

U.S. DEPARTMENT OF ENERGY  
OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT

**NUCLEAR WASTE TECHNICAL REVIEW BOARD  
EBS PANEL MEETING**

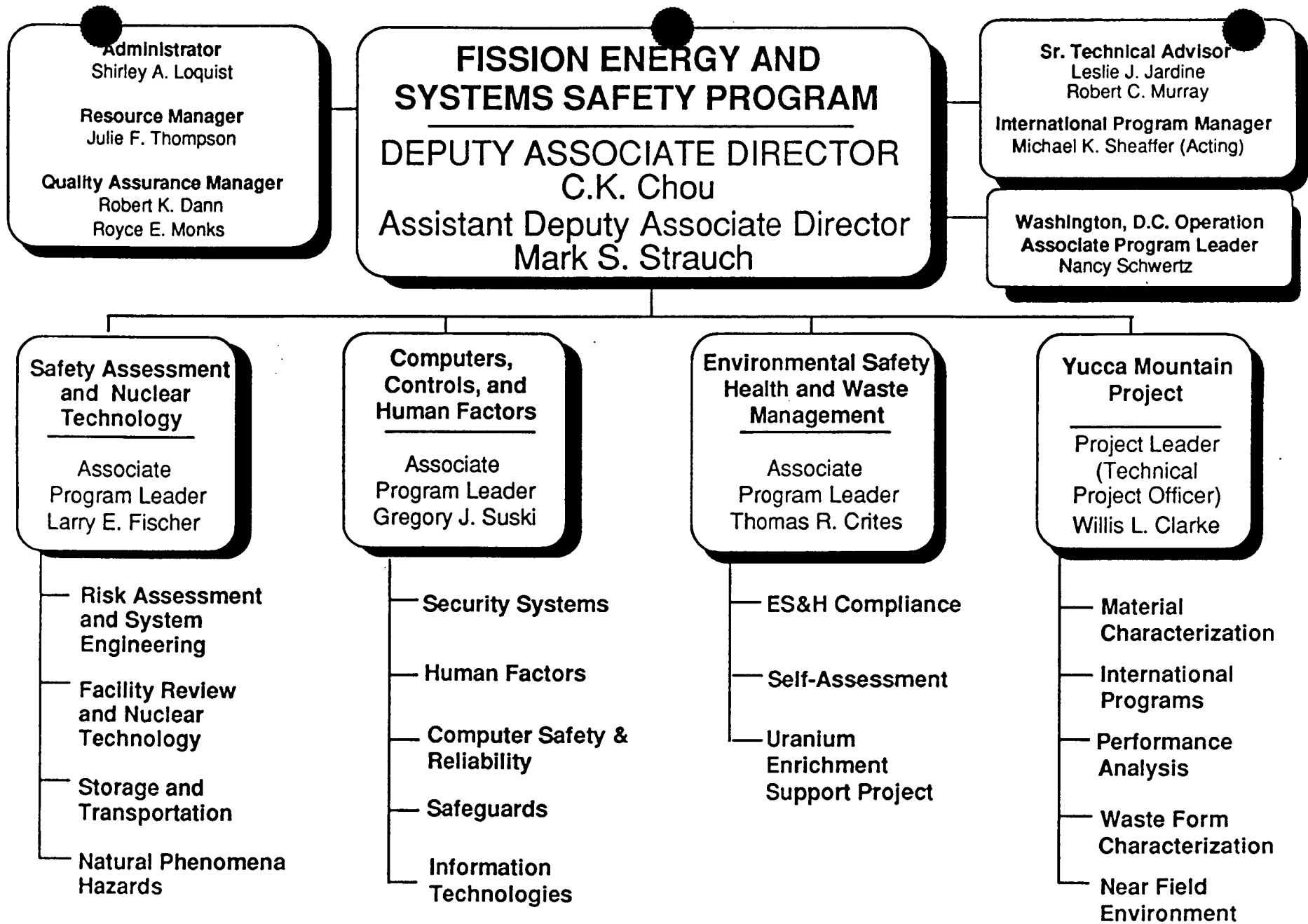
**SUBJECT: OVERVIEW OF  
OCRWM-SPONSORED ACTIVITIES  
AT LLNL**

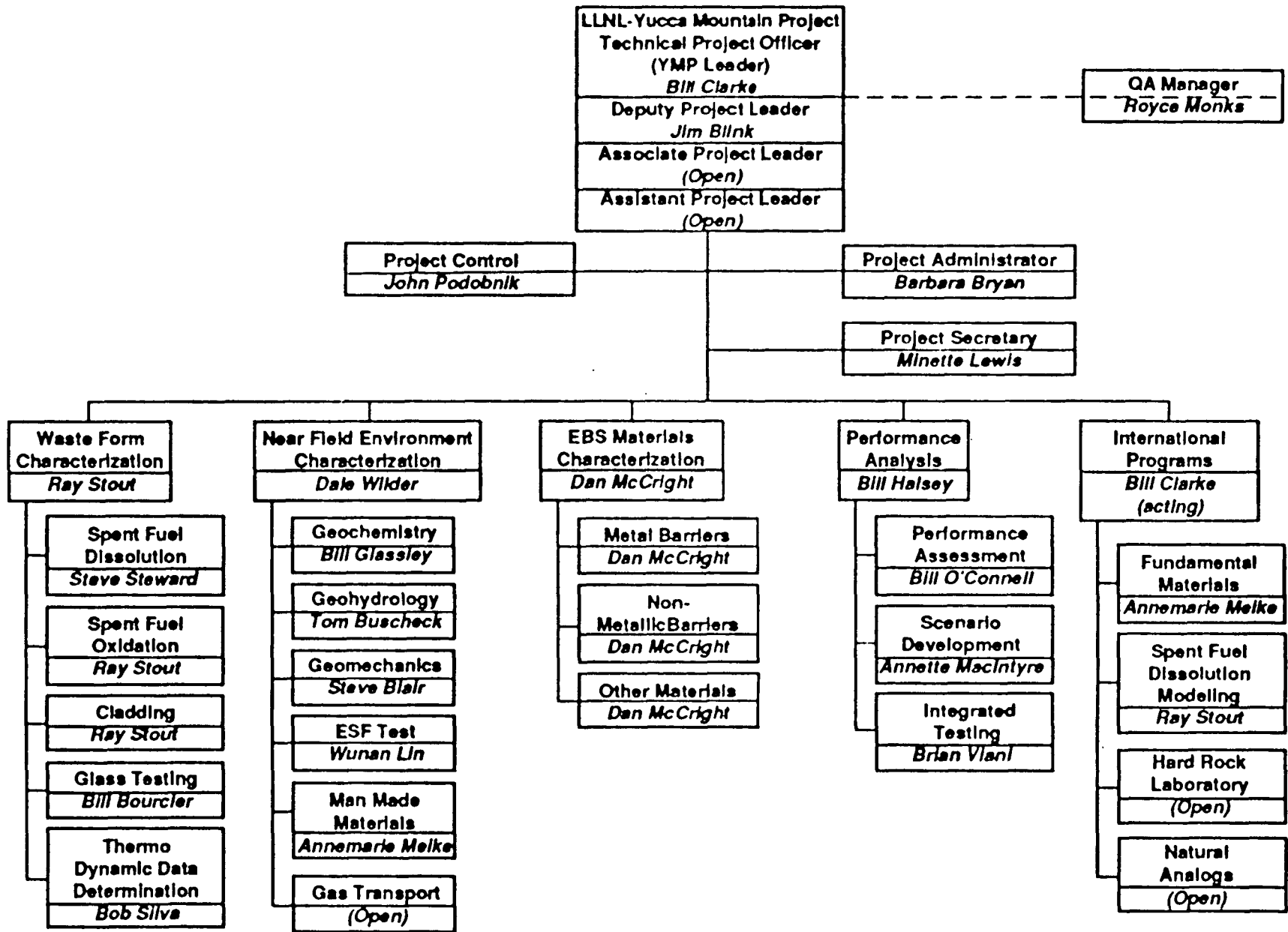
**PRESENTER: WILLIS L. CLARKE**

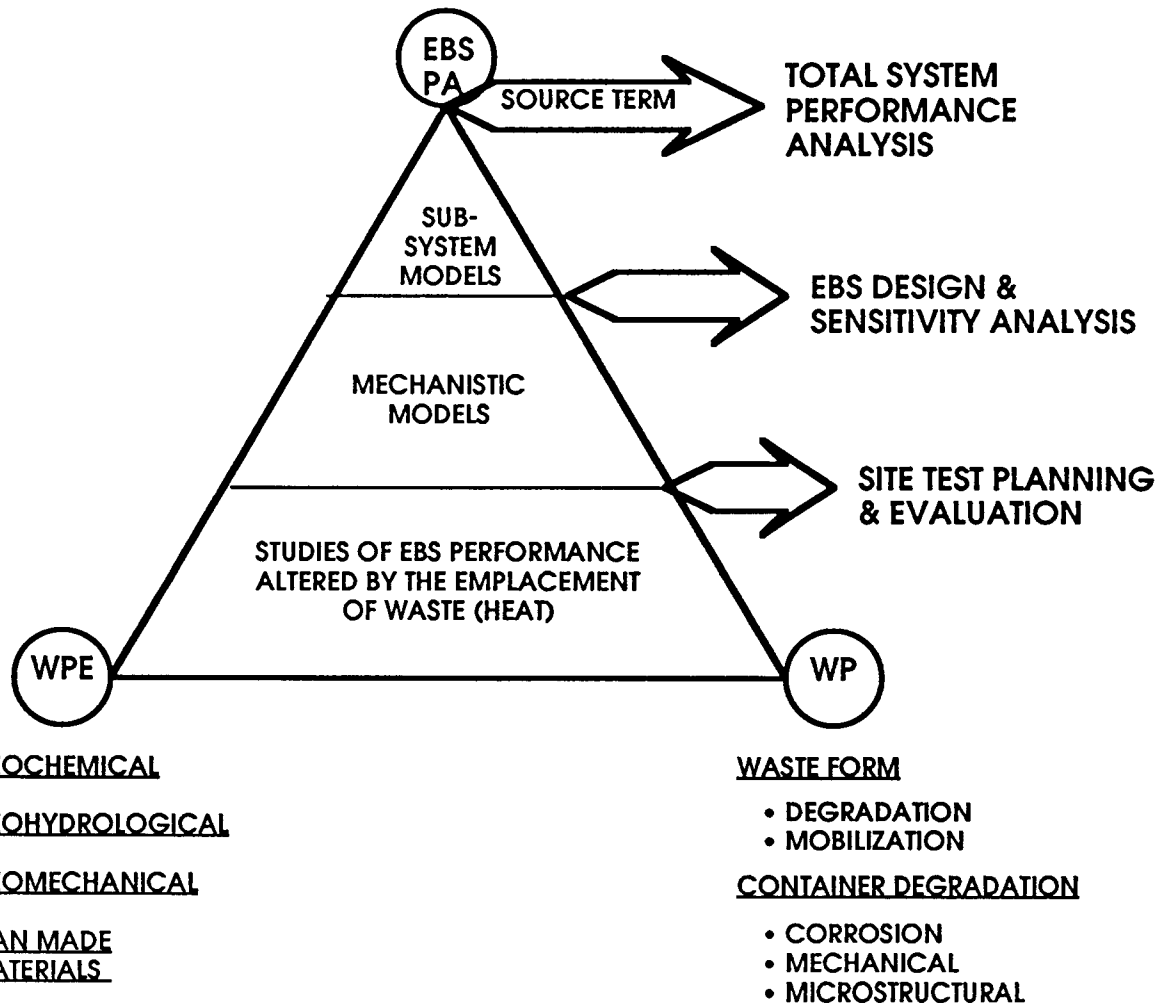
**PRESENTER'S TITLE  
AND ORGANIZATION: TECHNICAL PROJECT OFFICER  
LLNL-YUCCA MOUNTAIN PROJECT  
LIVERMORE, CA**

**PRESENTER'S  
TELEPHONE NUMBER: (510) 423-4571**

**PLEASANTON, CALIFORNIA  
MARCH 10-11, 1994**



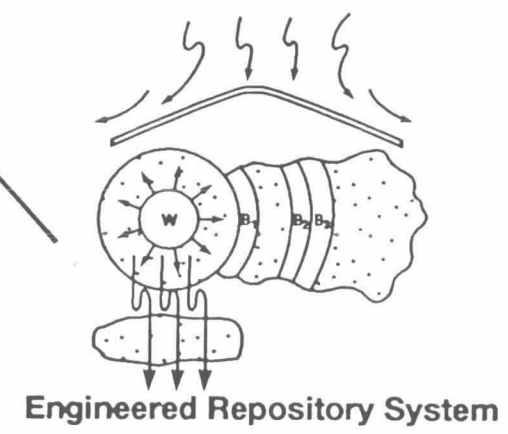
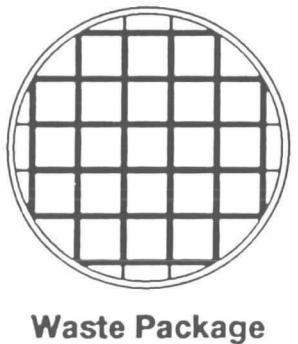
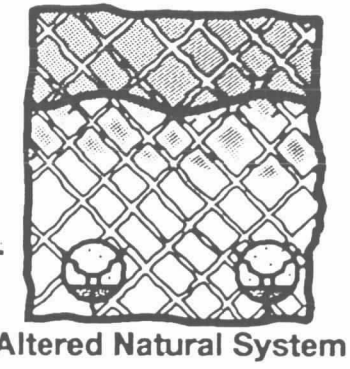
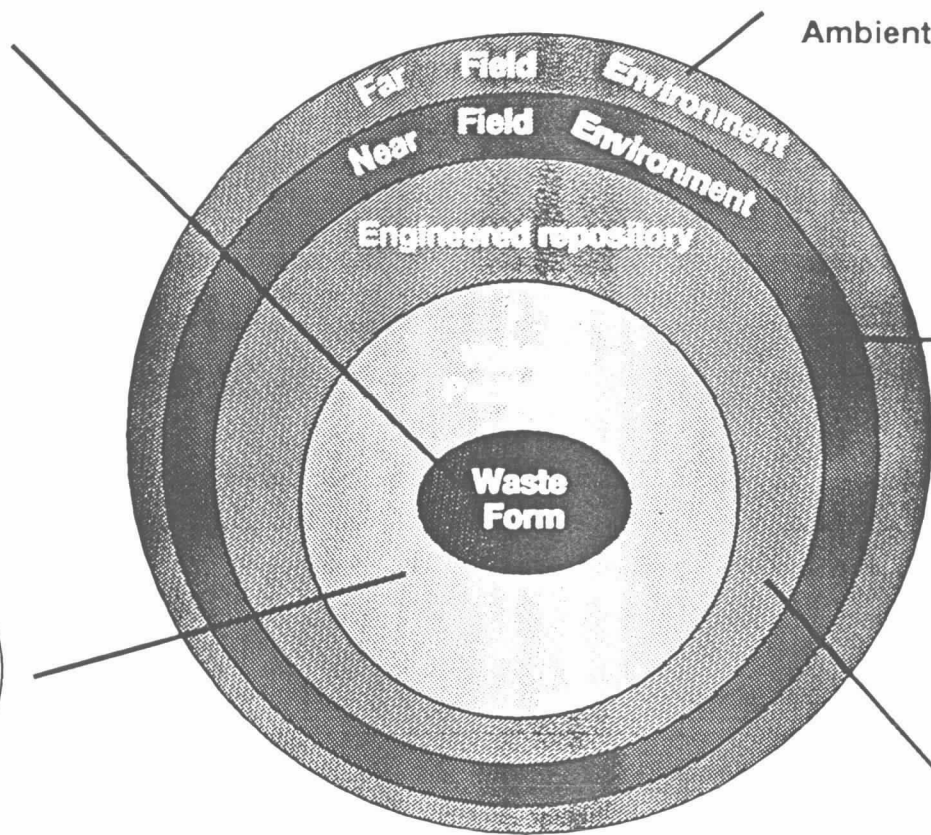
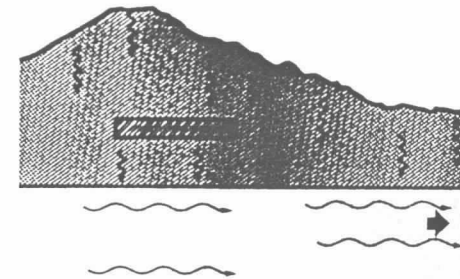
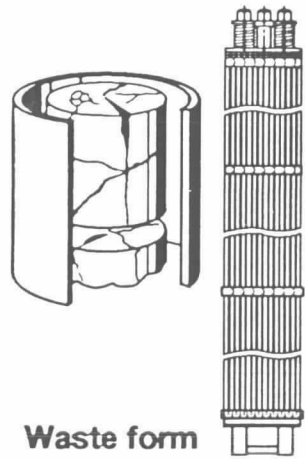




## LLNL ROLE IN THE YUCCA MOUNTAIN PROJECT

- PROVIDE THE TECHNICAL BASIS FOR THE DEVELOPMENT OF EBS MULTIPLE BARRIER DESIGN CONCEPTS
- CHARACTERIZATION OF THE WASTE PACKAGE ENVIRONMENT
- CHARACTERIZATION OF MATERIALS PERFORMANCE FOR WASTE PACKAGE AND ASSOCIATED EBS COMPONENTS
- CHARACTERIZATION OF DEGRADATION AND PERFORMANCE OF RADIOACTIVE WASTE FORMS
- DEVELOPMENT OF MODELS AND COMPUTER CODES TO PREDICT PERFORMANCE OF EMPLACED WASTE PACKAGES AND EBS COMPONENTS
- BULK OF TECHNICAL ACTIVITIES SUPPORTED IN WBS 1.2.2; BUT SOME SUPPORT IN 1.2.1, 1.2.3, AND 1.2.5

# Repository performance defense in depth



Bill Clarke - (510)-(423-4571)  
LLNL YMP - Project Manager

# Engineered Barrier System/Near Field Environment Performance Assessment

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## Objective:

EBS/NFE Performance Assessment integrates and abstracts the detailed mechanistic process models to produce subsystem models describing EBS performance. These models are then used for: test planning, design analysis, subsystem performance analysis and total system PA source term.

## Products:

### • Model Development:

Integrate abstractions of detailed: Geo-Hydrology, Geo-Chemistry, Geo-Mechanics, Container corrosion, Man-made materials, Waste form degradation (SNF and DHLW), Radionuclide mobilization and transport:

PANDORA - Detailed time evolution of a single waste package

YMIM - Integrated EBS/NFE subsystem description

### • Model Applications:

- Source Term For Total System Performance Assessment
- Subsystem regulatory compliance analysis
- EBS design support analysis
- Test planning and analysis
- Sensitivity and uncertainty studies

# **Waste Form Characterization Activities**

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## **Objective:**

- **To provide data, testing, and models for the physical properties, the degradation responses, and the radioactive release responses of spent fuel and glass waste forms for waste package and system performance assessments in the Yucca Mountain Project.**

## **Product:**

- **Preliminary Waste Form Characteristics Report (MO3)**

## **Contents are the available**

- **Physical property data for existing and projected SFWP and DHLW inventories**
- **Radionuclide data for existing and projected SFWP & HDLW inventories**
- **Test data and models for potential release rates from SFWP & DHLW**

# Waste Form Characterization Activities



<b>Model Development and Testing Activities</b>		<b>Status</b>
<b>Material Characterization Center</b>	<b>Characterize Spent Fuel at PNL</b>	<b>ongoing</b>
<b>Gaseous Release Response</b>	<b>Modeling – LLNL Tests – PNL</b>	<b>delayed</b>
<b>Cladding Failure Response</b>	<b>Modeling – LLNL Tests – PNL</b>	<b>delayed</b>
<b>SFWF Oxidation Response</b>	<b>Modeling – LLNL Tests – PNL &amp; AECL</b>	<b>ongoing</b>
<b>SFWF Dissolution Response</b>	<b>Modeling – LLNL &amp; AECL Tests – PNL, ANL, AECL, LBL &amp; LLNL</b>	<b>ongoing</b>
<b>Hardware Dissolution Response</b>	<b>Modeling – LLNL Tests – PNL &amp; ANL</b>	<b>delayed</b>
<b>Glass Waste Form Response</b>	<b>Modeling – LLNL Tests – ANL &amp; LLNL</b>	<b>ongoing</b>
<b>Thermo-Chemical Data (GeoChemical Solution Response)</b>	<b>Modeling – LLNL Tests – PNL, ANL &amp; LLNL</b>	<b>ongoing</b>



# **Materials Characterization Activities**

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- Objective:** To provide assessment of relevant degradation modes, test data and model development to (1) recommend materials for construction of the waste package, and (2) predict the long-term performance of these materials to meet the containment and controlled release objectives
- Products:**
- Engineered Materials Characterization Report (EMCR) (Summer 1994)
  - Survey on Non-Metallic Barrier Materials (end FY94)
- Contents:**
- Corrosion and oxidation behavior of candidate container materials relevant to Yucca Mountain environmental conditions (EMCR)
  - Supporting physical, mechanical, and microstructural properties of candidate container materials (EMCR)
  - Status of technology on fabricating non-metallic barriers (survey)
- Interaction with Design Team:**
- Formal participation in Design Interface Workshops
  - Informal and frequent contact with DOE/M&O design team participants

# **Near Field Environment Characterization**

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## **Objective:**

**To provide sufficient understanding of the environment that interacts with the components of the EBS, including waste package, waste form, and man-made materials to allow design of the EBS and assessment of its performance.**

**An important part of this characterization is to assess the environmental changes that result from emplacement of waste and thus this is not just a characterization of environment as it exists now.**

## **Products:**

- Near-Field Environment Report**
- Model and Technique Development**

## **Focus Areas**

- The amount, physical state, and chemistry of fluids that can contact waste package containers, waste form or other EBS components**

## **Near Field Environment Characterization (cont.)**

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- **The mechanical loading that can be imposed on WP containers, waste form or other EBS components.**
- **Thermal environment of EBS system**
- **Formation of colloids due to interaction with and between man-made materials**
- **Potential biological activity interactions with EBS**
- **Natural system electrical potential interactions with EBS components**
- **Transport and retardation mechanisms in altered natural system**

### **Discipline or technical specialty areas:**

- **Geochemistry**
- **Geohydrology/hydrothermal**
- **Geomechanics**
- **Man-Made Materials**
- **Field Tests**

# ORIGINAL TESTING OBJECTIVES

- 1. Understand effect of thermal pulse on hydrology/ geochemistry of altered zone**
- 2. Understand changes in waste package environment and altered zone that will influence water chemistry**
- 3. Understand environmental conditions that could cause waste package failure and mobilization of waste, i.e. provide input to design of material selection and emplacement configuration**
- 4. Predict transport of radionuclides through engineered barrier system and altered zone**
- 5. Understand how coupled processes in altered zone will impact waste package performance; provide input to total system performance assessment**

# **REASONS FOR TESTING OBJECTIVES**

- 1. For engineered barrier system release rates (Issue 1.5) need to understand changes in geochemical conditions that could alter radionuclide transport properties of host rock**
- 2. For ground-water travel time (Issue 1.6) need to understand geochemical data relevant to determining the extent of the disturbed zone**
- 3. For waste package characteristics (Issue 1.10) and seal characteristics (Issue 1.12) need to understand vadose zone water chemistry**

# **EVOLUTION OF DEFINITION OF NEAR-FIELD**

- 1. Original extent of near-field was borehole wall**
- 2. Next, near-field was some meters away from waste package depending on process of consideration**
- 3. Recognized that a larger zone than the near-field would be affected by heat; termed this the altered zone. Will examine extent of heat effect in this region**

# **PROGRAMMATIC INFLUENCES IN EVOLUTION OF THINKING**

- 1. Letter from NRC allowed DOE to take credit for more than 1000 years of substantially complete containment; this allowed use of the extended dry concept**
- 2. Emphasis of international community on long-term containment influenced enhancement of engineered barrier system and altered zone characterization studies**
- 3. More emphasis on man-made materials; developed into its own study**

# APPROVED CHANGES TO TESTING OBJECTIVES

- 1. Addition of altered zone characterization studies**
- 2. Man-made materials activity was separated from geochemistry of waste package environment and made into its own study**
- 3. Addition of large block test at Fran Ridge**
- 4. WBS changed from 1.2.2.2 and 1.2.2.3.4 to 1.2.3.12 and 1.2.3.10.3 for better consolidation of testing objectives**



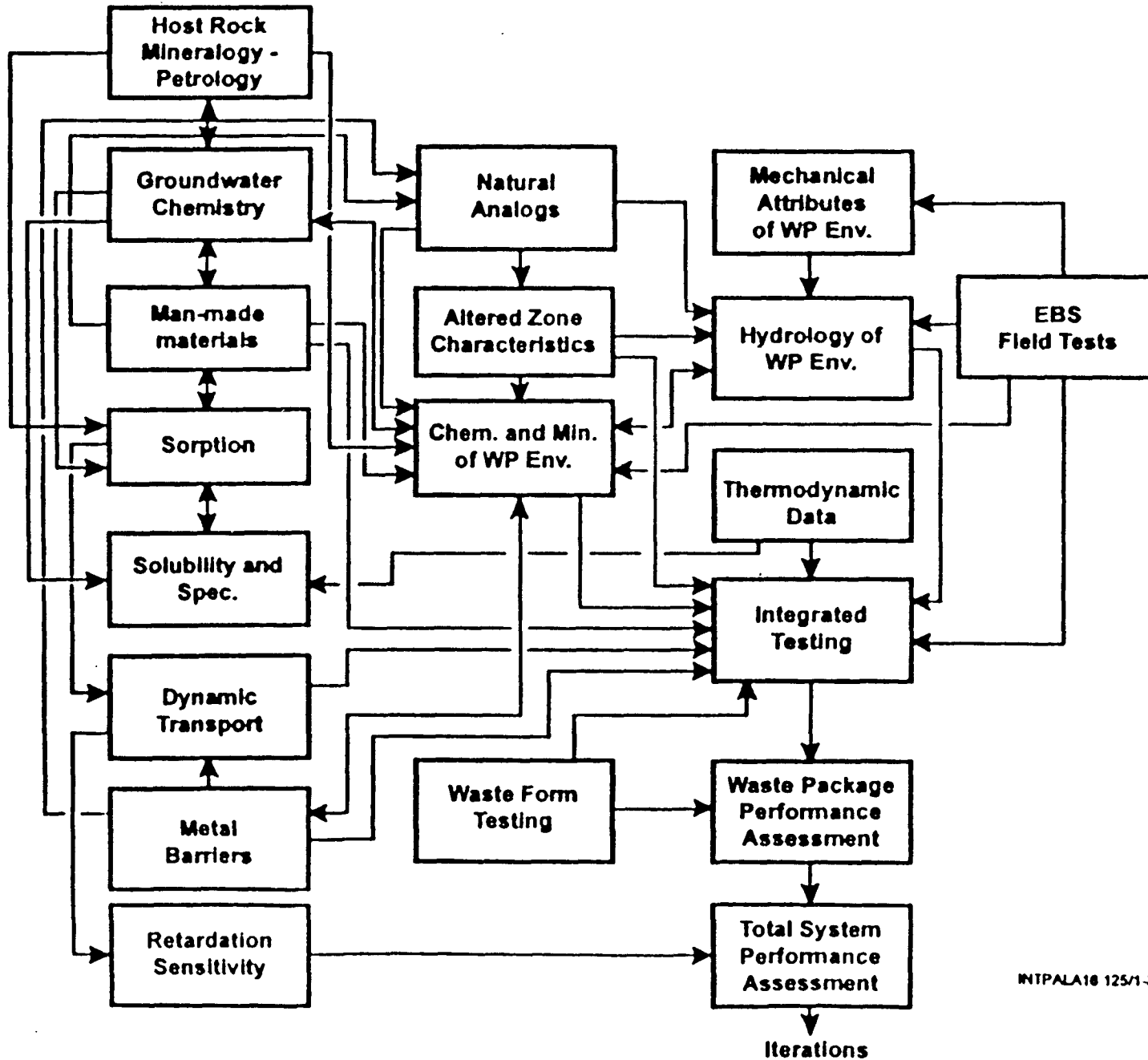
# **RECOMMENDED CHANGES TO TESTING OBJECTIVES**

- 1. Early access to large-scale heater test to test hydrologic models and all other temperature-dependent models**
- 2. Acceleration of man-made materials investigations**
- 3. Greater emphasis on characterization of altered zone properties and processes**
- 4. Reevaluate interface between information needs as applied to altered zone**

# **INTEGRATION WITH OTHER TECHNICAL ELEMENTS**

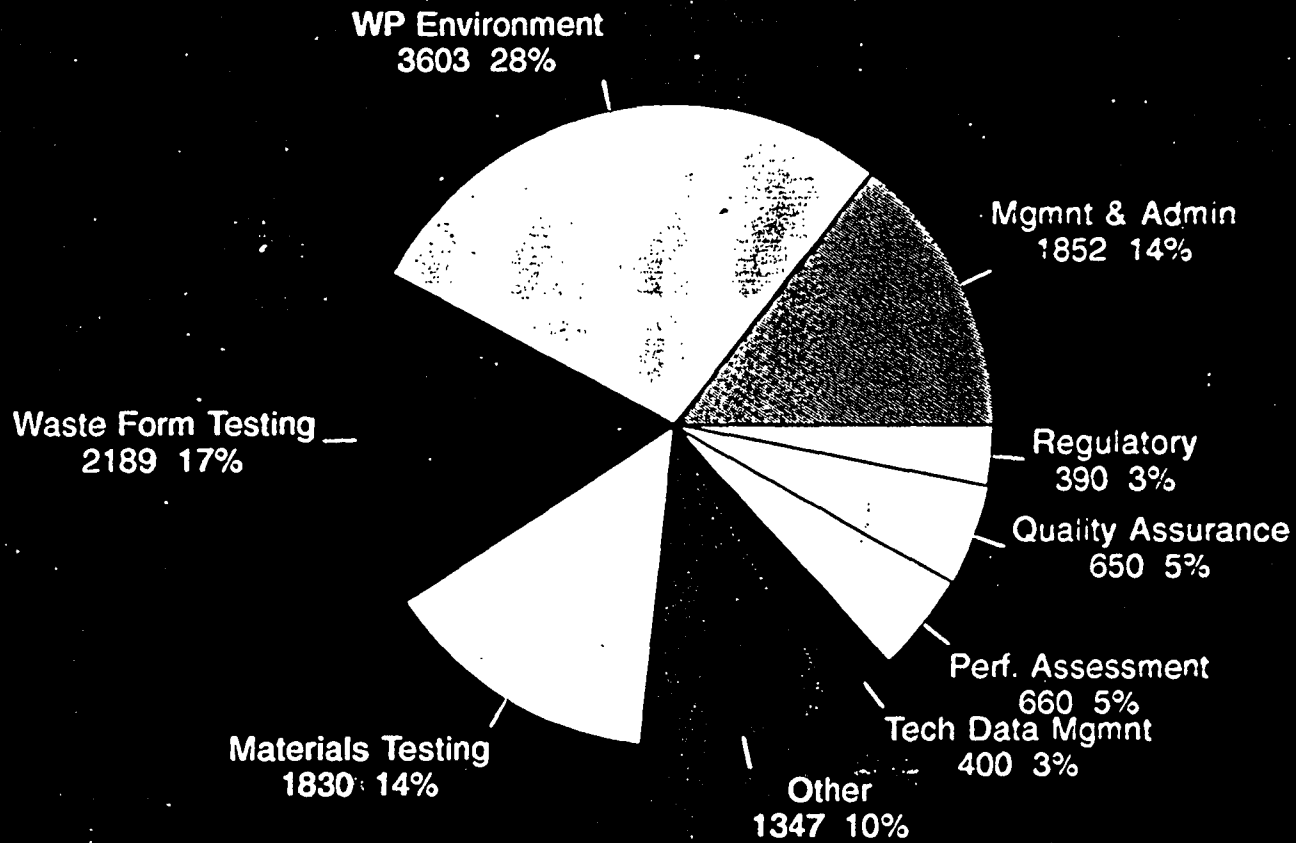
- 1. Integrated testing will link geochemistry studies**
- 2. Links to waste package and repository design and to performance analyses**
- 3. Inputs from unsaturated and saturated zone hydrology and geochemistry**
- 4. International programs**
- 5. Coordination/integration through GIT, HITF, and Solubility Working Group**

# FLOW OF INFORMATION - RADIONUCLIDE MIGRATION



# DISTRIBUTION OF BUDGET BY TECHNICAL AREA

## LLNL-YMP - FY 1994



Total LLNL-YMP Budget = \$12,921