SUBJECT: CONCEPT OF REPOSITORY OPERATION-SUBSURFACE

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Overview

• Current concept of operations (subsurface) and its compatibility with
  – Waste isolation and thermal management strategies
  – Drift monitoring, retrieval
  – Reasonably available technology needs
• Use of ventilation during preclosure period
• Alternative concepts considered
• Drift monitoring and maintenance after emplacement
• Summary
Key Concepts for Subsurface Operation

- Integrated rail transport will be used for subsurface transport of waste packages
- Waste packages will be emplaced in-drift in a horizontal mode
- Individual waste packages will not be shielded to personnel limits
Key Concepts for Subsurface Operation

(Continued)

• Remote handling and robotics will be used, where applicable, to achieve the concept of as low as reasonably achievable (ALARA)
• No human entry will be allowed in an emplacement drift while waste packages are present
• Repository will be designed for a retrievability period of up to 100 years
• Backfill options will be maintained
Conceptual Repository Subsurface Facilities Layout
WASTE PACKAGE TRANSPORT CASK LOADING
Offloading MPC-Based Waste Package into End of Emplacement Tunnel
Underground Locomotive Moving Waste Package to Emplacement Location

LOCOMOTIVE
(Operated Remotely)

PREVIOUSLY EMLACED MPC WASTE PACKAGES

MPC BASED WASTE PACKAGE

EMPLACEMENT TUNNEL
Compatibility with Current Thermal Management Strategy

The following design and operational concepts are being evaluated to maintain flexibility with respect to the thermal management strategy:

- Waste acceptance strategy for emplacement
- Arrangement of drifts and waste package spacing
- Utilization of "edge effect"
- Re-positioning of waste packages prior to closure
- Aging of selected waste packages at the repository
- Ventilation of emplacement drifts
Compatibility with Current Thermal Management Strategy

Waste acceptance strategy for emplacement

- Oldest fuel first (OFF) vs. youngest fuel first, at least 10 years (YFF + 10)
  - OFF total heat output 68.3 mW
  - YFF (+10) total heat output 85.6 mW
  - A 17.3 mW difference in emplaced heat
Compatibility with Current Thermal Management Strategy

Waste acceptance strategy for emplacement

- Current waste emplacement rate is 70,000 MTU emplaced in 23 years
- Flexibility of thermal strategy can be increased by lowering the emplacement rate and by providing lag storage facility
850 MTU/YR EMPLACEMENT RATE @ 25 MTU/AC
2 TBM OPERATION

DRIFT LAYOUT WITH CHANGE IN SPACING MID-BLOCK
INTERIM ESF/REPOSITORY CONCEPTUAL LAYOUT: OPTION 1
WITHOUT EALCO MILLS DRIFTS

PAGE OF 1/1
DRAWN: R. CHESTNUT
DESIGNED: O. MACENZIE
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CONCEPTUAL
Compatibility with Current Thermal Management Strategy

Arrangement of drifts and waste package spacing:

- Many combinations of waste package and drift spacing can lead to same areal thermal loading
- Various arrangements will lead to different thermal near-term regimes for the same areal load
MINIMAL DISTURBANCE EMPLACEMENT PATTERN

LOCALIZED DISTURBANCE EMPLACEMENT PATTERN
Compatibility with Current Thermal Management Strategy

Utilization of “Edge Effect”

- Repository edge will shed heat at a higher rate due to boundary condition
- Take advantage of this phenomenon to emplace waste packages at higher density to achieve the desired thermal load
PACKAGE SPACING STRATEGY TO UTILIZE THE EDGE EFFECT

NOT TO SCALE
Compatibility with Current Thermal Management Strategy

Re-positioning of waste packages
- Adjust thermal loading any time before closure
- Smooth out uneven localized thermal loads
GANTRY CONCEPT 'ROTATING HINGE DESIGN'
FOR TRANSPORT/EMPLACEMENT OF WASTE PACKAGE

WASTE PACKAGE 66 METRIC TONS (1.8 m DIA x 5.7 m LONG)
Compatibility with Reasonably Available Technology

- The following current concepts of operation are considered to be compatible with reasonably available technology:
  - Excavation system using TBM and mechanical excavation of shafts
  - Transportation of waste package using rail system
  - Emplacement of waste packages using rail cart or gantry system
MECHANIZED TBM LAUNCH CONCEPT

- TBM
- TRANSITION TUBE
- HORIZONTAL CLAMP CYLINDERS (2)
- LAUNCH TUBE
- RAIL MOUNTED CARRIER
- INVERT SEGMENT
- TBM LAUNCH MAIN
- POSITIONING CYLINDER
- THRUST REACTION SHOE
Compatibility with Reasonably Available Technology

- Concepts requiring further evaluation for compatibility with reasonably available technology:
  - Emplacement drift maintainability for 100-year retrievability period
  - Retrieval equipment
  - Cooling during retrieval
  - Recovery from accident events
  - Backfill system
  - Remote handling and application of robotics
  - Monitoring
Compatibility of Current Concepts with Retrieval

- Option for retrievability is integral in all concepts being considered
- Emplacement method and drift orientation (level, straight) should facilitate retrievability
- Emplacement drifts are oriented favorably with joint system to promote stability and are planned to be supported robustly
- Backfill (if used) will be emplaced only at closure
- Access drifts, shafts, and ramps are all away from emplacement area for accessibility during retrieval
Use of Ventilation During Preclosure Period

• Ventilation can be used during emplacement and caretaker period of time to meet various thermal strategies
  – Remove heat and moisture
  – Maintain a target drift surface/air temperature
  – Smooth out “hot spots” during preclosure period
Effect of Water Vapor on Airflow for Drift Temperature Control

Water Supply Needed to Reduce Airflow for Drift Temperature Control

11 Tonne per Day per Drift
= 1,200 Liter/min
Maintain Emplacement Drift Temp. at 90 °C by Continuous Ventilation

<table>
<thead>
<tr>
<th>Year</th>
<th>Air Quantity (YFF/+10)</th>
<th>Additional Shafts (8 m Diam)</th>
<th>Air Quantity (OFF)</th>
<th>Additional Shafts (8 m Diam)</th>
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<tbody>
<tr>
<td></td>
<td>m³/s (kcfm)</td>
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<td>m³/s (kcfm)</td>
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<td>2010</td>
<td>128 (272)</td>
<td>-</td>
<td>127 (270)</td>
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<td>2015</td>
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<td>998 (2,115)</td>
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<td>317 (762)</td>
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<td>287 (609)</td>
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</tbody>
</table>

TOTAL # OF ADD. AIR SHAFTS: 2 (for YFF) 2 (for OFF)

* Based on 100 MTU/Acre
Alternative Concepts of Operations Considered to Date

- Vertical emplacement in boreholes of MPC-based 12- and 21-PWR waste packages
  - Thermal analyses and systems study indicated the unfeasibility of emplacing large waste packages in boreholes

- Sub-surface waste package transportation system
  - Trucks and crawler mounted transport vehicles were considered. With development of <3% grade repository layout, integrated rail system was the preferred method

- Many options of excavation methods using tunnel boring machine are under consideration
Drift Maintenance and Monitoring Concepts

- Emplacement drifts are oriented favorably with respect to joint sets and excavated at less than 30 percent extraction ratio to promote stability.
- Drifts support system through retrievability period is being evaluated in FY95.
- Remote handling may be used to perform routine monitoring activities during the preclosure period (planned for FY96).
Summary

• Current concepts of operation are geared towards maintaining flexibility to meet the evolving thermal and waste isolation strategies

• Various methods such as emplacement mode, waste package spacing, relocation options, and others are being evaluated for maintaining operational flexibility

• Reasonably available technology is being evaluated for construction, operation, and closure

• Alternatives are being evaluated for all major design features, and few have been closed to date