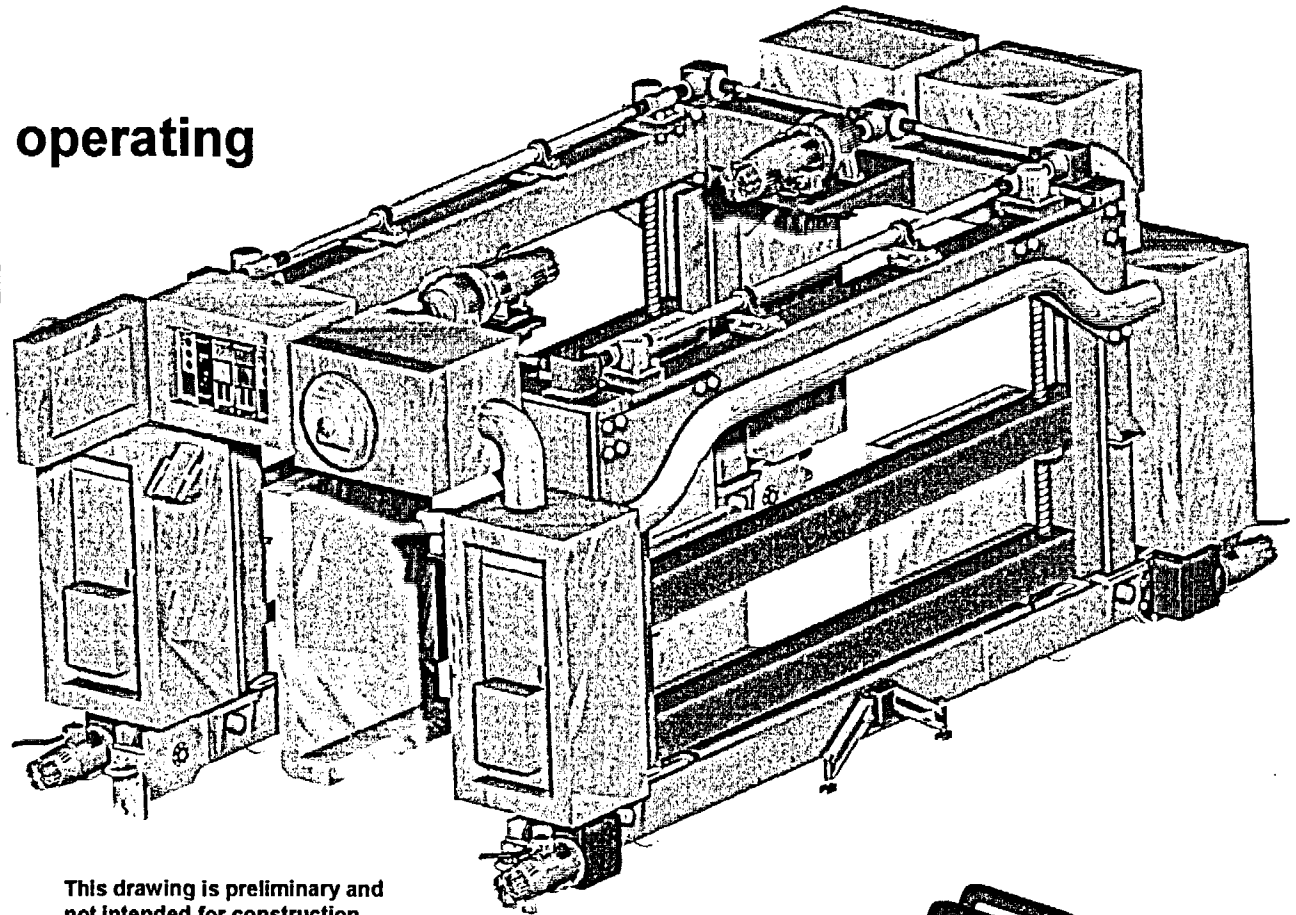


# Emplacement Gantry

- Moves and emplaces waste packages on pallets within emplacement drift
- 40-60 tons weight
- 1.7 mph maximum operating speed
- Remote controlled



This drawing is preliminary and not intended for construction, procurement, or fabrication.

# Subsurface Facility Preliminary Preclosure Safety Analysis and Classification Results

- There are no Category 1 or Category 2 event sequences in the subsurface facilities
- Structures, systems, and components that prevent Category 1 or Category 2 event sequences are important to safety
- The following structures, systems, and components are important to safety because they are credited with prevention:
  - Waste package
  - Waste package transporter
  - Emplacement gantry



# Subsurface Facilities Preliminary Classification Results

- The following features are important to waste isolation because they are important to meeting 10 CFR 63.113 performance objectives
  - Subsurface facility
  - Drift inverts
  - Drip shields
  - Saturated zone (between repository and accessible environment)
  - Unsaturated zone (above and below the repository)
  - Waste packages
  - Commercial and naval spent nuclear fuel cladding
  - Waste form



# **Subsurface Facilities As Low As Is Reasonably Achievable and Worker Safety**

- **Unshielded waste packages are transported in a shielded transporter**
- **Drift turnouts are designed to reduce the dose rates in the access mains**
- **Emplacement drift ventilation control doors also provide personnel access control**
- **Differential pressure between emplacement and development areas**





# Waste Package



# Waste Package Design Process

- **Design for preclosure**

- **Waste package is designed such that breach is beyond Category 2 for postulated event sequences to support the Preclosure Safety Analysis**
- **The following postulated event sequences will be evaluated:**
  - ♦ **Object falls onto the waste package**
  - ♦ **Waste package drops, dynamic events, swingdowns, tipovers, etc.**
  - ♦ **Vibratory ground motions**
  - ♦ **Parametric fires**
  - ♦ **Preclosure design-basis rock fall**



# Waste Package Design Process

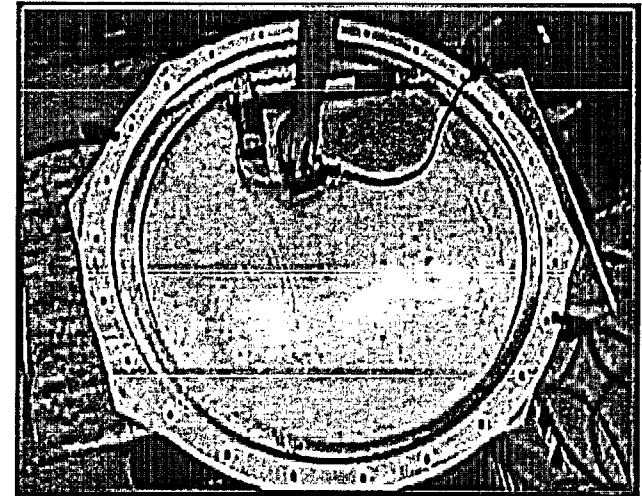
(Continued)

- **Analyze for postclosure**
  - **Analyze postulated events (drip shield installed) and provide information to support model abstractions for total system performance assessment, including assessment of corrosion potential**
    - ♦ **Damage from rock fall**
    - ♦ **Damage from vibratory ground motion**
    - ♦ **Weld flaw distribution**
    - ♦ **Waste package and weld area stress state**



# Waste Package Mockups

- **FY 2000 waste package mock-up (based on site recommendation design)**
  - Fabricated a quarter-length test mock-up to investigate the feasibility of fabrication
  - Performed residual stress measurements before and after mock-up welding
  - Demonstrate machine welding and non-destructive evaluation techniques
  - Used in several development studies
- **Spread ring mock-up**
  - Mock-up of the single spread ring design and engagement tool was constructed
  - Operated successfully



# Waste Package Development Studies

- **Development studies serve several purposes:**
  - Provide information and rationale for design and fabrication issues
  - Support analyses and model reports that are developed for total system performance assessment
- **The following studies have been completed:**
  - Weld Flaw Distribution
  - Induction Annealing
  - Laser Peening - Depth of Compressive Stress
  - Controlled Plasticity Burnishing - Depth of Compressive Stress
  - Residual Stress Measurement Analyses
  - Neutron Diffraction Analyses



# Waste Package Development Studies

(Continued)

- **The following studies are planned or continue in FY 04**
  - **Weld Material and Base Material Variability Study**
  - **Laser Peening and Controlled Plasticity Burnishing Corrosion Study**
  - **Fracture Toughness Study**
  - **Welding Interpass Temperature Study**



# Waste Package Prototype Program

- Prototyping is an integral part of design
- Prototyping will demonstrate the fabrication processes before manufacture of the production units
  - Ensures that waste packages can be manufactured as designed
- Prototypes will be used to:
  - Verify the closure processes and systems
  - Demonstrate waste package handling processes
  - Train operators for start-up and operations



# Waste Package Prototype Program

(Continued)

- **15 waste package prototypes have been planned, scheduled, and budgeted**
- **Prototypes will be produced over a six-year period from calendar year 2003 through 2008**
- **Request for proposal for the first waste package prototype procurement issued in July 2003**
  - **21 element pressurized water reactor waste package with absorber plates, full scale, includes all internals**
  - **Manufactured in strict compliance with all current design requirements including application of the American Society of Mechanical Engineers Section III Code N-Stamp**
- **Award of fixed-price contract is expected by end of calendar year 2003**

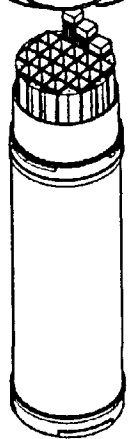
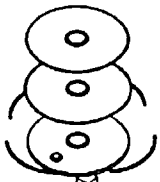


YUCCA MOUNTAIN PROJECT

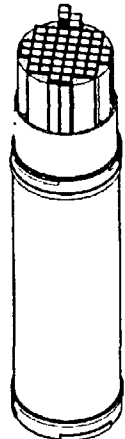


# Waste Package Configurations

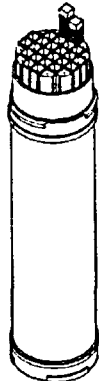
10 waste package configurations



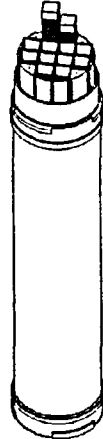
21-PWRCR



44-BWR



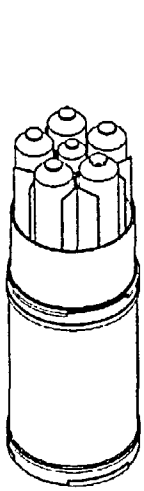
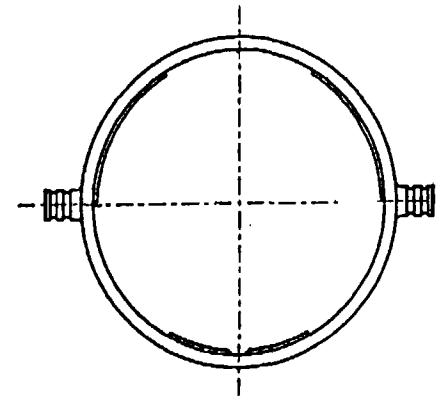
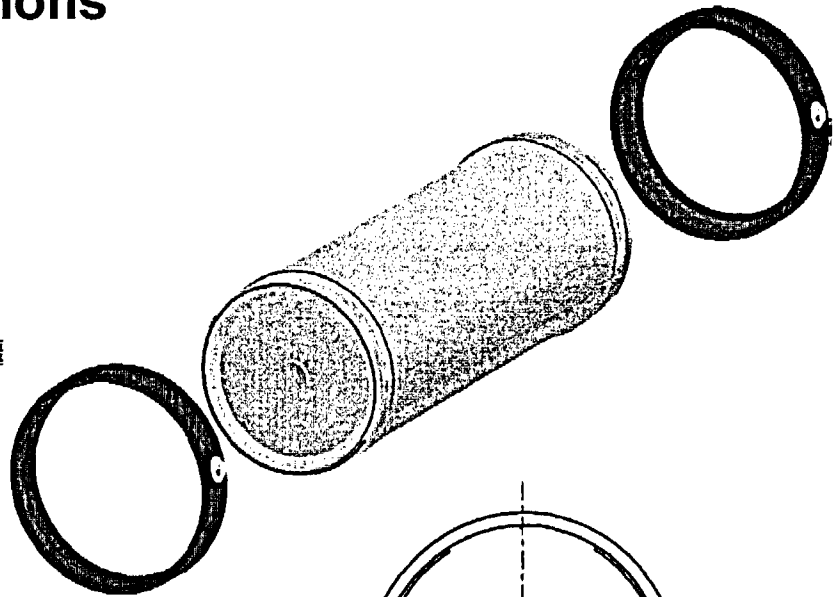
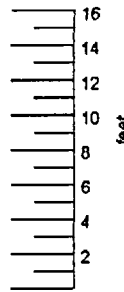
24-BWR



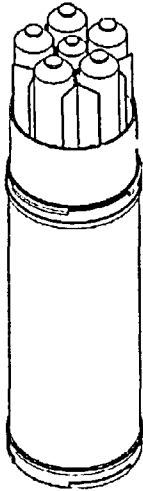
12-PWR



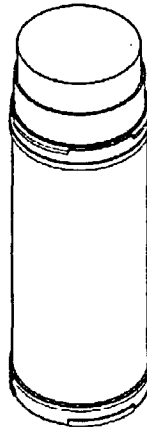
21-PWRAP



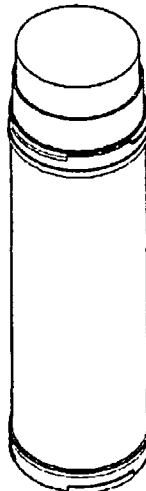
5-DHLW/DOE  
SNF Short



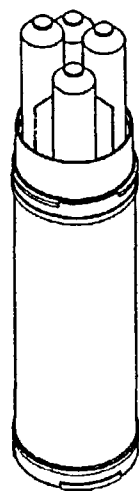
5-DHLW/DOE  
SNF Long



Naval SNF  
Short



Naval SNF  
Long



2-MCO2-DHLW

This drawing is preliminary and not intended for construction, procurement, or fabrication.

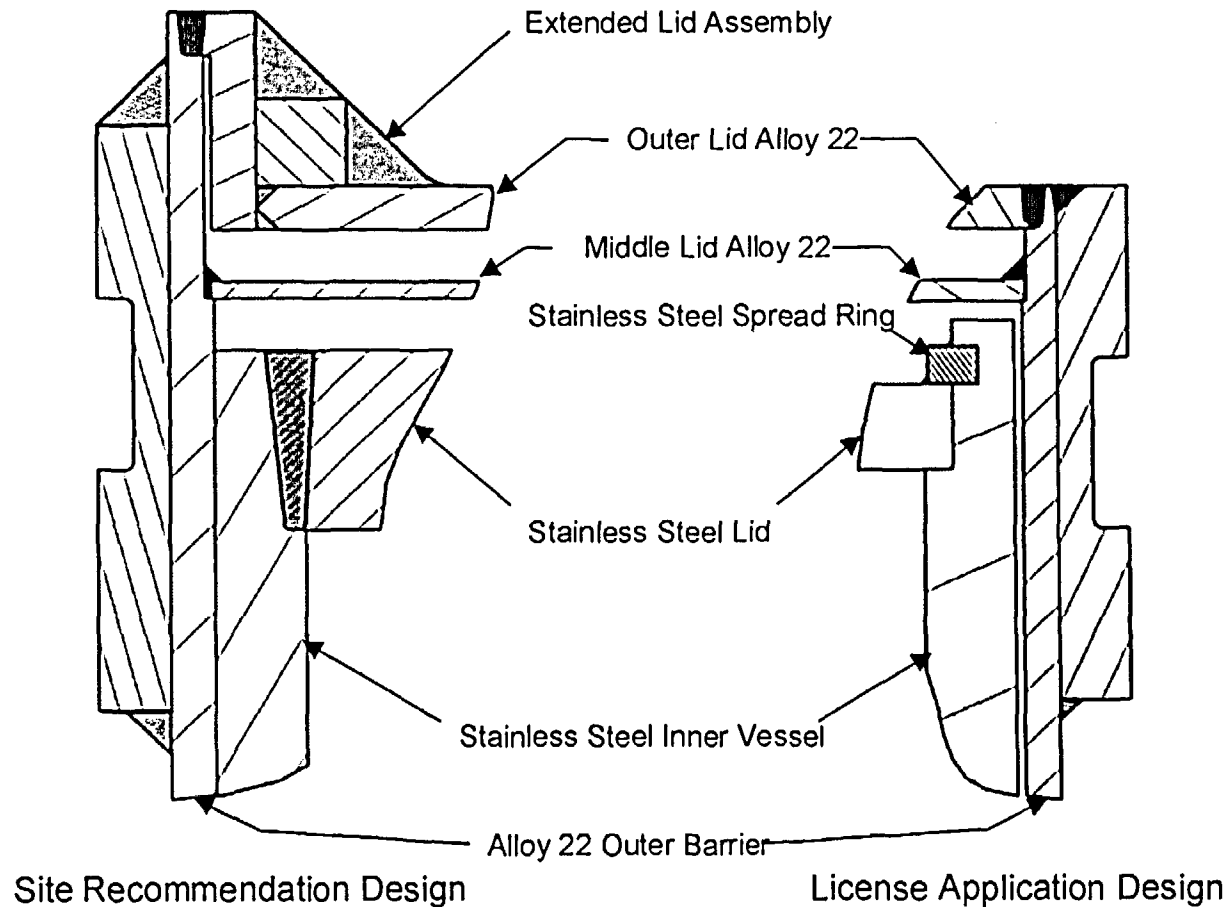


# Waste Package Design Changes

- **Recent design detail changes**
  - Replaced the extended outer lid with a flat lid
  - Replaced induction annealing with either laser peening or low-plasticity burnishing as the outer lid closure weld stress mitigation technique
  - Changed the middle lid weld configuration from a full penetration weld to a fillet weld and delete the stress mitigation step
  - Reduced the stainless steel inner lid thickness from 3 to 4 inches to 2 inches and changed the closure method from a full penetration weld to a spread ring with seal welds
  - Replaced the split trunnion collar design with a one-piece twist-on design
  - Changed the gap between the inner vessel and outer corrosion barrier to accommodate differential thermal expansion



# Waste Package Closure Details



This drawing is preliminary and not intended for construction, procurement, or fabrication.

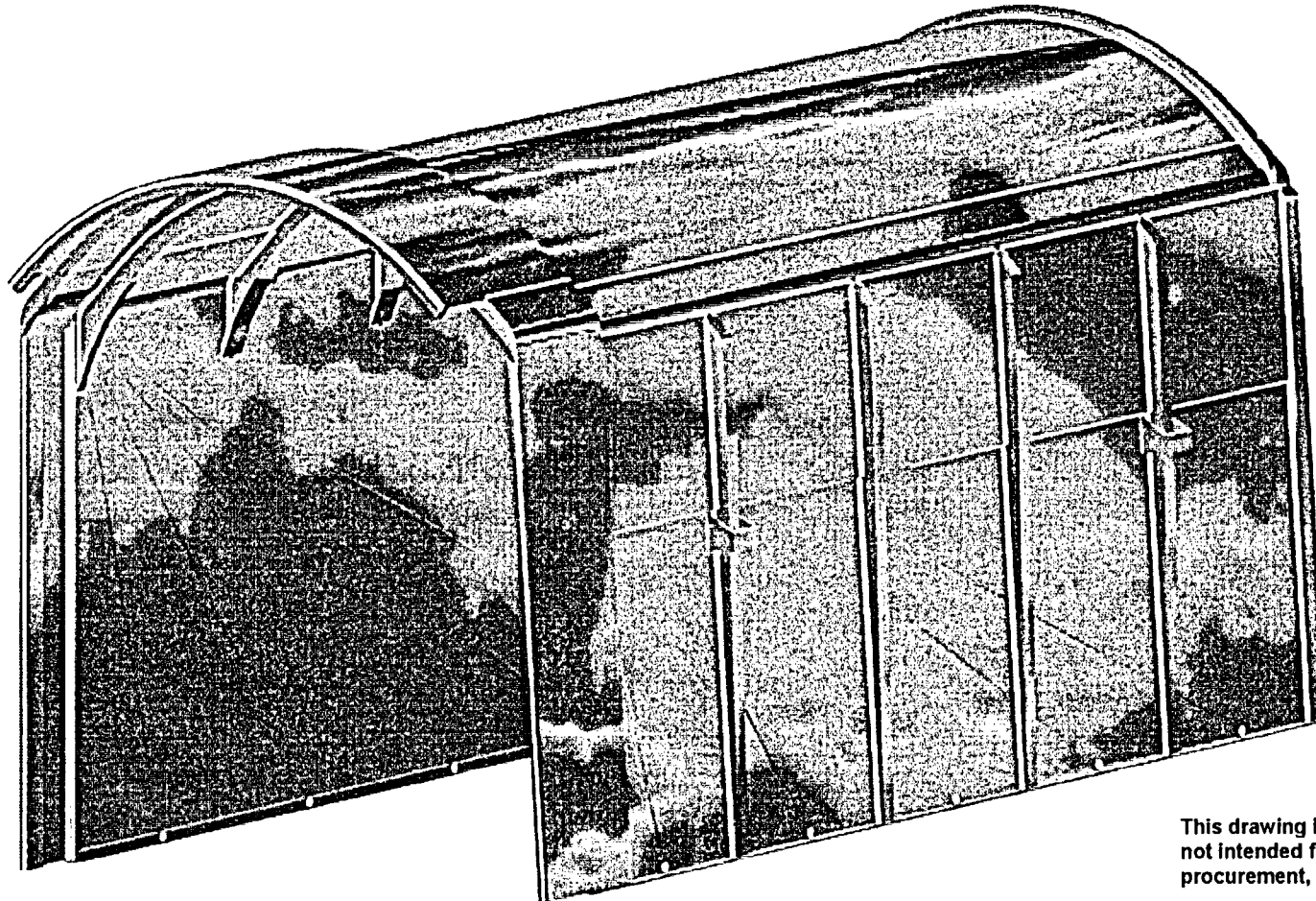


# Drip Shield Design Process

- **Analyze for postclosure**
  - **Analyze postulated events and provide information to support model abstractions for total system performance assessment**
  - **Postulated events include:**
    - ♦ **Rock fall**
    - ♦ **Vibratory ground motion**



# Drip Shield Illustration



This drawing is preliminary and not intended for construction, procurement, or fabrication.



# Drip Shield Design Changes

- **Potential drip shield design detail changes not yet adopted**
  - Increased distance from drip shield to waste package to prevent drip shield contact with the waste package in the event of rock fall
  - Increased stiffness for bending loads and stresses along the bulkheads
  - Added longitudinal stiffener beams between the bulkheads along the axial direction, to provide additional strength for bending loads along axial length
  - Simplified handling and interlocking features
- **Material selection remains unchanged**



# Waste Package Preliminary Preclosure Safety Analysis Results

- **Preclosure safety considerations**
  - The waste package design considers both Category 1 and Category 2 event sequences as defined by preclosure safety analysis
  - Waste package breach is therefore beyond Category 2

# Waste Package Preliminary Classification Results

- The following structure, system, and component is important to safety:
  - Waste package
- The following features are important to waste isolation:
  - Waste package
  - Drip shield



# Summary

- **Preliminary preclosure safety analysis indicated April 2003 design would be able to meet regulatory performance objectives**
- **Structures, systems, and components which are important to safety have been identified**
- **Engineered features which are important to waste isolation have been identified**
- **Complete design development to support License Application**
- **Preclosure safety analysis to be updated based upon final License Application design**
- **No new event sequences are anticipated, so ability of License Application design to meet regulatory performance objectives is expected**





U.S. Department of Energy  
Office of Civilian Radioactive Waste Management

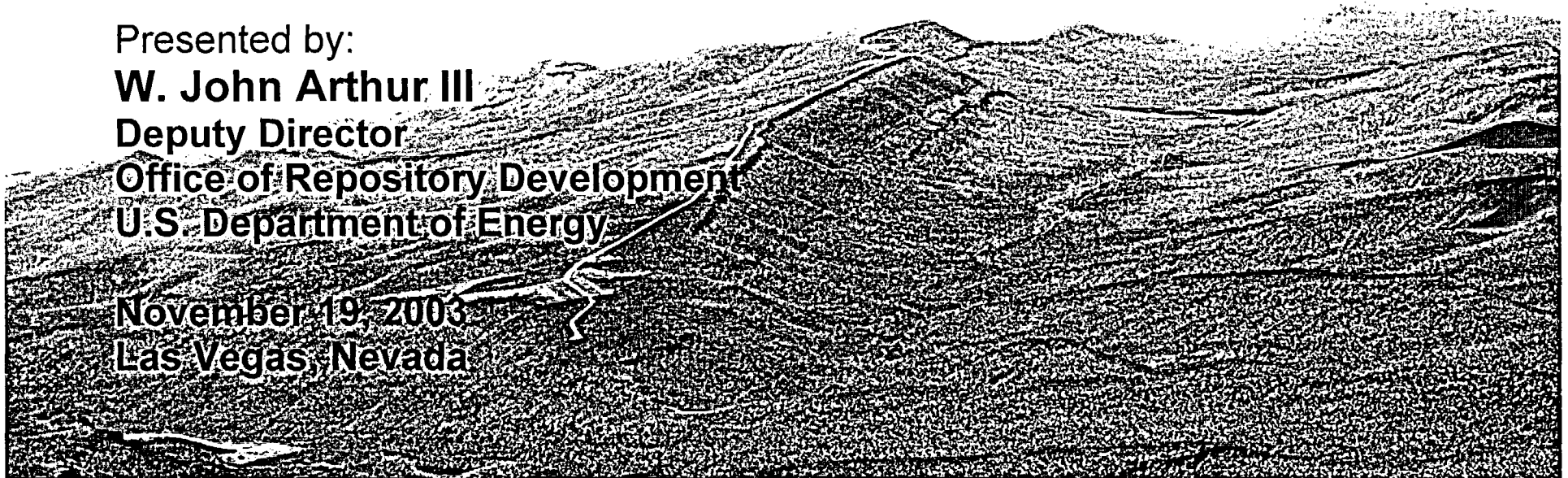


# Exhibits

Presented to:  
**Advisory Committee on Nuclear Waste**

Presented by:  
**W. John Arthur III**  
Deputy Director  
Office of Repository Development  
U.S. Department of Energy

November 19, 2003  
Las Vegas, Nevada



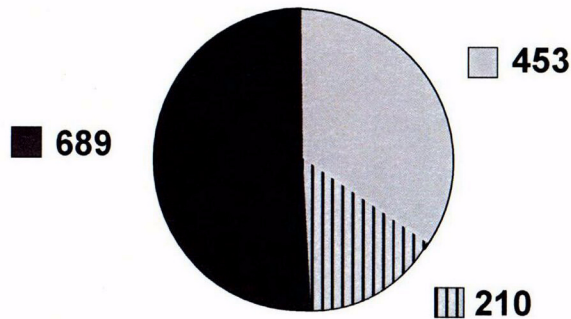
# Management Assessment of Progress Towards License Application

<u>COMPONENT (WEIGHT)</u>	<u>% COMPLETE (6/03)</u>	<u>%COMPLETE (10/03)</u>
• KTI Agreements Addressed (10%)	50%	60%
• LA Document (20%)	5%	7%
• Preclosure Safety Assessment (10%)	14%	51%
• TSPA-LA (30%)	35%	63%
• Design (30%)	<u>25%</u>	<u>40%</u>
• TOTAL WEIGHTED % COMPLETE	25%	43%



# Status of LA Data, Codes, and Models<sup>1</sup>

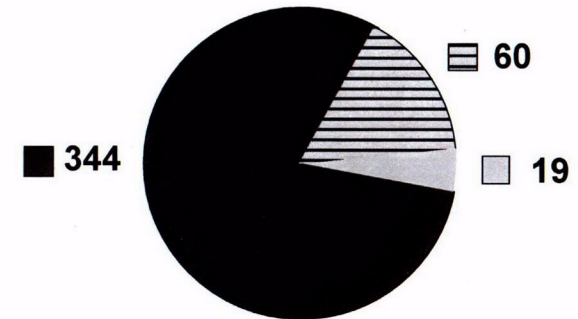
Data (Estimate)



**Total Data Sets: 1,352**

- Qualified: 689 (51%)
- Being Verified: 453 (34%)
- ▨ Being Developed: 210 (15%)

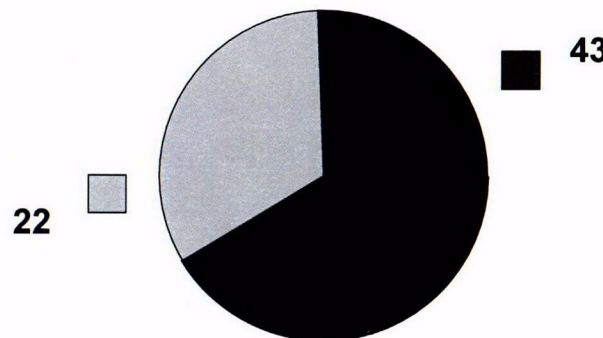
Codes (Estimate)



**Total Codes: 423**

- ▨ Qualified & Verified: 60 (14%)
- Qualified (Legacy/re-testing): 344 (81%)
- Developing/verifying: 19 (5%)

Model Reports<sup>2</sup>



**Total Model Reports Directly Supporting LA: 65**

- Completed: 43 (66%)
- Being Developed: 22 (34%)

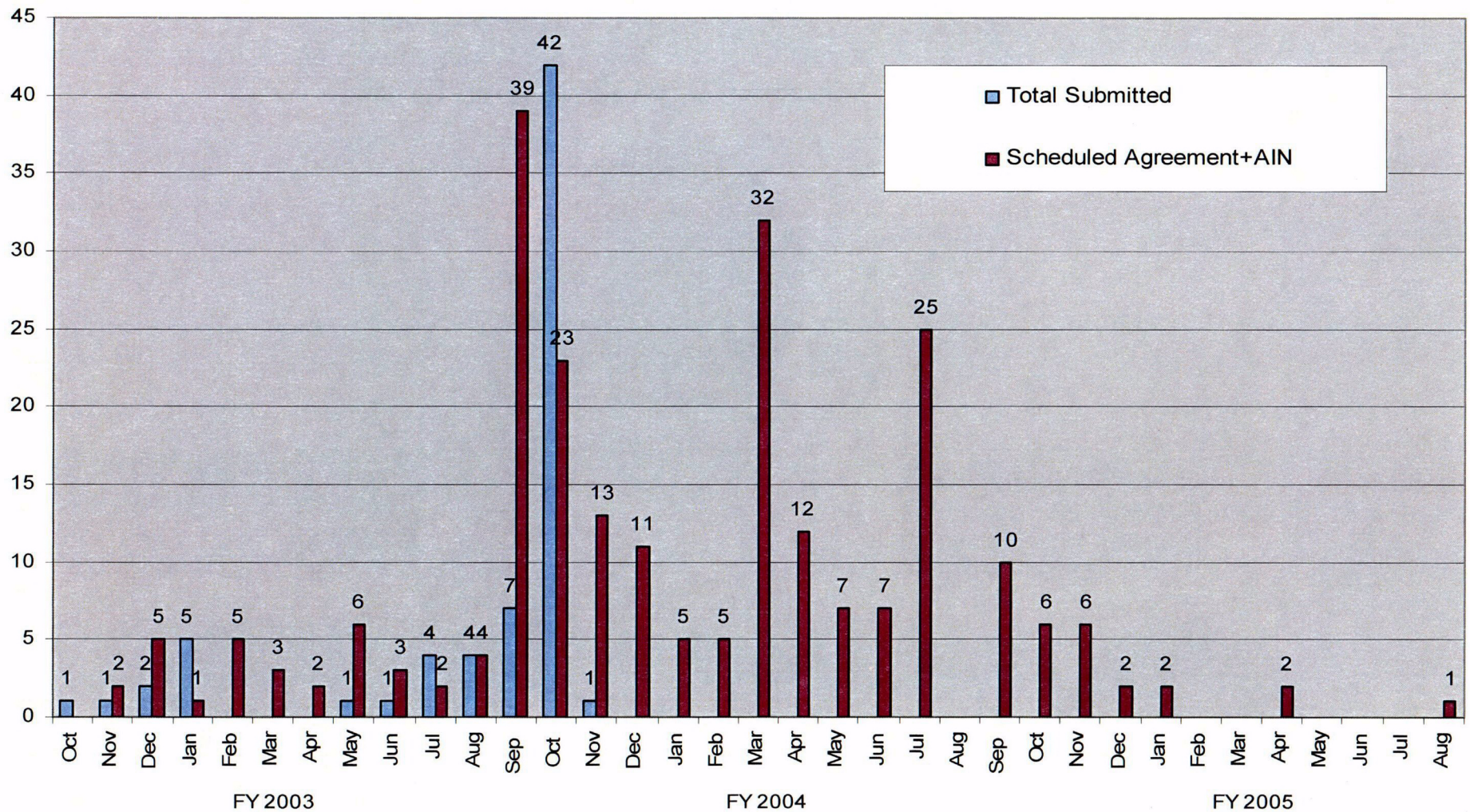
<sup>1</sup>Status of qualification activities for LA and completion of reports

<sup>2</sup>Model Reports may contain multiple models





# Scheduled KTI Submittals vs. Actual

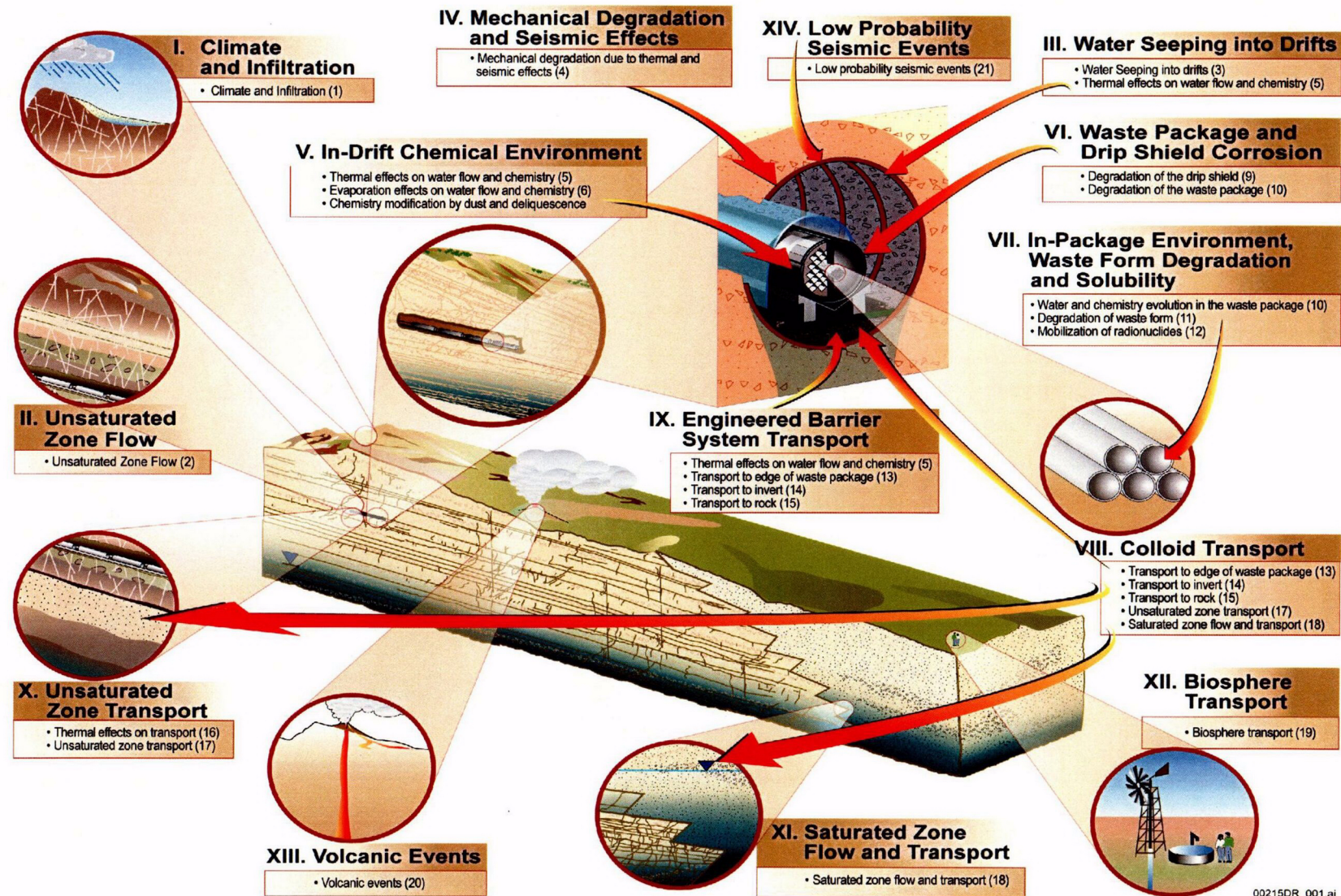


C12



# Integrated Technical Basis KTI Response Groups

## (And Related Process Model Groups)

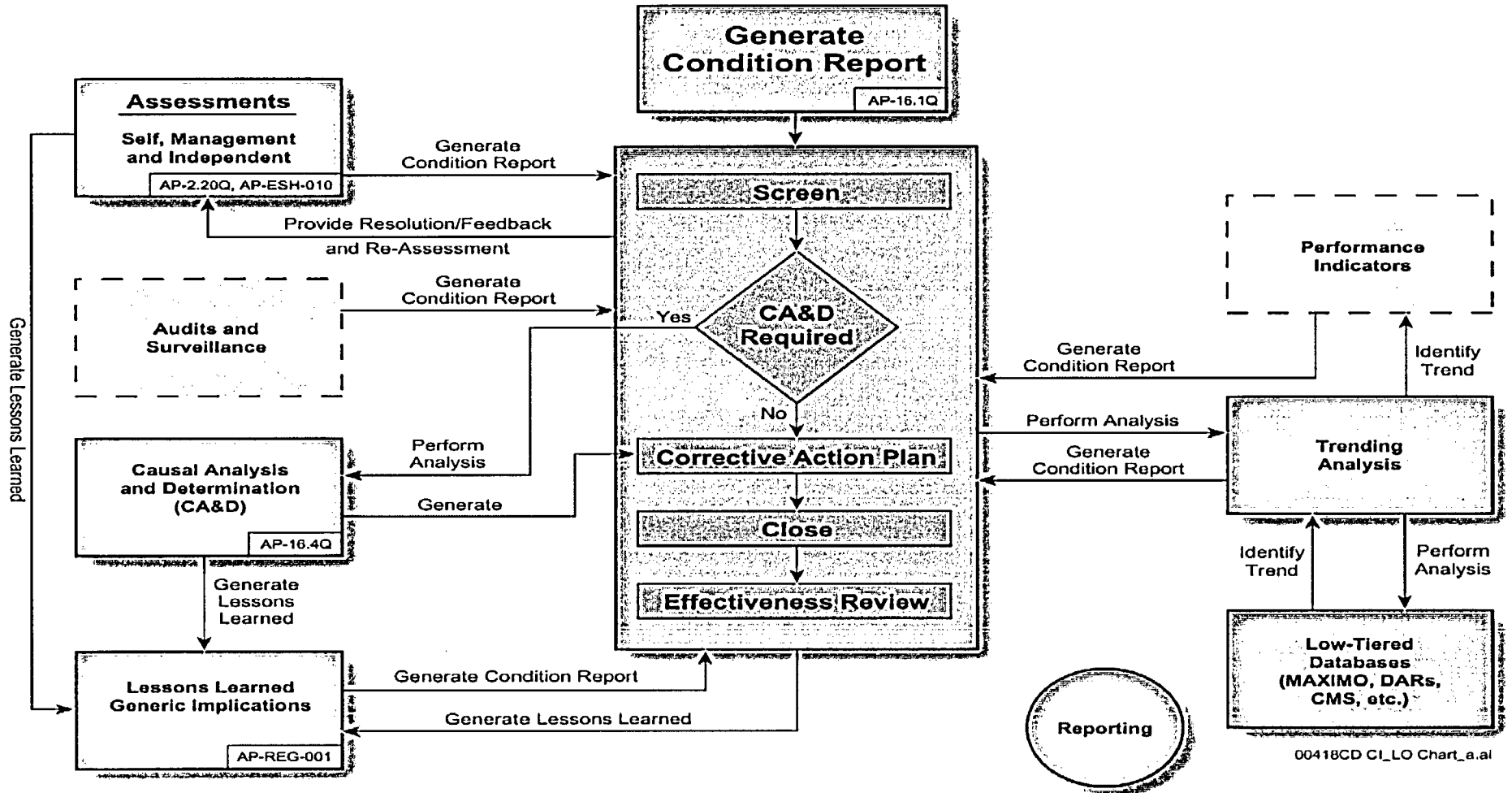


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# Corrective Action Program - Process

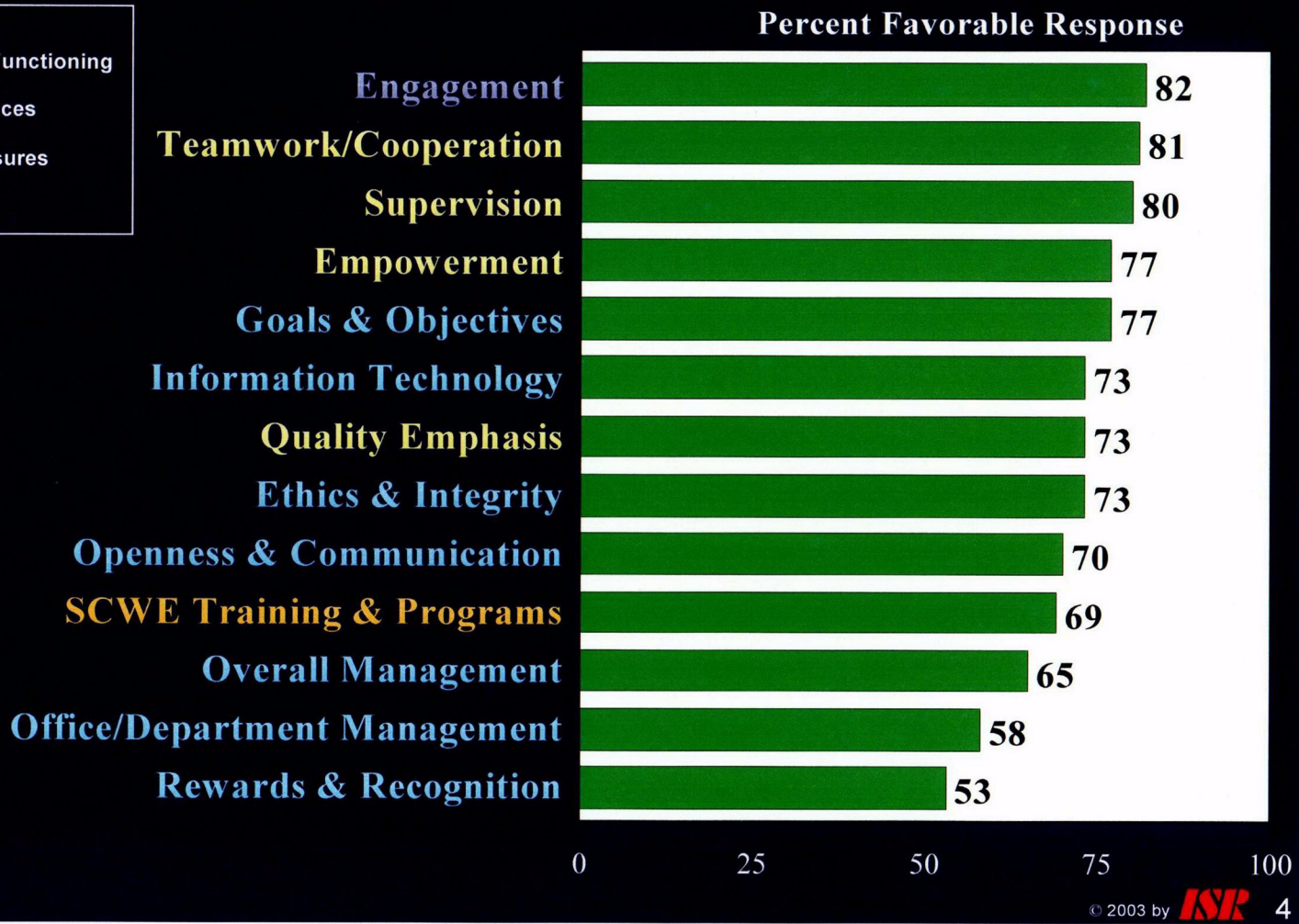
## Continuous Improvement Learning Organization





# OCRWM 2003 Safety Conscious Work Environment Survey (N=1,492)

- Legend:**
- Organization Functioning
  - Work Experiences
  - Outcome Measures
  - SCWE



**OCRWM**

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C14



Office of Civilian Radioactive Waste Management

# OCRWM

## 2003 Safety Conscious Work Environment Survey

*Administration: August 18 through September 5*

Outgoing	Returned	Return Rate	Margin of Error
2,287	1,492	65%	+/- 1.5%



# Results Summary

## Strengths to Maintain:

- Emphasizing Quality
- Setting and Communicating Goals & Direction
- Encouraging Openness & Receptiveness to Input
- Building Trust and Maintaining Integrity
- Involving Employees in Decisions
- Keeping SCWE as a Priority
- Encouraging & Recognizing Team Work

## Areas for Improvement:

- Managing Change
  - Planning & Communication of Reorganizations
  - Setting Objectives and Priorities
  - Keeping Quality Focus
- Communicating Organizational Performance
- Ensure Sufficient Authority Levels
- Perceived Effectiveness of CAP

**OCRWM**

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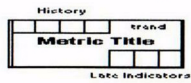




# Yucca Mountain Project Performance Indicators

Yucca Mountain Project  
Performance Indicators based on September 2003 Data

	Primary		Secondary					Focus Areas							
	Metric Title	History	Metric Title	History	Metric Title	History	Metric Title		History						
NO-TCCMEKROW	5.1 Cross Cutting Indicators		6.1.1 SCWE		5.1.2 Accountability &		5.1.3 Project Quality Focus		5.1.4 Project Schedule & Timeliness		5.1.5 Efficiency and Cost Focus		5.1.6 Stakeholder Confidence		
	1.1 Licensing	Y Y	1.1.1 License Application Development	Y Y	1.1.2 NRC Interactions	Y Y	1.1.3 License Support Network Input	Y G	1.1.4 NRC Commitments	B G	1.1.5 Key Technical Issues	Y Y			
	1.2 Engineering/Design	Y Y	1.2.1 Surface Facilities	Y Y	1.2.2 Subsurface Facilities	G Y	1.2.3 Engineered Barriers	G G	1.2.4 Route and Integration Management	B					
	1.3 Safety Analysis	Y Y	1.3.1 TSPA	Y	1.3.2 Performance Confirmation	G	1.3.3 Preclosure Safety Analysis	G						1.3.3 Open	
MANAGEMENT	2.1 Project Support	G G	2.1.1 Project Controls	G	2.1.2 Security	B	2.1.3 Information Technology	B	2.1.4 Emergency Management	B	2.1.5 Records Management	G		2.1.5 Open	
	2.2 Safety and Health		2.2.1 ISM	G	2.2.2 Occupational Injuries/	Y	2.2.3 Safety & Health Assessments	G	2.2.4 Safety and Health Program Performance	G				2.2.5 Open	
	2.3 Quality Assurance	Y Y	2.3.1 Technical Product Compliance	W	2.3.2 Verification of Project Quality	Y	2.3.3 Quality Program Health	R						2.3.3 Open	
	2.4 Corrective Action Mgmt System	Y Y	2.4.1 Prevention	W	2.4.2 Self Reporting Culture	R	2.4.3 Causal Analysis & CAP Development	W	2.4.4 Timely & Effective CAR	Y	2.4.5 CAP Performance & Infrastructure	W			
ORGANIZATION	2.5 Management Framework		2.5.1 Procedure Quality		2.5.2 Procedure Revision Timeliness		2.5.3 Procedure Compliance		2.5.4 Procedure Development						
	2.6 Environmental Management		2.6.1 Environmental Stewardship		2.6.2 Environmental Permits		2.6.3 Environmental Compliance		2.6.4 Envir. Prog. Performance					2.6.3 Open	
	2.7 Project Management	Y Y	2.7.1 Cost Performance (Overall CPI)	Y	2.7.2 Schedule Performance (Overall SPI)	Y	2.7.3 Scope Baseline	G	2.7.4 Risk & Contingency	G	2.7.5 Key Deliverable Critical Path	Y G	2.7.6 Project Financial Management	G G	
	2.8 Organizational Culture	G	2.8.1 Employee Concerns		2.8.2 Performance Measures		2.8.3 Communication		2.8.4 Process Improvement		2.8.5 Open		2.8.4 Open		
3.1 External		3.1.2 LSN (CACI)		3.1.5 Funding				3.1.1 Open		3.1.3 Open		3.1.4 Open			



- Key**
- B** Exceptional program, innovative process, or superlative performance; significantly exceeds expectations
  - R** Degraded or adverse performance warranting significant level of management attention, resources, and improvement.
  - G** Effective performance which meets or exceeds requirements and expectations; therefore, only a maintenance level of management attention or resources is needed.
  - W** Insufficient data or not applicable
  - L** Gray for Late - Updated metric not provided by due date.
  - Y** "Marginal". Yellow can be used to denote either of two conditions:
    - Borderline or declining performance, which needs increased management attention and resources to achieve desired performance or to reverse a negative trend.
    - Acceptable performance that relies on a set of conditions which could change and quickly send performance into the "Red" category. For example, if events such as the loss of a key manager, the denial of a request for an exemption, or a policy change on the part of a regulator...





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Office of Civilian Radioactive Waste Management

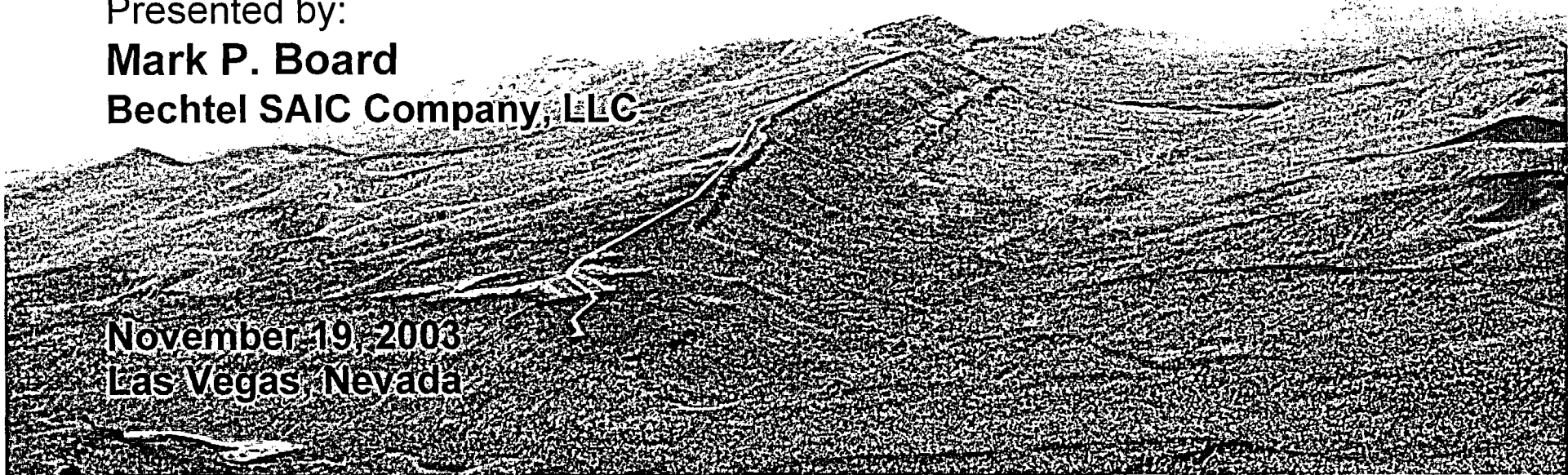


# Mechanical Drift Degradation Analysis

Presented to:  
**Advisory Committee on Nuclear Waste**

Presented by:  
**Mark P. Board**  
**Bechtel SAIC Company, LLC**

**November 19, 2003**  
**Las Vegas, Nevada**

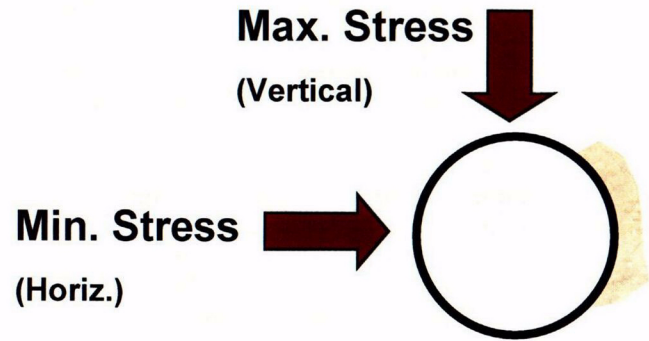


# Outline

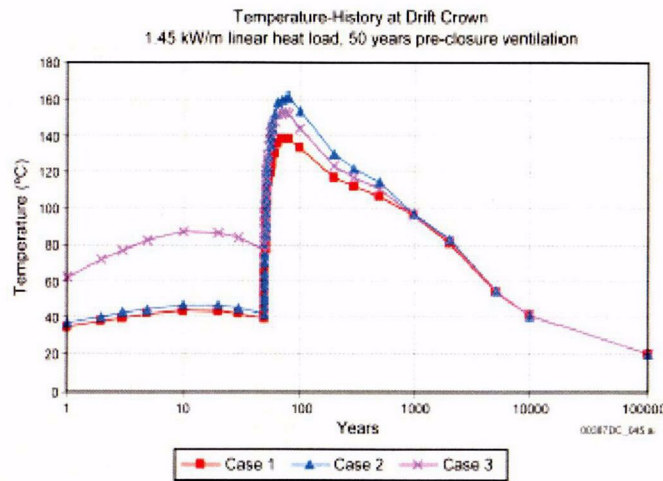
- **Summarize general sources and mechanisms of mechanical degradation**
- **Review site geology and layout**
- **Review methodology for simulation and prediction of drift degradation**
- **Presentation of results of drift degradation to in situ, thermal, seismic and time-dependent loading**
- **Contrast results of DOE and NRC drift degradation results and approaches**



# Sources of Mechanical Degradation

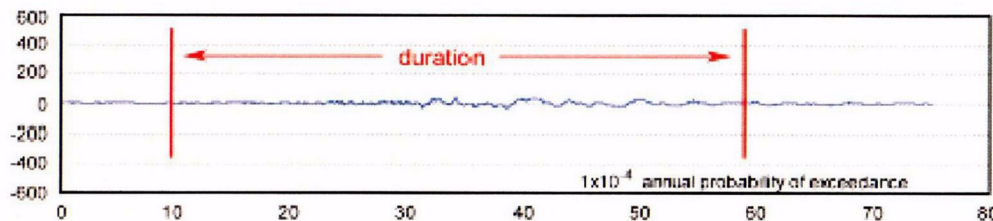


- Mechanical degradation is damage or yield induced in the rock mass surrounding drifts as a result of applied stresses or time-dependent mechanical effects



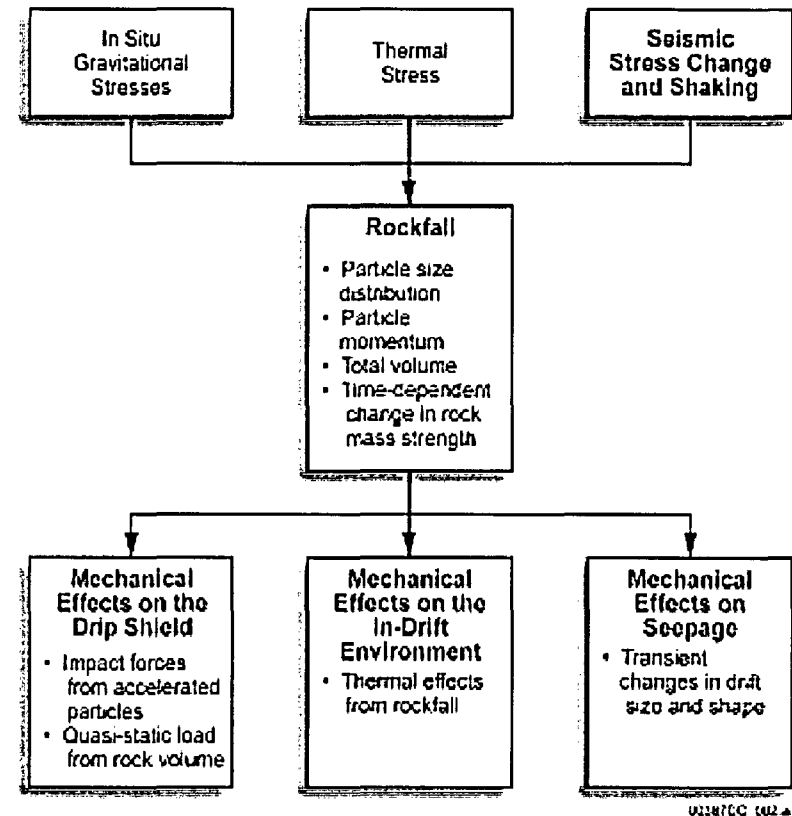
- Three primary sources of stress change

- In situ gravitational stress
- Thermal loading
- Seismic load



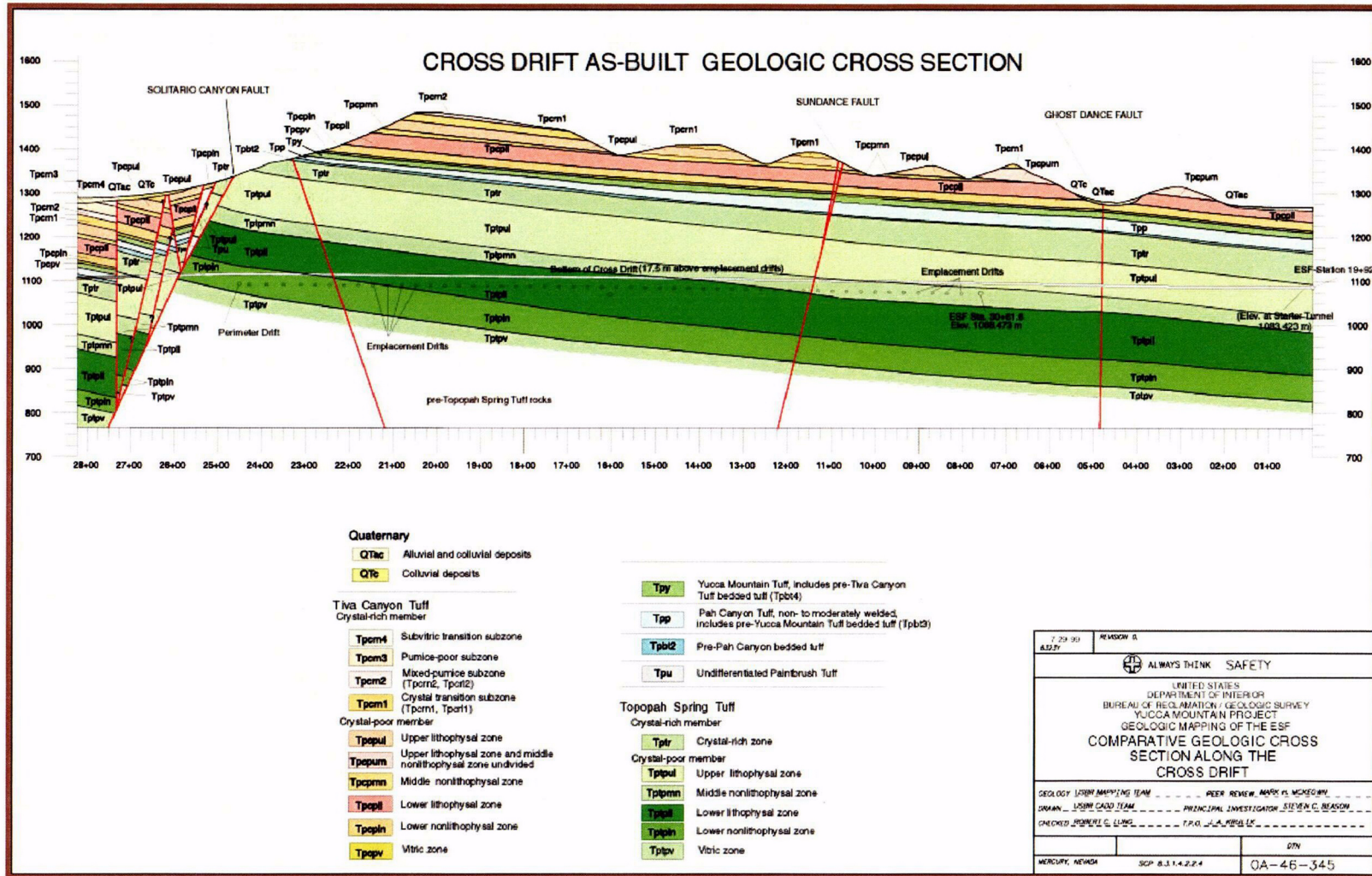
# Use of Rockfall in Performance Assessment

- **Rockfall has three potential areas of performance impact:**
  - **Mechanical effects - waste package in preclosure safety assessment, and drip shield in postclosure performance assessment**
  - **In-drift environment - thermal effects of rockfall**
  - **Seepage - change in drift size and shape, rockfall in drift**

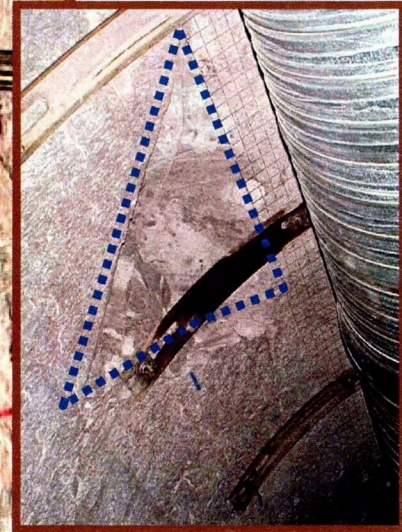
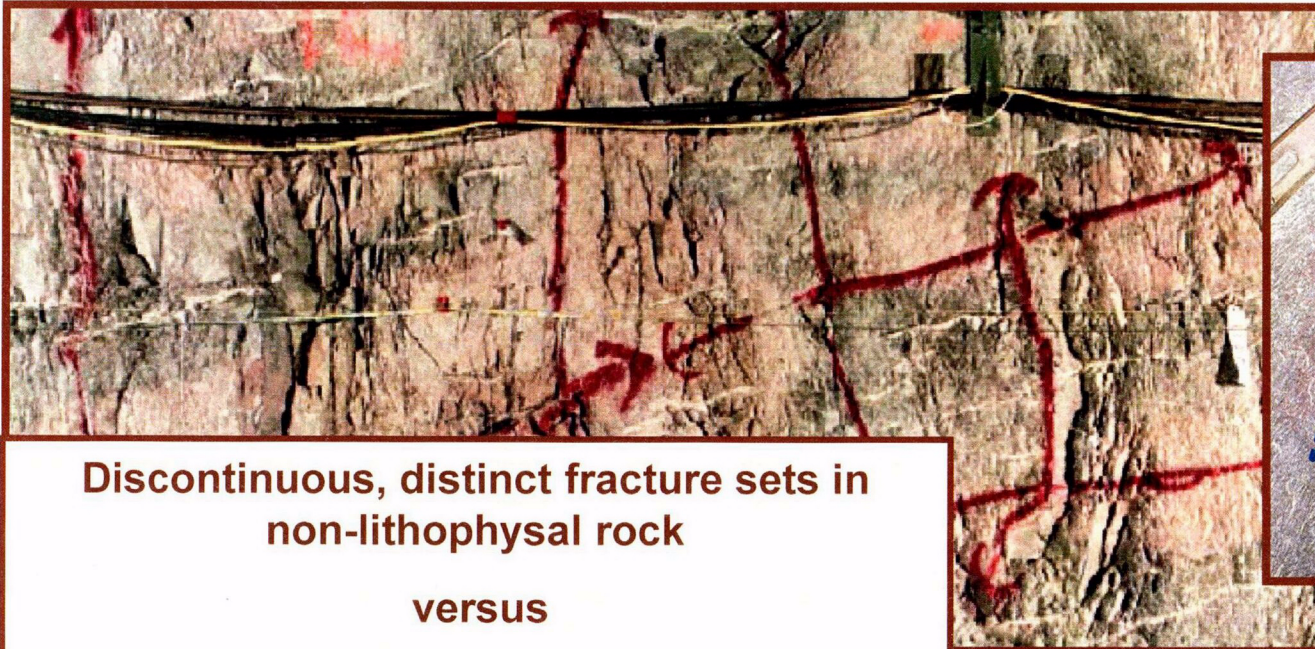


# Site Conditions

## East-West Geologic Cross Section



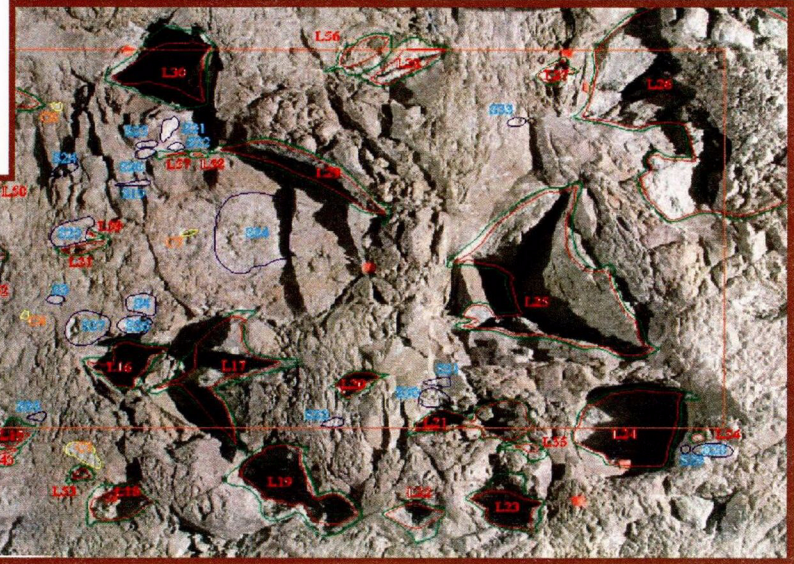




**Discontinuous, distinct fracture sets in  
non-lithophysal rock**

**versus**

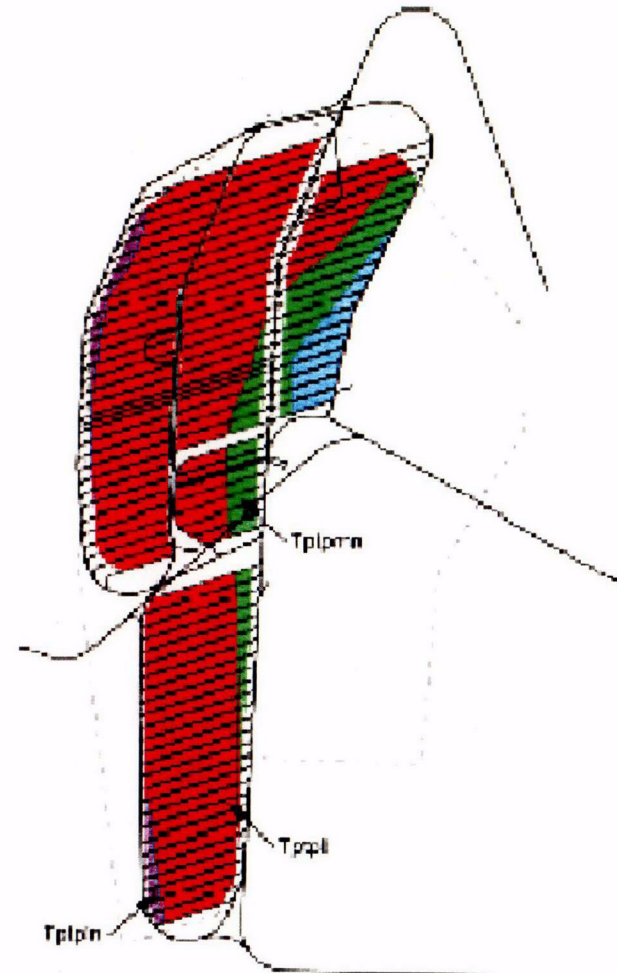
**short, ubiquitous fractures  
with irregular cavities in  
lithophysal rock**





# Repository Rock Units

- **70,000 metric tons of heavy metal baseline emplacement**
  - 3 percent lower non-lithophysal
  - 80.3 percent lower lithophysal
  - 12.4 percent middle non-lithophysal
  - 4.4 percent upper lithophysal

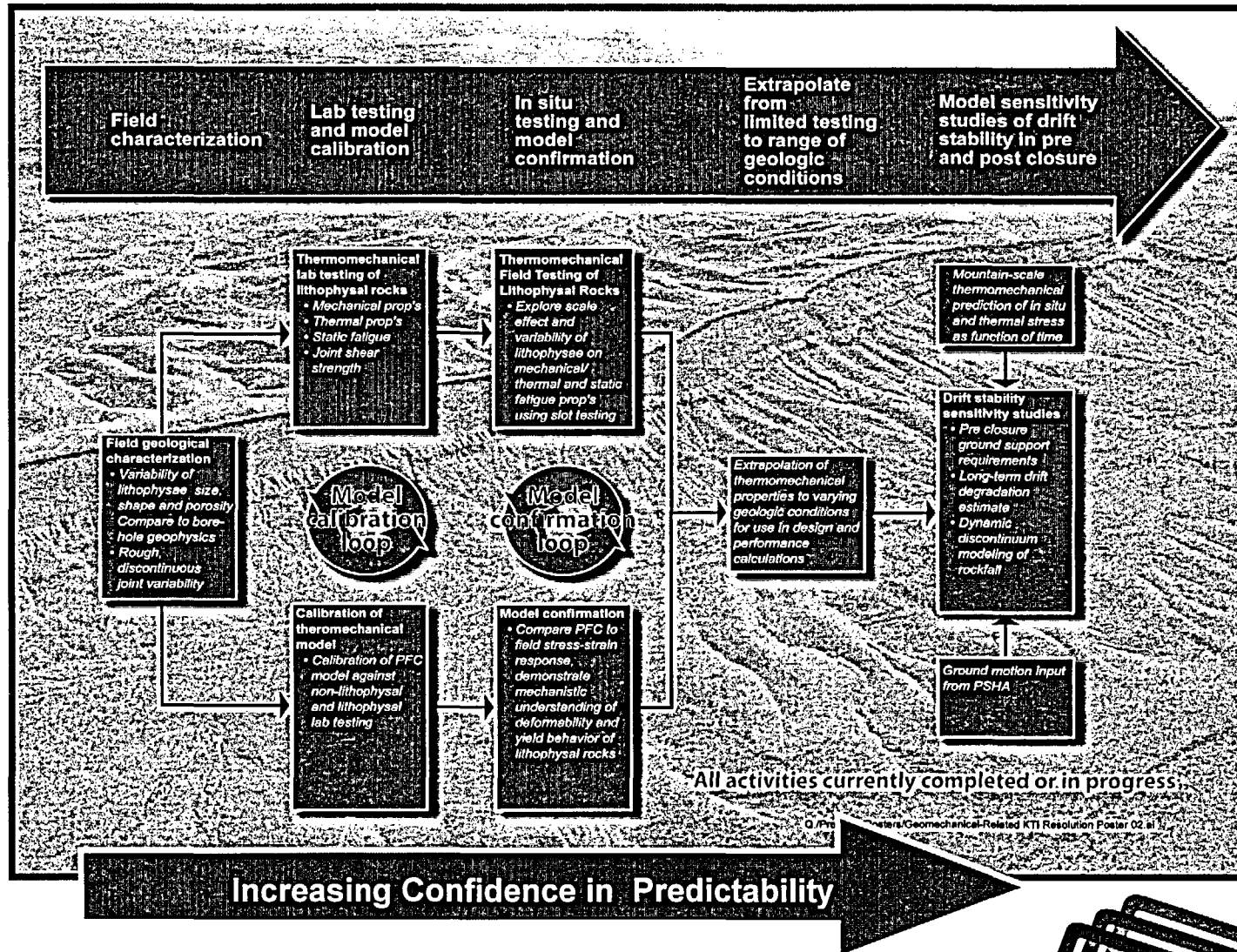


# Observations in Existing Tunnels

- **Exploratory Studies Facility (25' diameter) and Enhanced Characterization of the Repository Block (16') developed through all proposed repository host rock units**
- **Excavations 5-7 years old**
- **Light ground support (friction bolts and wire mesh in roof - typically no support in walls)**
- **No observed rockfall in tunnels (minor spalling in Drift Scale Test during thermal overdrive testing)**
- **Deformation measurements show excavations in equilibrium**



# Geomechanical Performance Assessment and Design Strategy



# Geotechnical Rock Mass Properties - Non-Lithophysal Rock

- Development of stochastic model of fracturing using FracMan program
- Determination of shear properties of joints from direct shear testing and in situ geotechnical mapping

