trans. Through Unsat. Fractured Rock	U. of Arizona	325K
Field Meas. of Crustal Motion in Death Valley	Cal. Tech.	50K
Scale Effects in Fluid Flow	U. of Arizona	125K

TABLE 1

VOLCANIC SYSTEMS OF THE BASIN & RANGE RESEARCH PROJECT

10 CFR 60.122(c)15: EVIDENCE OF IGNEOUS ACTIVITY SINCE THE START OF THE QUATERNARY PERIOD

KEY TECHNICAL UNCERTAINTIES RELATED TO IGNEOUS ACTIVITY:

- Inability to sample igneous features
- Low resolution of exploration techniques to detect and evaluate igneous features
- Development and use of tectonic models related to igneous activity
- Developing a conceptual groundwater flow model
- Prediction of future changes in the hydrologic system (due to tectonism)
- Conceptual model representation of the natural and engineered systems
- Variability in the model parametric values
- Prediction of future system states (disruptive scenarios)

INDEPENDENT RESEARCH IN VOLCANISM IS NEEDED TO:

- Evaluate these KTUs

- Provide a basis to question how DOE research will address the potential consequences of igneous activity on repository performance

- Evaluate DOE's responses to these questions

TABLE 2

FIELD VOLCANISM RESEARCH PROJECT

ACCOMPLISHMENTS IN THE LAST SIX MONTHS [and since project inception]

ACTIVITIES RELATED TO PROVIDING GEOLOGIC INSIGHT INTO PROBABILITY MODELS

- Collection and Analysis of Samples for Petrogenesis Studies [Hill, Luhr]
- Review of Seismic Tomography Method and Application to Small Volume Basaltic Cinder Cone Fields [Sanders, Connor]
- Analysis of Magnetic Field Anomalies Associated with Shallow Intrusions [Parra, Connor]
- Mapping of Shallow Intrusions Associated with Neogene Volcanism in the Basin and Range [Hill, Templeton]
- Review of Literature on Dike-Fault Interaction and Development of Conceptual Models Related to Dike-Fault Interaction [McDuffie, Mahrer, Connor, Young]

ACTIVITIES RELATED TO UNDERSTANDING THE CONSEQUENCES OF VOLCANISM

- Preliminary Study of Diffuse Degassing at Cerro Negro Volcano [Connor]
- Preliminary Study of Energetics of the Cerro Negro Eruption [Connor]

TABLE 3

TECTONICS RESEARCH

KEY TECHNICAL UNCERTAINTY TOPICS

3.2.1.5 STRUCTURAL DEFORMATION

Poor resolution of critical exploration methods and uncertainty in interpretation and modeling techniques available to detect and investigate structural geologic features in the subsurface.

Evaluation of faulting mechanisms in alluvium.

Development and use of conceptual tectonic models as related to structural deformation.

3.2.1.7 CORRELATION OF EARTHQUAKES WITH TECTONIC PROCESSES

Correlation of earthquakes with tectonic features.

3.2.1.8 INCREASING EARTHQUAKE FREQUENCY/MAGNITUDE

Inability to predict the likelihood of earthquake occurence over the next 10,000 years.

Paleofaulting data indicates that seismic activity has migrated randomly from one major range from fault system to another in the Basin and Range ectonic province. Therefore there is considerable uncertainty that the relatively low seismicity at Yucca Mountain will continue over a 10,000 year period.

3.2.1.9 EVIDENCE OF IGNEOUS ACTIVITY

Development and use of conceptual tectonic models as related to igneous activity.

OBJECTIVES

The overall objective is to improve the capability of NRC to review licensing and performance assessment issues related to tectonics.

At this time, the primary goal is to examine the sufficiency of existing data and methods to determine compliance with both the qualitative regulatory requirements, and with the quantitative performance objective.

TABLE 4

KEY TECHNICAL UNCERTAINTIES ADDRESSED BY THE GEOCHEMISTRY RESEARCH PROJECT

- Characterizing the Chemistry of Groundwater in the Partially-Saturated Zone
- Determining the Alteration of Mineral Assemblages Due to Thermal Loading
- Identifying Geochemical Processes that Adversely Affect the EES
- Gas Flow and Gaseous Radionuclide Transport
- Prediction of the Thermal-Mechanical-Hydrological-Chemical Responses of Rock and Groundwater
- Conceptual Model Representations of the Natural System

Objectives:

- Understand Ambient Geochemical Conditions and Potential Changes in Geochemical Conditions and Processes at the Proposed HLW Repository
  - Near-Field Geochemistry
  - Far-Field Geochemistry
- Evaluate Issues and Uncertainties in Predictive Geochemical Models Used in Performance Assessment

Technical Approach:

Task 2 - Geochemical Modeling of Gas-Water-Rock Interactions

Task 3 - Experimental Studies of Mineral-Solution Reaction Kinetics and Equilibria

TABLE 5

SORPTION MODELING FOR HIGH LEVEL WASTE PERFORMANCE ASSESSMENT

TECHNICAL APPROACHES AND OBJECTIVES:

Sorption Experiments:

- Derive sorption data on uranium and other radionuclides
- Evaluate effects of solution chemistry and rock/mineral properties
- Identify sorption processes/mechanisms important to Yucca Mountain environment

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Hydrogeochemical and Sorption Modeling:

- Develop alternative(s) to K_D models
- Use simplified mechanistic approaches to describe and predict radionuclide sorption/retardation
- Evaluate suitability of alternative models to performance assessment needs

KTUs:

- Identity and magnitude of the effects of geochemical processes that reduce radionuclide retardation
- Parametric representation of retardation processes
- Capacity of alteration mineral assemblages to inhibit radionuclide migration
- Effect of degree of saturation on radionuclide sorption

TABLE 6

SEISMIC ROCK MECHANICS RESEARCH PROJECT

LICENSING NEED:

- Compliance Determination with Respect to Thermal-Mechanical/Thermal-Mechanical-Hydrological (Including Repetitive Seismic Load) Effects for Subsurface Facilities Design and Performance Assessment

KEY TECHNICAL UNCERTAINTIES:

- Prediction of Thermal-Mechanical (Including Repetitive Seismic Load) Effects on Stability of Emplacement Drifts and Emplacement Boreholes for Design Review and Input for Waste Package

- Prediction of Thermal-Mechanical-Hydrological (Including Repetitive Seismic Load) Effects on Emplacement Drifts and Emplacement Boreholes to Provide Input for Waste Package and System Performance Assessment

OBJECTIVES:

- Reduce Seismic Related Key Technical Uncertainties that will Affect Repository Design and Performance in Jointed Rocks

- Develop Methodologies to Support:

  - Development of Seismic Design Compliance Determination Method (CDM) for License Application Review Plan (LARP)

  - Preclosure and Postclosure Repository Performance Assessment Relevant to Seismic Loads

  - Review of ESF Title II Design Relevant to Seismic Loads

TABLE 7

SEISMIC ROCK MECHANICS RESEARCH PROJECT
Task 9 — DECOVALEX Modeling

LICENSING NEEDS:

- Compliance Determination with Respect to Thermal Loads for Underground Facility Design and Performance Assessment

KEY TECHNICAL UNCERTAINTY:

- Prediction of Thermal-Mechanical-Hydrological (Including Repetitive Seismic Load) Effects on Emplacement Drifts and Emplacement Boreholes to Provide Input for Waste Package and Total System Performance Assessment

OBJECTIVES:

- Develop Methodologies, Through Participation in DECOVALEX, to Support:
  - Development of Thermal Loads Design Compliance Determination Method (CDM) for License Application Review Plan (LARP)
  - Preclosure and Postclosure Repository Performance Assessment Relevant to Thermal Loads
  - Review of ESF Title II Design Relevant to Thermal Loads

TECHNICAL APPROACH

- To Investigate Suitable Computer Codes for Coupled Thermo-Hydro-Mechanical Modeling
- To Identify Needs for Further Development of Computer Codes
- To Design and Conduct Validation Experiments

TABLE 8

INTEGRATED WASTE PACKAGE EXPERIMENTS PROJECT

KEY TECHNICAL UNCERTAINTIES

- Prediction of Environmental Effects on the Performance of Waste Packages and EBS
- Extrapolation of Short Term and Laboratory Prototype Test Results to Predict Long-Term Performance
- Prediction of Thermomechanical Effects on the Performance of Waste Packages
- Prediction of Release Rate Parameters Such as Size, Shape And Distribution of Penetrations of Waste Packages
- Determining the Magnitude of the Effect of Geochemical Processes that Adversely Affect the EBS
- Characterizing the Chemistry of the Groundwater in Partially Saturated Hydrologic Zone of Yucca Mountain

TECHNICAL APPROACH

- Provide Data Compatible with Models Developed in EBS Program (Use of Short Term Tests for Long-Term Prediction)
- Experimental Verification of Model Predictions and Assumptions
- Study Classes of Materials. Develop Analysis Techniques Applicable to a Wide Range of Materials and Designs
- Prioritize Environmental Factors Using Screening Tests and Target More Detailed Tests on Important Factors (eg.Chloride, pH, Nitrate)
- Guide Long-Term Testing Strategies
- Develop Techniques and Guidance for Integrated Near-field Environment and Waste Package Performance Program

TABLE 9

GEOCHEMICAL NATURAL ANALOGS RESEARCH PROJECT

Selected Key Technical Uncertainties:

- Uncertainty in Modeling Groundwater Flow through Unsaturated Fractured Rock Caused by the Lack of Codes Tested Against Field Data
- Experimental Confirmation of the Basic Physical Concepts of Groundwater Flow through Unsaturated Fractured Rock is Needed
- Equal or Increased Capacity of Alteration Mineral Assemblages to Inhibit Radionuclide Migration
- Uncertainty in Identifying Geochemical Processes that Reduce Radionuclide "Retardation"
- Conceptual Model Representations of the Natural System

Objectives:

Task 1 - Literature Review

- Compile and Evaluate Research Conducted on Natural Analogs Relevant to HLW Contaminant Transport at Yucca Mountain
- Identify Potential Sites at which to Undertake a Natural Analog Study

Task 2 - Site Selection

- Select a Site or Sites with a High Likelihood of Yielding Information on Processes and Events Controlling Contaminant Transport in a Yucca Mountain Repository

Task 3 - Data Acquisition

- Develop Methodologies for Data Acquisition and Implement Those Methodologies for the Analog Sites

Task 4 - Interpretation of Data and Modeling

- Interpretation of Data Collected for the Analog Sites
- Development of Conceptual and Numerical Models for the Geochemical Evolution of the Sites
- Evaluation of the use of Data from Natural Analogs for Support of Performance Assessment Modeling of a Yucca Mountain Repository

TABLE 10

PERFORMANCE ASSESSMENT RESEARCH

REGULATORY BASIS:

- 10 CFR 60.112 - Overall System Performance Objective for the Geologic Repository After Permanent Closure

KEY TECHNICAL UNCERTAINTIES (KTUs):

- Prediction of Future System States (Task 1)
- Conceptual Models of Natural and Engineered Systems (Task 1)
- Validation of Mathematical Model (Task 3)

OVERVIEW OF PROJECT:

- Conceptual Model Development
  - Disruptive Scenarios
  - Matrix-Fracture Interactions
  - Near-Field Flow Phenomena
- Computational Model Development
  - Parallel Algorithms
  - Numerical Methods for Flow and Transport
- Model Evaluation
  - INTRAVAL
  - Validation of Flow Models

TABLE 11

PERFORMANCE ASSESSMENT RESEARCH

CONCLUSIONS FROM YUCCA MOUNTAIN IMPLEMENTATIONS:

- Climate Change
  - Infiltration Rates: Highly Variable Between Assessments
  - Temporal Probability Model: Not Currently Modeled
- Volcanism
  - Indirect Effects: Not Currently Modeled
  - Hydromagmatic Effects: Currently Assumed Effusive
  - Spatial and Temporal Probability Models: Currently Uniform Models
- Human Intrusion
  - Indirect Effects: Not Currently Modeled
  - Drilling Frequency: Highly Variable Between Assessments
- Seismo/Tectonics
  - Effects on Borehole and Drift Stability: Not Currently Modeled
  - Aseismic Effects: Not Currently Modeled
  - Secondary Faulting: Only EPRI Considered
  - Waste Package Impingement: Only NRC Considered

TABLE 12

STOCHASTIC ANALYSIS OF LARGE SCALE FLOW AND TRANSPORT IN UNSATURATED FRACTURED ROCK

REGULATORY BASIS: 10 CFR 60.113(a)(2) Groundwater Travel Time
10 CFR 60.122(b)(7) Favorable Conditions

KEY TECHNICAL UNCERTAINTIES:

Spatial Variability of Hydrogeologic Model Parameters and its Effect on Groundwater Travel Time Uncertainty

Developing a Conceptual Groundwater Flow Model that is Representative of the Yucca Mountain Flow System

Determining Effective Hydrogeologic Characteristics for Unsaturated Media

OBJECTIVES:

- Data Review and Modeling Approaches (Task 1)
- Submodels and Separate Effects (Task 2)
- Large-Scale Flow and Transport Simulations and Analyses (Task 3)
- Reporting of Results (Task 4)
- Enhancement and Documentation of BIGFLOW (Task 5)
- Effective Hydraulic Property Calculations (Task 6)

TABLE 13

REGIONAL HYDROGEOLOGIC PROCESSES OF THE DEATH VALLEY REGION

KEY TECHNICAL UNCERTAINTIES:

- Development of a Conceptual Flow Model that is Representative of the Yucca Mountain Site Groundwater Flow System
- Appropriateness of Assumptions and Simplifications in Mathematical Models
- Determining the Fastest Path of Likely Radionuclide Travel from the Disturbed Zone to the Accessible Environment
- The Nature of the Large Hydraulic Gradient Located North of Yucca Mountain
- Adverse Effects of Future Groundwater Withdrawals on the Flow System
- Ability to Predict Location and Quantity of Future Groundwater Withdrawals
- Conceptual Model Representations of Natural and Engineered Systems
- Spatial and Temporal Variability of Model Parametric Values

OBJECTIVES OF PROJECT:

- Construct a Strategy for Assessing Existing and Alternative Conceptual Models of the Regional Hydrogeologic Regime.
- Establish a Framework for Determining the Likelihood that Models of the Regional Flow System Developed by the Applicant Incorporate Those Features, Processes, and Events that Have the Potential to Compromise Repository Safety.

TABLE 14

THERMOHYDROLOGY RESEARCH PROJECT

KEY TECHNICAL UNCERTAINTIES:

- Determining the Extent of the Disturbed Zone
- Uncertainty in Identifying Which Conceptual Models Adequately Represent Isothermal and Nonisothermal Liquid and Vapor Phase Movement of Water through Unsaturated Fractured Rock at Yucca Mountain
- Uncertainty in Modeling the Formation of Perched Zones by Thermally Driven Flow
- Gas Flow and Gaseous Radionuclide Transport
- Prediction of the Evolution of Groundwater Conditions Near and Within the Engineered Barrier Systems (EBS)
- Prediction of Environmental Effects on the Performance of Waste Packages and the Engineered Barrier System (EBS)

OBJECTIVES:

- Assess DOE activities Through an Improved Understanding of Thermohydrologic Phenomena in Partially Unsaturated Media
- Quantify Observable Performance-Affecting Thermohydrologic Phenomena using Laboratory Experiments
- Investigate Thermohydrologic Phenomena and Evaluate Mathematical Models using Numerical Simulations
- Relate Laboratory Results to Field-Scale Experiments and Repository Setting through Similitude

TABLE 15

TASK 10: HYDRAULIC/PNEUMATIC TRACER FIELD TESTS

UAz Investigators: Amado Guzman (Doctoral Candidate)
Shlomo P. Neuman (Faculty Advisor)

Technical Objectives:

This task addresses some of the key technical uncertainties and user needs described in the NRC High-Level Radioactive Waste Research Program Plan (Nureg. 1406). In particular, the proposed activities are designed to:

1. Determine the relationship between hydrologic parameters obtained for pneumatic and hydraulic tests

2. Extend the existing data base for the Apache Leap Tuff Site (ALTS) to determine both the spatial variability and the statistical distribution of the permeability

3. Understand the relationship among measurements performed at different scales and their compatibility with the scale of the conceptual and mathematical models

4. Evaluate the applicability of existing flow and transport models to unsaturated fractured rock at the measurement scales at the ALTS

TABLE 16

SUBTASK 11.1:
CARBON AND NOBLE GAS ISOTOPES AS INDICATORS OF TRAVEL TIMES AND FLOW PATH IN FRACTURED UNSATURATED TUFT

UAz Investigators:	Gregg R. Davidson (Doctoral Candidate) R.L. Bassett (Faculty Advisor)
Collaborators:	Heinz Loosli (University of Bern, Switzerland) Bernhard Lehman (University of Bern, Switzerland) William Murphy (CNWRA)

Technical Objectives:

Key Technical Uncertainties as identified in NRC (1993), "There is a great uncertainty in determining the relative proportion of fracture versus matrix flow in the unsaturated zone, including identification of the conditions and/or which fracture flow will dominate."
(p. A-42 NRC, 1993)

Specific Objectives of this research are:

1. Test the assumption that formation air and unsaturated zone pore water are in isotopic equilibrium with respect to carbon.

2. Determine the impact of pore water extraction by compression techniques on pore-water chemistry.

3. Compare carbon-14 results with noble gas isotopic measurements to determine the reliability of carbon-14 for travel time estimates.

4. Determine the time and flow pathway required for surface runoff to reach the perched aquifer.

5. Determine the mass balance of carbon in the unsaturated zone.

TABLE 17

SUBTASK 11.2:
Uranium Isotope Constraints on Vadose Zone Moisture Movement in a Fractured Tuff

UAz Investigators: Ernest Hardin (Doctoral Candidate)
R.L. Bassett (Faculty Advisor)

Collaborators: Fred Pallait (USGS)

Technical Objectives:

The study will examine total U and $^{234}U/^{238}U$ in rock and water samples representing two generalized pathways at Apache Leap: rapid recharge to the perched zone through fractures, and slower recharge mostly through the tuff matrix. It is anticipated that this could lead to an approach for characterizing the recent history of pore water encountered underground at Yucca Mountain. An ancillary benefit would be greater understanding of conditions that contribute to U retardation in situ.

Objectives:

1. Characterization the variation of $^{234}U/^{238}U$ and total U, together with major ions and other trace metals, in groundwater of the vadose zone/perched system at Apache Leap.

2. Examine the relationship between $^{234}U/^{238}U$ ratio measurements in associated samples of groundwater and rock.

3. Characterize U source minerals and U-bearing secondary minerals along generalized vadose zone and perched aquifer flow pathways.

4. Identify reaction path models consistent with groundwater chemical analyses and petrographic data, and compare with indications of U retardation reactions based on total U and $^{234}U/^{238}U$ measurements.

TABLE 18

SUBTASK 13.1:
INVESTIGATION OF A PERCHED WATER ZONE

UAz Investigators: Betsy Woodhouse (Doctoral Candidate)
R.L. Bassett (Faculty Advisor)

Collaborators: Ginny Colten-Bradley (USNRC)
Gary Stirewalt (USNRC)

Technical Objectives:

Key Technical Uncertainties as identified by NRC (1993) include the potential for perched water bodies to form and saturate parts of a repository in the vadose zone. To address this uncertainty, the potential for future perched water bodies to form must be predicted. Predictions would depend on a knowledge of the flow behavior of water in unsaturated fractured rock for different flux rates through Yucca Mountain. At present there is much uncertainty about how to collect unsaturated hydrologic property data for fractures and how to model unsaturated fracture flow. The NRC will therefore need to conduct independent research.

The following objectives will be pursued at the Apache Leap Research Site:

1. Determine the cause for a reduced hydraulic conductivity zone where perched water occurs.

2. Determine the recharge mechanisms for the perched zone.

3. Study flow through fractures as a mechanism for recharge to the perched zone.

4. Determine the recharge rate, or travel time from surface precipitation to recharge at the perched zone.

TABLE 19

SUBTASK 13.2:

ESTIMATION OF GAS TRANSPORT PARAMETERS IN UNSATURATED FRACTURED TUFF

UAz Investigators: Alan M. Geddis (Doctoral Candidate)
R.L. Bassett (Faculty Co-Advisor)
P.J. Wierenga (Faculty Co-Advisor)

Collaborator: Mr. Edwin P. Weeks (USGS, Denver)

Technical Objectives:

1. Molecular diffusion of atmospheric chlorofluorocarbons will be estimated. Preliminary results from a solution by Weeks, et. al (1982), suggests D_{eff} = 0.0632 m^2/d as a first approximation for F-11 in ALRS tuff matrix material. A reliable detection limit in the parts per trillion by volume (ppt_v) range should allow estimation of F-11 concentration to the 100 ft depth (vertical) not considering the effect of fractures, which may enhance gas movement. Matrix gas from core squeezing will be collected, and tested for CFC content. This may address parts of user needs 401, 404, 703.

2. Fundamental physical properties of tuff that pertain to gas flow need to be evaluated further. At present a thermodynamically "correct" air pycnometer is being machined. This instrument can accurately estimate the air filled porosity of core samples taken during drilling. Basic and necessary material parameters such as particle density and air-filled porosity at various water contents will be measured. Knowledge of this type of tortuosity can aid in estimating an effective diffusion coefficient. All 650 ft of core has been recovered and stored for this type of use. This may address parts of user needs 401, 404, 703.

3. Various existing FORTRAN computer models can be applied to the observed data. Sensitivity analysis of various parameters such as tortuosity will be performed. Interesting new methods as in Nilson et. al, (1990,91a,91b) could be tested. This could address parts of user need 403.

TABLE 20

SUBTASK 11.3: **Modeling Transport in a Finite Fracture Network**

UAz Investigators: Thomas M. Fitzmaurice (M.S. Candidate)
R.L. Bassett (Faculty Advisor)

Collaborators: Amvrossios C. Bagtzoglou (CNWRA)

Technical Objectives:

Key Technical Uncertainty is the same as SUBTASK 10.1

Specific Objectives of this research are:

1. Use the model NEFTRAN to simulate transport of solute through a fracture network analogous to the zone between Queen Creek and the Never Sweat Tunnel.

2. Use identified hydraulic parameters from the site to match the observed breakthrough curves for electrical conductivity data.

3. Optimize the parameters to fit the data and determine if these new parameters fit within the range of variability of the actual measurements.

TABLE 21