SAND2009-4512P

Repository Science

KRMC Training Program

Module 2: Overview of Pre-Operational Programs

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Key Information from Underground

- Groundwater flow and radionuclide transport
- Natural and induced changes in the geological barrier
- Design and construction of the repository
- Hydrogeochemistry of pore waters
- Rock mechanics

Types of Underground Work

- Characterization
- Testing
- Technology development
- Demonstration activities

Underground Characterization

In situ investigations to provide detailed understanding of:

- Geologic, hydrogeologic, geochemical, structural, and mechanical properties of the host rock
- Host rock responses to imposed changes
- Data required for safety assessments

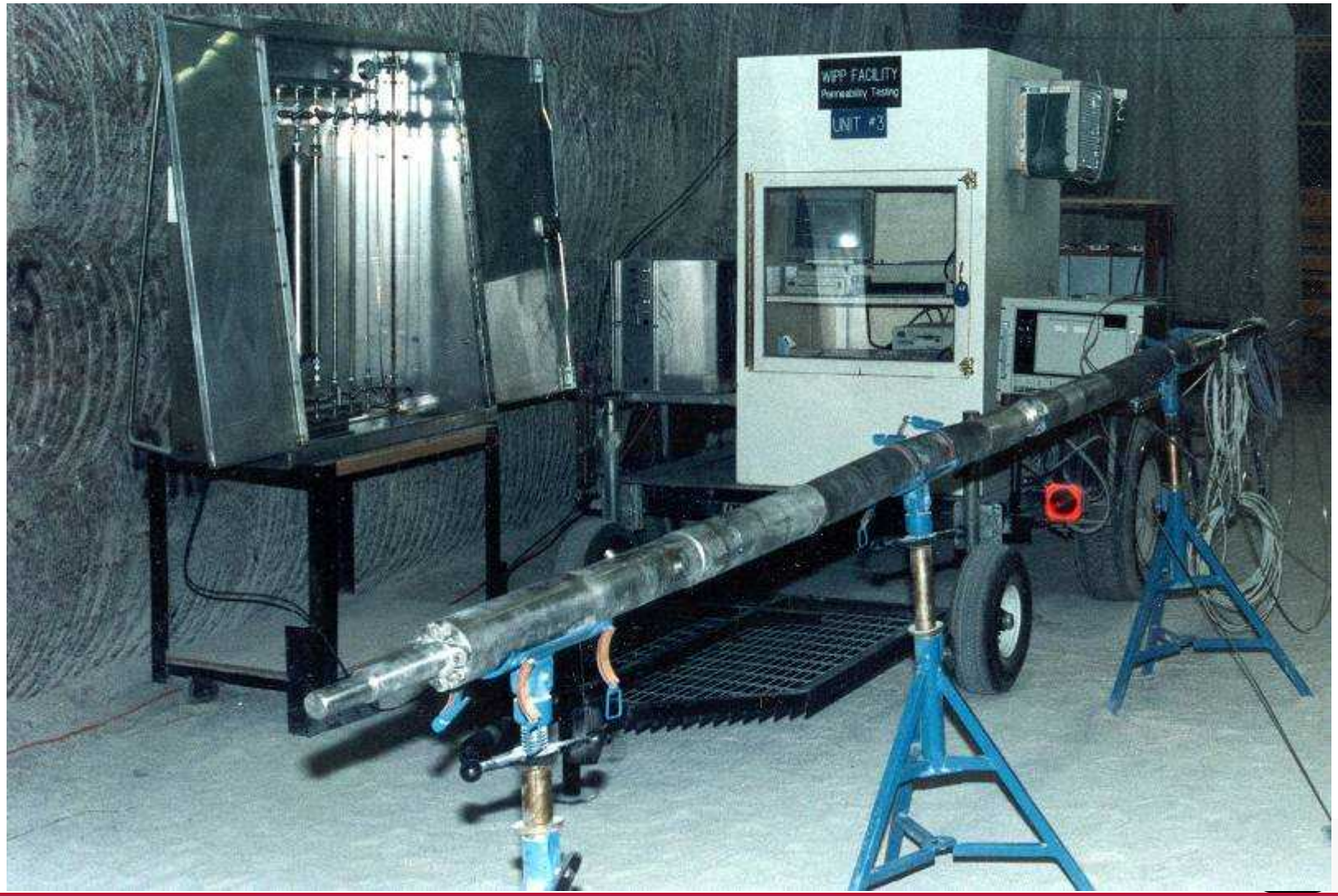
Underground Priorities

- Better characterization of *in situ* stresses—need to understand before designing main repository excavations
- Characterization of fracture sets—orientation, density, extent, hydraulic properties, interconnectedness—need to understand before siting waste packages or disposal cells
- Hydrogeochemical sampling and characterization—need to perform before redox potential is affected by excavations

Underground Hydraulic Testing

- Testing underground allows easier, and more controlled, access to repository horizon than testing in boreholes drilled from land surface
- Underground testing allows the long test durations needed for low-permeability media
- Care must be taken to differentiate testing in the excavation damaged zone (EDZ) from testing in the far-field

Underground Hydraulic Testing



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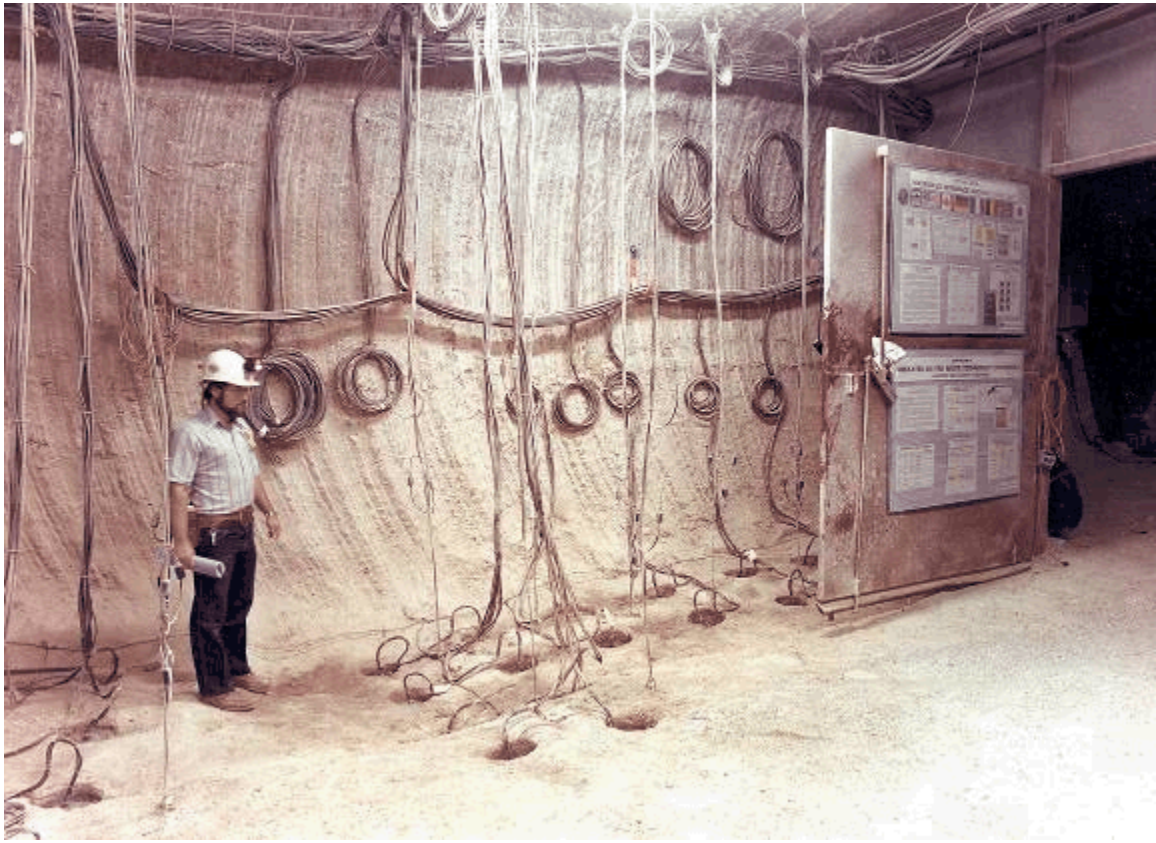
Large-Scale Brine Inflow Experiments

Underground Testing

- Testing of engineered materials (e.g., waste packages) and excavation methods
- Evaluation of the performance of characterization methods
- Testing of conceptual and numerical models

Materials Interface Interactions Testing



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Testing of Waste-Package Performance

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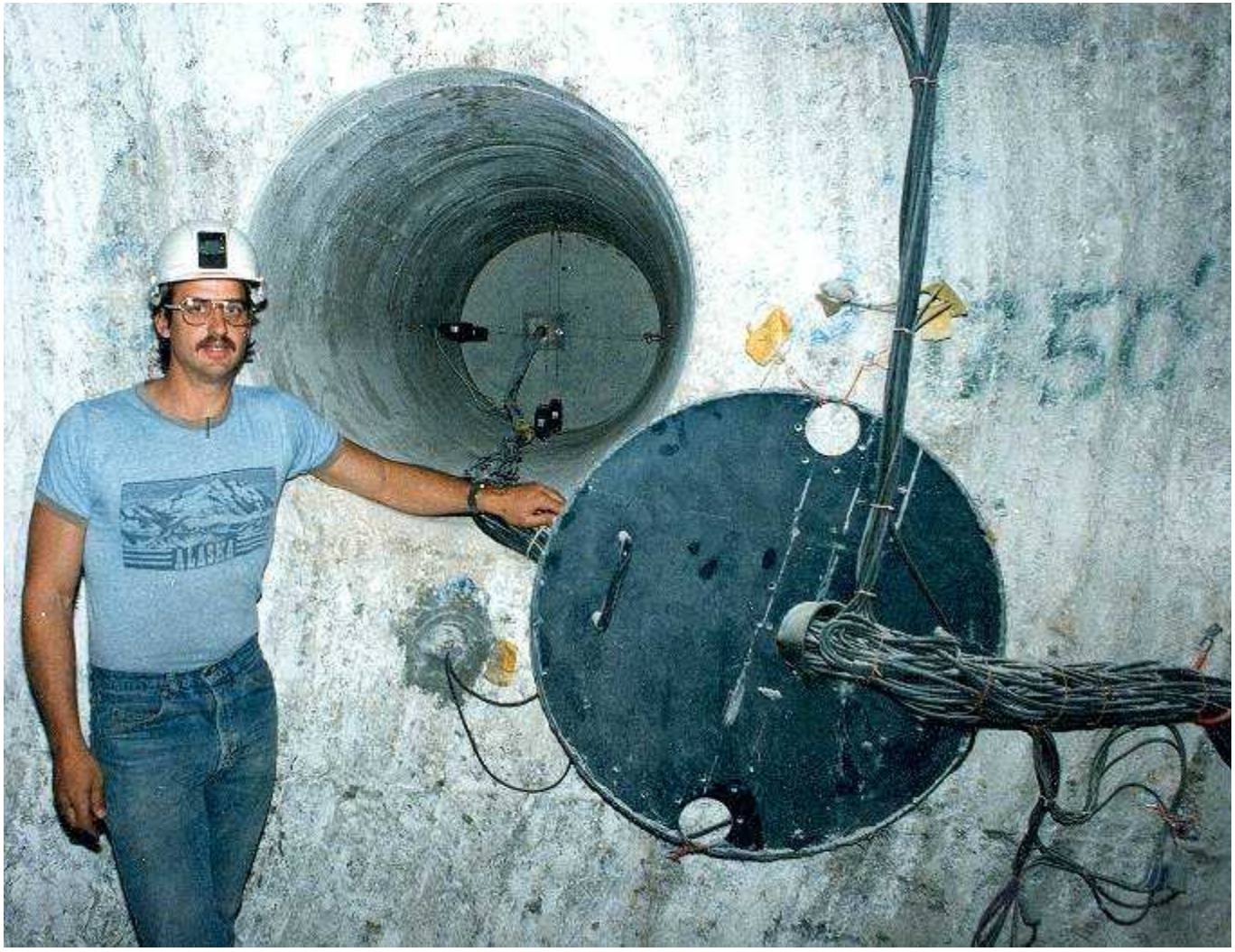
Testing of Salt-Closure Models



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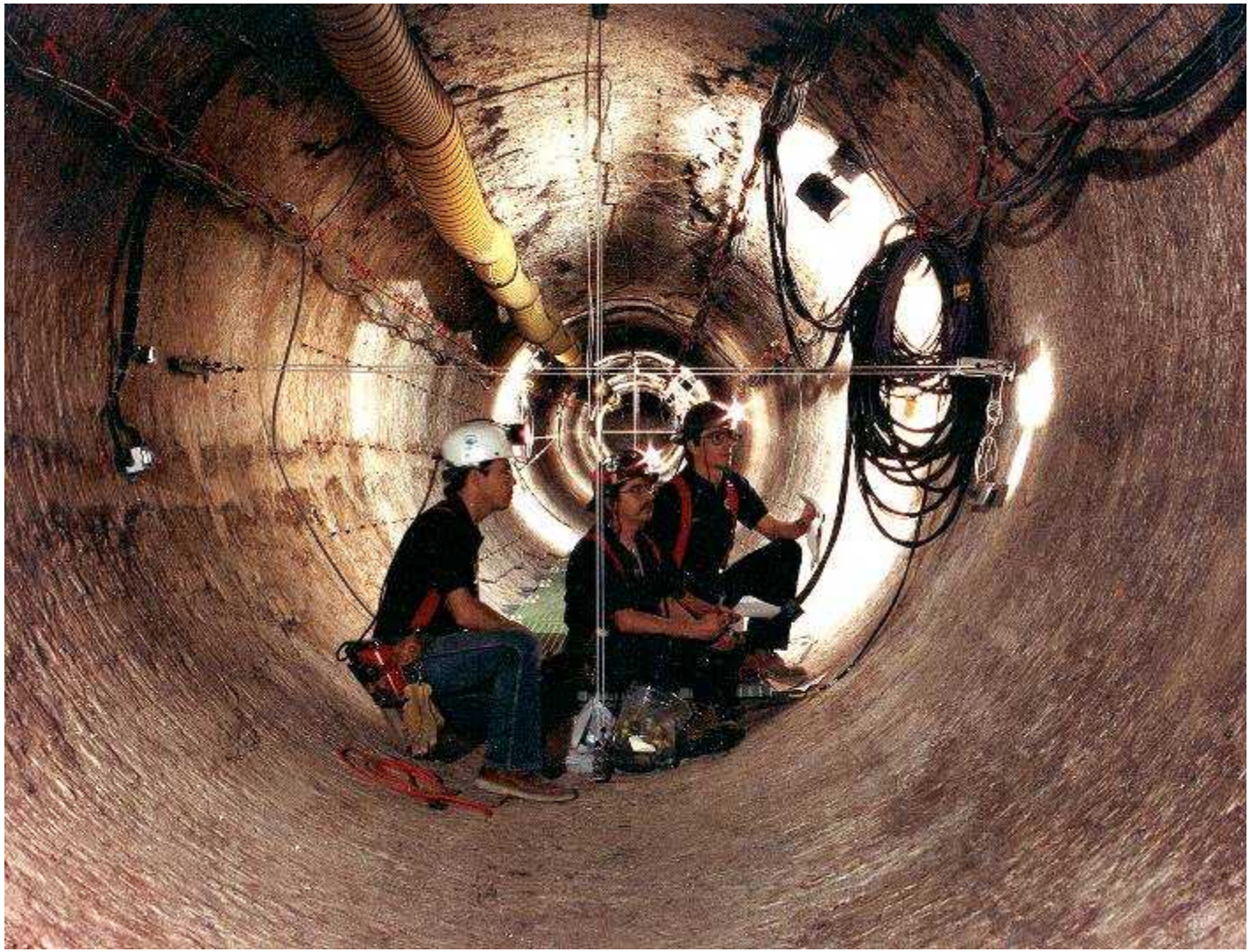
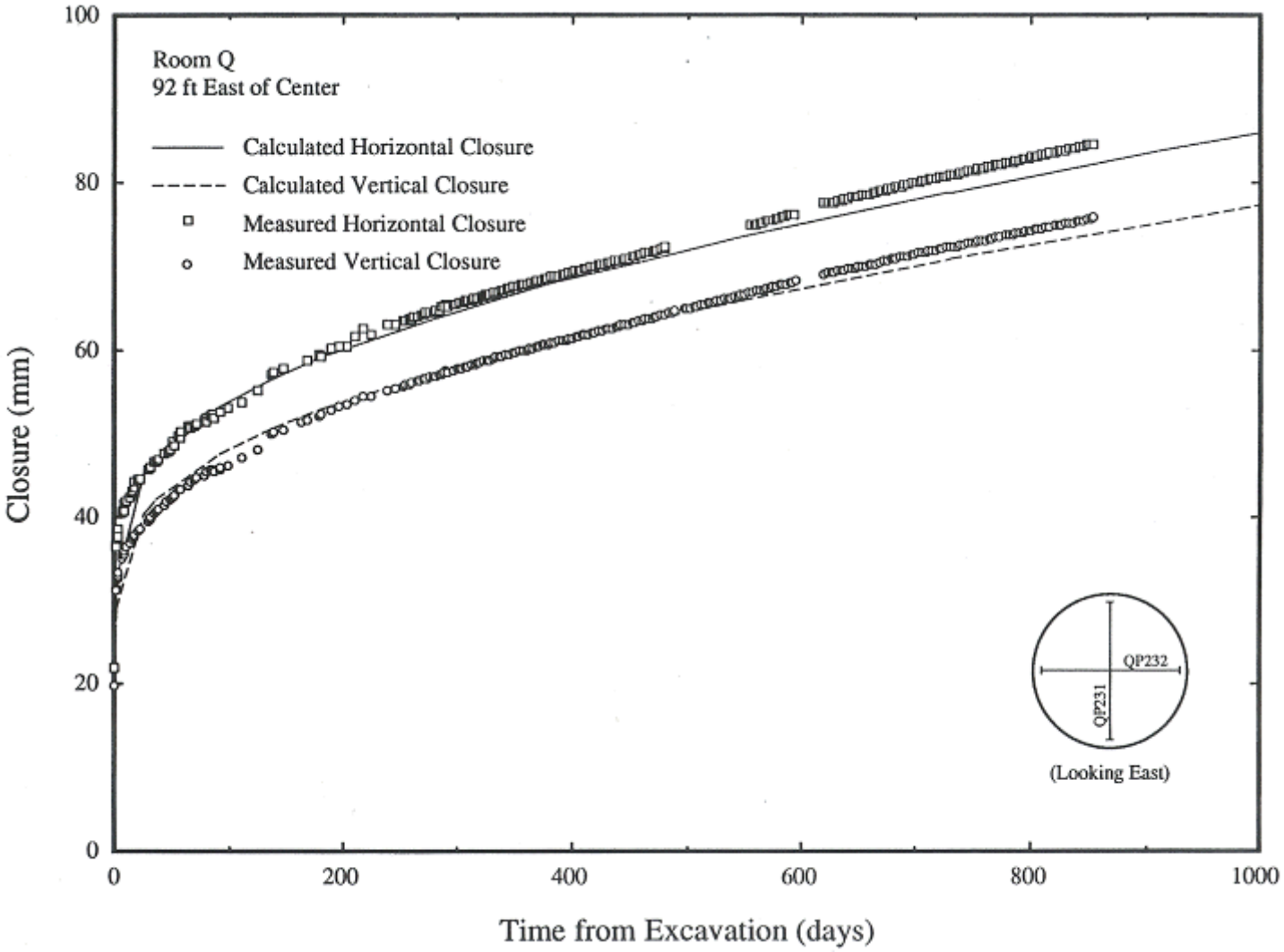
Testing of Salt-Closure Models (2)



Testing of Salt-Closure Model



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Testing of Heat-Response Model

- Circular room excavated with circular central pillar
- Circular geometry simplifies modeling

Testing of Heat-Response Model

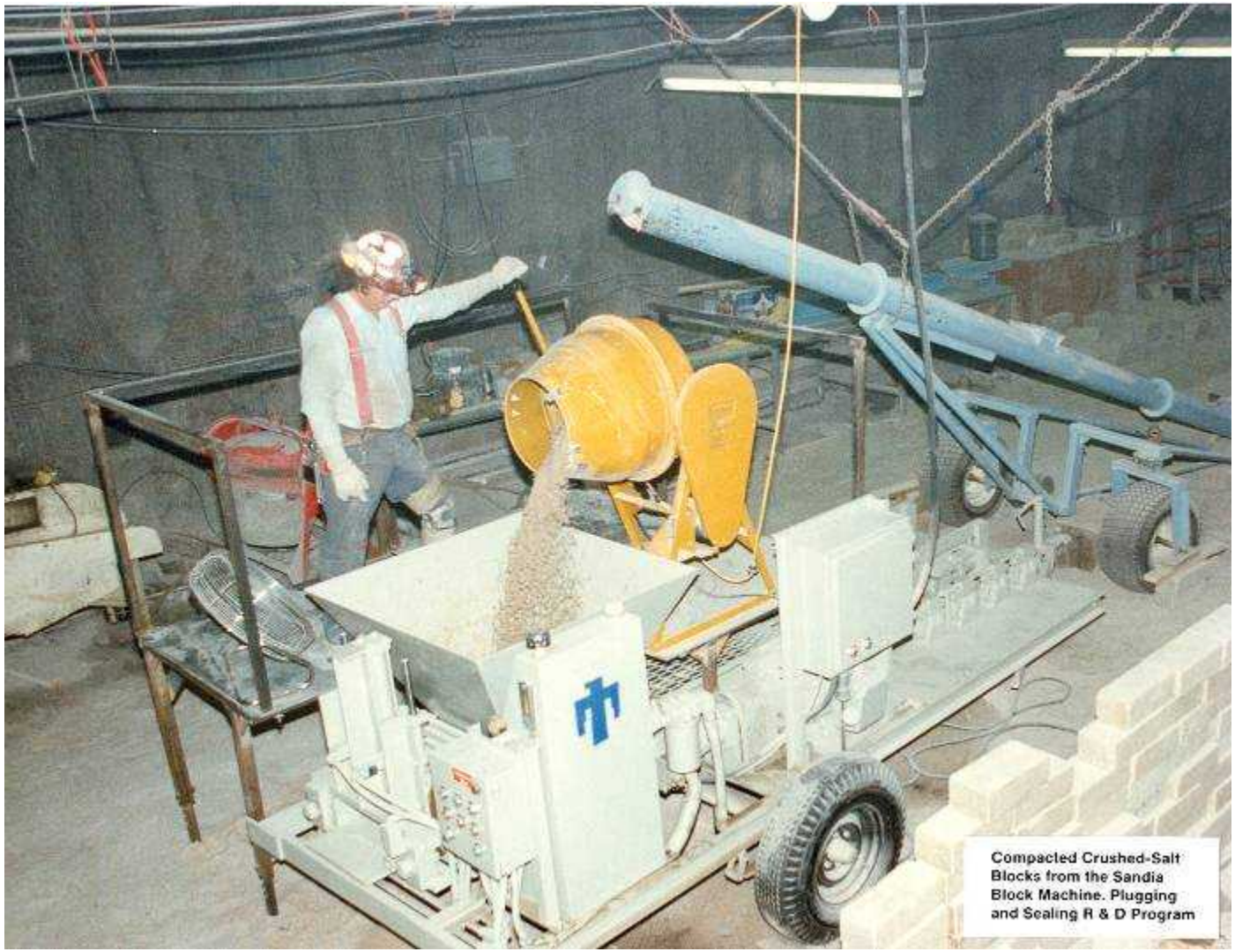
- Circular pillar wrapped with heaters to measure effects on salt creep rate

Technology Development

Development of equipment, techniques, and expertise for:

- **Underground characterization**
- **Underground testing**
- **Repository construction**
- **Repository operation**
- **Construction of engineered barriers**
- **Repository closure**

Technology Development



Compacted Crushed-Salt Blocks from the Sandia Block Machine. Plugging and Sealing R & D Program

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Demonstration Activities

- Full-scale demonstration of the feasibility of the repository design and construction
- Demonstration of the behavior and performance of components of the repository
- Demonstration of sealing, waste emplacement, and waste retrieval techniques
- May include trial disposal of actual waste
- Public tours

Demonstration of Remote-Handled Waste Emplacement

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Demonstration of Design and Excavation Feasibility

- Simulated high-level waste canisters
- 18 W/m^2 heat generation
- Demonstrate effects of heat on salt and brine migration

Demonstration of Sealing Methods

Building Confidence through Public Tours

Summary and Conclusions

- Key information to be obtained underground:
  - Hydrogeologic properties of host rock
  - Detailed understanding of rock mechanics
  - Detailed understanding of repository geochemical environment
  - Excavation-induced changes to natural system

Summary and Conclusions (2)

- Types of underground activities:
  - Characterization/experiments
  - Testing of methods, materials, and models
  - Development of technologies
  - Demonstration of methods and overall feasibility

Summary and Conclusions (3)

- Prioritization of underground activities:
  - Need to characterize *in situ* stresses before designing main repository excavations
  - Need to characterize fracture sets before siting waste packages or disposal cells
  - Need to characterize hydrogeochemical environment before redox potential is affected by excavations