General Training On Methodologies For Geological Disposal in North America

IAEA Network of Centers of Excellence

Natural and Engineered barriers at the Waste Isolation Pilot Plant

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Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company,
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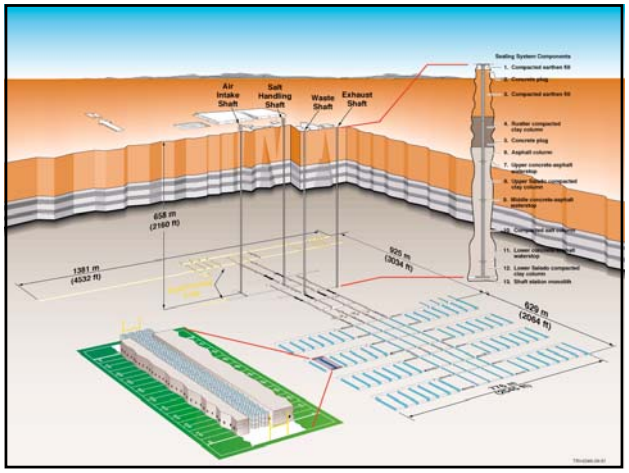
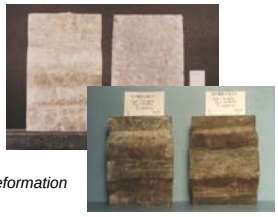


Topics

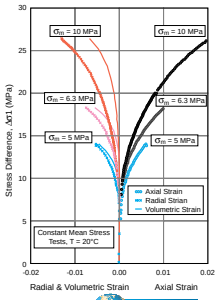
- Salt as a Natural Barrier
- Shaft Seal System Design and Analysis
- Panel Closures
- Engineered Barrier (magnesium oxide)
- Questions (?)

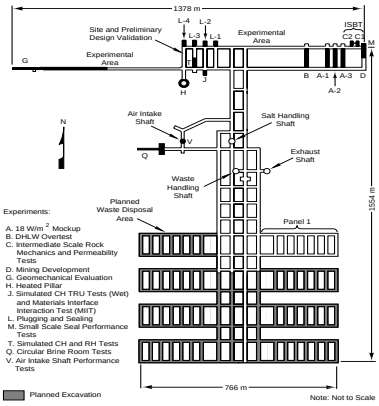
Salt Mechanics Are Well Understood

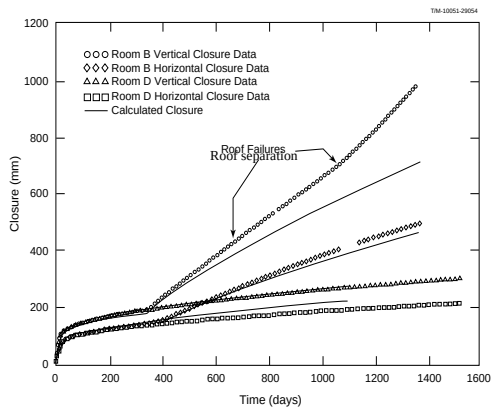
Micromechanics



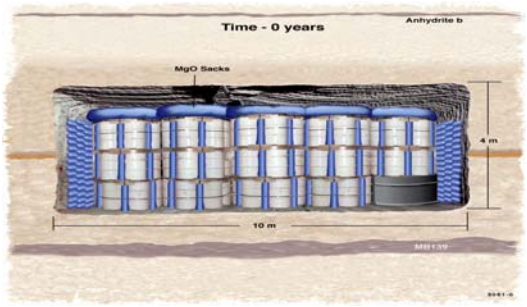
Plastic Deformation



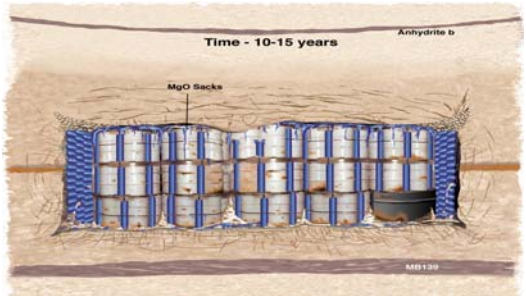




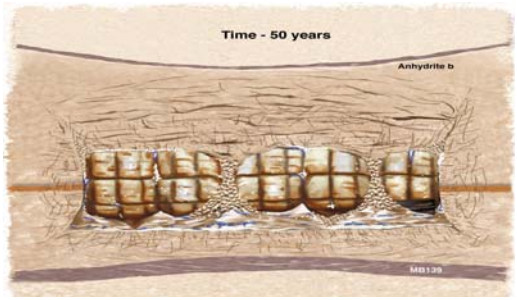
Initial Emplacement



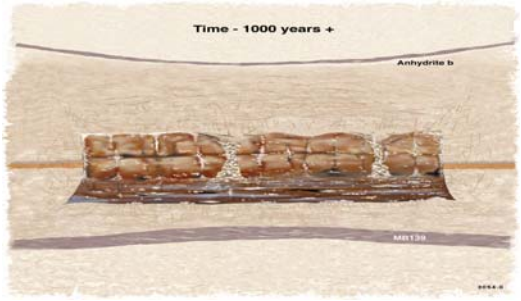
Short-Term Evolution



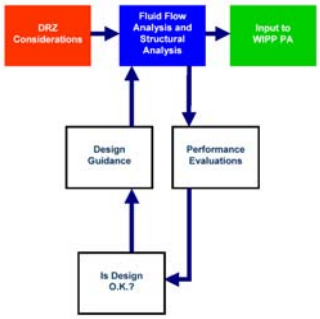
Intermediate Evolution



Long-Term Evolution



Shaft Seal System Analysis Process



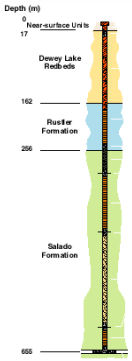
Design Guidance

- Limit hazardous constituents reaching regulatory boundaries
- Restrict groundwater flow through the sealing system
- Use materials possessing mechanical and chemical compatibility
- Protect against structural failure of system components
- Limit subsidence and prevent accidental entry
- Utilize available construction methods and materials

Material Specifications

- Functions
  - Material characteristics
    - Construction
      - Performance requirements
        - Verification methods

WIPP Shaft Seal System



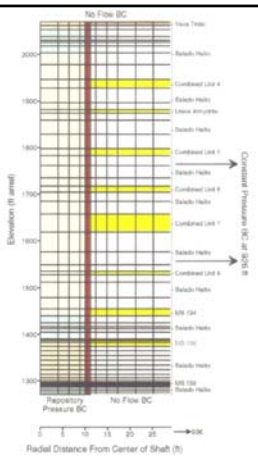
Seal System Analyses

- Fluid (brine) flow
  - Early conditions (downward flow)
  - Salt column performance
  - Long-term (ambient) conditions
- Structural
- Sensitivity analysis

Conclusions

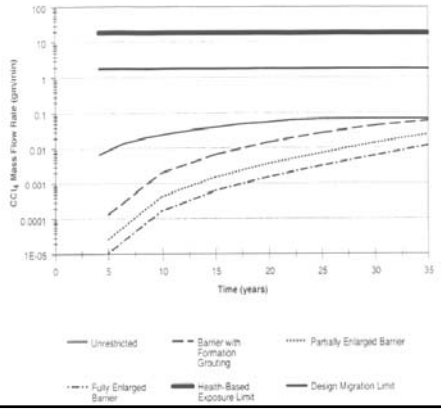
The WIPP shaft seal system effectively limits fluid flow within the seal system.

- Brine flow volumes from the Rustler downward are insignificant relative to the salt-column gas saturated pore volume and the repository pore volume.
- The salt column becomes an effective barrier to gas and brine migration by 100 years after closure.
- Long-term flow rates within the seal system are limited.

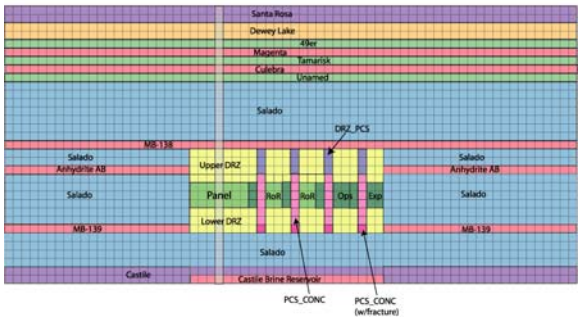


Panel Closures

- Requirements
  - Mine worker safety
    - Mine Safety Health Administration
  - Hazardous materials isolation
    - Resource Conservation and Recovery Act
      - US Environmental Protection Agency delegated authority to the New Mexico Environmental Department
      - Consultation and Cooperation Agreement with State of New Mexico
  - US Environmental Protection Agency
    - Long-term isolation requirements
      - None

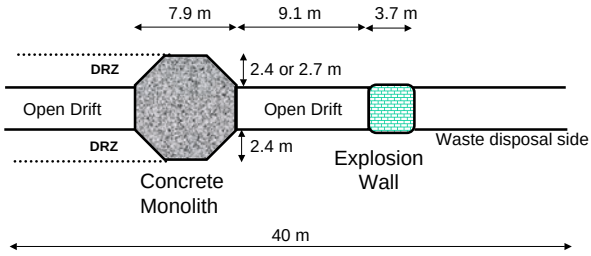


Long-Term Performance Assessment



(Logical grid)

Side View of Option D Panel Closure



(Dimensions from CCA)

The Role of MgO in the WIPP

- Definition of barriers
  - EPA defines barriers as "*any material or structure that prevents or substantially delays movement of water or radionuclides toward the accessible environment*"
- MgO will decrease solubility of actinide elements
  - DOE states in the Compliance Certification Application that MgO, panel closures, shaft seals, and borehole plugs would satisfy the EPA's assurance requirement for multiple natural and engineered barriers
- EPA rules May 1998 that MgO is the <u>only</u> engineered barrier
  - MgO thus an essential component of the certified design of the repository

Waste and MgO Placement at WIPP

Summary

- Natural setting provides substantial geologic barrier
- Detail provided for shaft seal system design and analysis provided confidence to regulators and stakeholders
- Panel closure design subject of regulatory scrutiny
- Magnesium oxide adds confidence and assurance, per regulatory requirement
- Questions ?