General Training On Methodologies For Geological Disposal in North America

IAEA Network of Centers of Excellence

Subsurface Facilities Design and Operations

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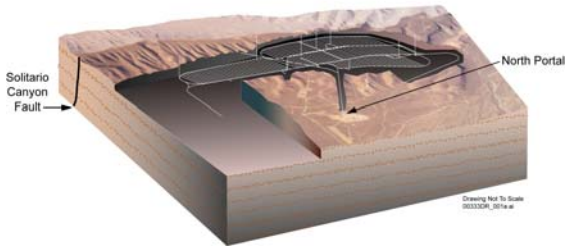
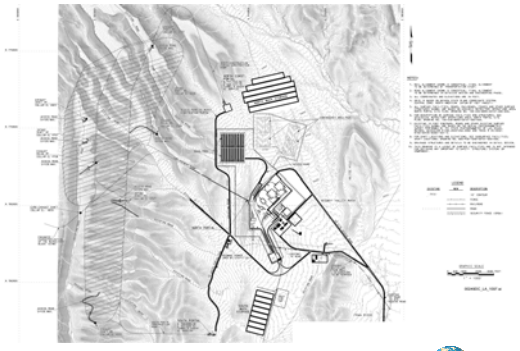
Introduction

- Repository Overview
- Process for Selecting the Emplacement Area Footprint
- Selection Criteria Used
- Geologic Setting of the Repository Host Horizon (including cut-away animation)
- The Engineered Systems – Emplacement Equipment, Ventilation, Ground Support, etc.
- The Engineered Barriers – Waste Package and Drip Shield Design

Repository Overview

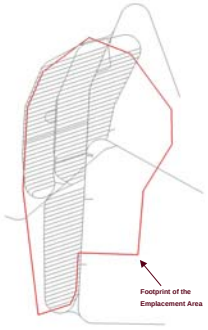


Site Plan



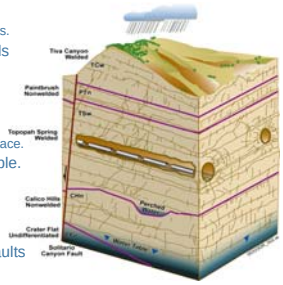
Footprint of Emplacement Area

- Proposed footprint is primarily located within the Site Recommendation (SR) emplacement area.
  - 81% of the proposed footprint lies within the SR Emplacement Area
  - SR Emplacement Area has been reduced by 23% (11% in the Southern Area)
- Footprint within previously characterized Rock mass.
- Footprint was established to reduce modeling uncertainties.
  - North Area - Water table uncertainties
  - Southeast Area - Faulting uncertainties (Imbricate fault system)
  - South and West Areas - Limited characterization data



Footprint Bounding Criteria

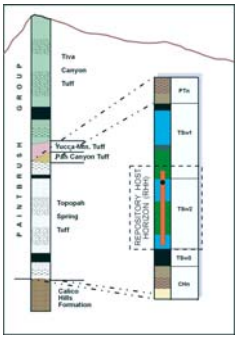
- A 100 m (328 ft) standoff from the Paintbrush Nonwelded Hydrogeologic Unit.
  - To prevent alterations due to hydrothermal effects.
- A 60 m (197 ft) standoff from the Calico Hills Nonwelded Hydrogeologic Unit.
  - To limit thermally driven alterations.
- A 10 m (33 ft) minimum thickness of the Paintbrush Nonwelded Hydrogeologic Unit.
  - To prevent excess seepage from the ground surface.
- A 120 m (394 ft) standoff from the water table.
  - To accommodate potential future water level rise (climate change).
- A 30 m (98 ft) standoff from perched water.
  - To avoid vaporization.
- A 60 m (197 ft) standoff from Quaternary faults with potential for significant displacement.
  - To reduce the impact of potential faulting.



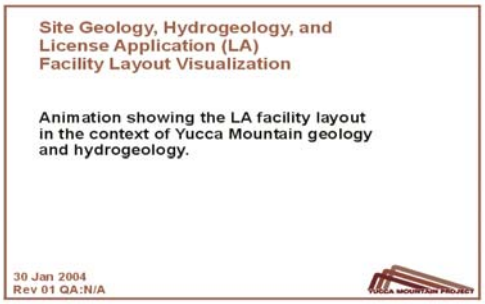
Repository Host Horizon

- Repository to be located within the Repository Host Horizon.
- The Repository Host Horizon Consists of Four Geological Subunits of the Topopah Spring Formation.
- Subunit Thickness

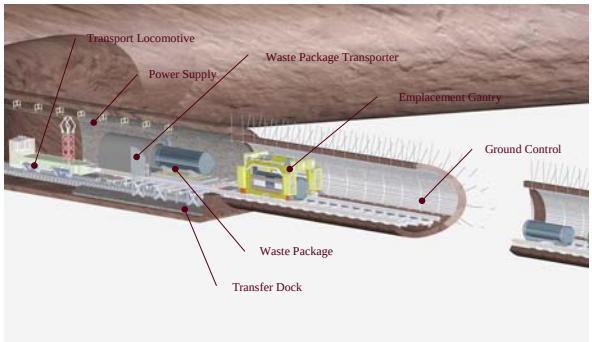
TSw1		
	Upper Lithophysal (Tptpul)	50 to 80 m (160 - 260 ft)
TSw2		
	Middle Non-Lithophysal (Tptpmn)	30 to 40 m (100 - 130 ft)
	Lower Lithophysal (Tptpll)	70 to 120 m (230 - 390 ft)
	Lower Non-Lithophysal (Tptpln)	10 to 60 m (30 - 200 ft)



License Application Facility Animation



Emplacement Equipment

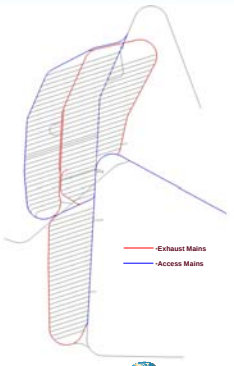


Thermal Management

- Thermal Management Goals
  - Preclosure
    - Maximum drift wall temperature is 96°C (205°F)
  - Postclosure
    - Maximum cladding temperature is 350°C (662°F)
      - Provide margin to failure by creep rupture
    - Maximum postclosure drift wall temperature is 200°C (392°F)
      - Avoid adverse mineralogical transitions
    - Provide free drainage of liquid phase water between drifts
- Thermal Management Operational Solutions
  - Waste Package Spacing
    - 0.1 m (0.3 ft)
  - Thermal Line Load
    - 1.45 kW/m (0.44 kW/ft)
  - Emplacement Drift Spacing
    - 81 m (266 ft)
  - Maximum Waste Package Power
    - 11.8 kW

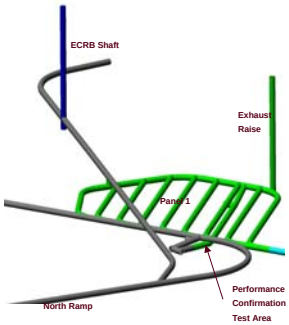
Ventilation

- Ventilation Concept
  - Emplacement operations occur on the cooler intake side.
- Flexibility
  - Design enables individual drifts to be isolated without interrupting emplacement operations.
  - High degree of operational available , redundant intake and exhausts
- Controls
  - System utilizes a single control point for each emplacement drift.
  - Regulators located at turnout for ease of maintenance
- Isolation
  - The system maintains positive control of the airflows through the use of two ventilation systems (one for emplacement and one for construction).
  - The system prevents leakage from the exhaust to the intake side.

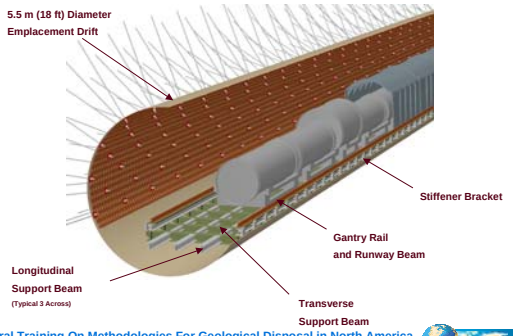


Panel 1

- Available emplacements drifts
  - 8
- Useable emplacement drift
  - Approximately 4,100 m (13,400 ft)
- Geological Location
  - 1/2 in the lower lithophysal
  - 1/2 in the middle non-lithophysal
- Ventilation
  - Intake - North Ramp
  - Exhaust - Exhaust Raise
- Performance Confirmation
  - A portion of Panel 1 will be used as a test area.



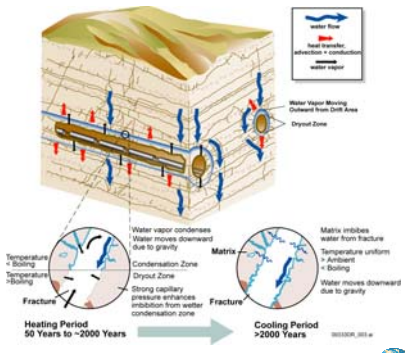
Emplacement Drift Isometric



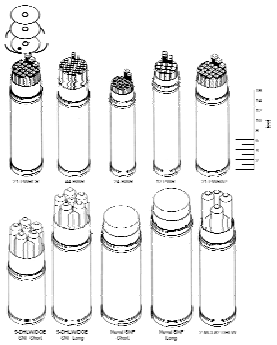
In-Drift Configuration

- Ground Support
  - Temporary Ground Support
    - Friction rock bolt and mesh ground support system
  - Permanent Ground Support
    - Stainless Steel Friction rock bolts with Stainless steel perforated sheets (Bernold-type)
    - 240 degree coverage
- Invert
  - Two Components System
    - Steel frame
      - Preclosure Corrosion Allowance - 1.6 mm (1/16 in)
    - Crushed tuff ballast material
      - 100% passing 5.1 cm (2 in)
      - <5% passing U.S. # 200 sieve size
- Invert Functions
  - Crushed tuff
    - Creates an engineered barrier to diffuse flow of radionuclides.
    - Supports pallet, waste package, and drip shield during postclosure period.
  - Steel Frame
    - Provide stable travel way Structural steel supports pallet, waste package, and drip shield during preclosure.

Thermal Hydrologic Process



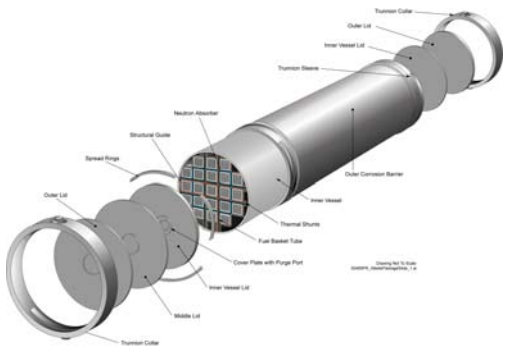
Ten Different Waste Package Configurations



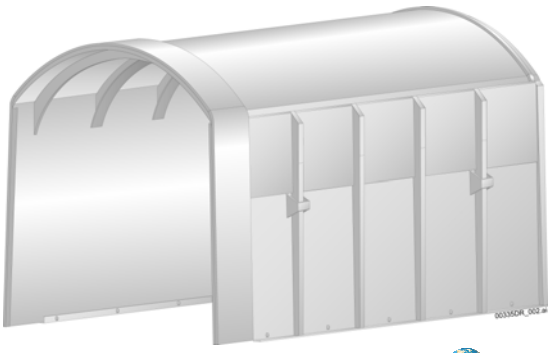
WP Level of Design For License Application

- 10 waste package configurations
- Aligned with the various waste forms.
- One design with varying diameters, lengths, weights, and internal basket configurations.

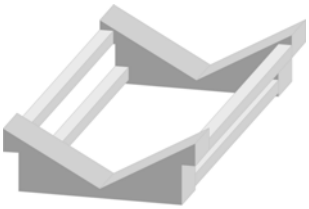
21-PWR Waste Package Assembly



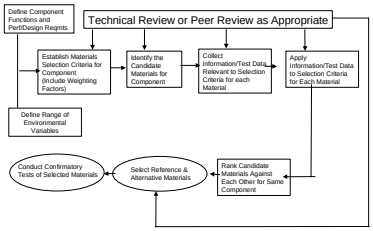
Drip Shield



Emplacement Pallet



Component Material Selection Process



Component Materials

- Waste Package Outer Corrosion Barrier:
  - Alloy 22
- Waste Package Inner Vessel (Structural Shell):
  - Type 316 Nuclear Grade Stainless Steel
- Waste Package Internals:
  - A516 Carbon Steel
- Drip Shield:
  - Titanium Grades 7 and 24
- Waste Package Emplacement Pallet:
  - Alloy 22 & Type 316L Stainless Steel

Summary - What Was Covered

- An overview of the repository design and subsurface layout.
- Critical selection criteria for the natural barriers used to define the footprint.
- A description of the natural barriers, and the location of the engineered systems.
- A description of the engineered systems and engineered barrier design.