NUCLEAR WASTE TECHNICAL REVIEW BOARD
FULL BOARD MEETING

SUBJECT: SUBSURFACE REMOTE OPERATIONS

PRESENTER: ALDEN M. SEGREST

PRESENTER’S TITLE AND ORGANIZATION: MANAGER, MGDS DEVELOPMENT
MANAGEMENT AND OPERATING CONTRACTOR
LAS VEGAS, NEVADA

TELEPHONE NUMBER: (702) 794-1924

ARLINGTON, VIRGINIA
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Remote Operations Issue

The issue is the application of remote handling technology to subsurface repository operations, which is characterized by

- High radiation environment
- Elevated temperatures
- Confined operating area
- Access limitations for maintenance/repair
Why is the Remote Operations Issue an Important one to Repository Subsurface Design?

- Emplacement drifts will compose 90% of the subsurface area

- Under normal conditions, emplacement drifts are off-limits to personnel due to high heat (up to 200 °C) and high radiation
  - Therefore, all operations within emplacement drifts during and after waste emplacement must be operated remotely

- Repository design concept relies on the successful implementation of remote systems
Impacts of the Remote Operations Issue on Design

- Loaded disposal container
  - Transport from waste handling building at the surface to emplacement drift entrance
  - Transfer at emplacement drift entrance
  - Emplacement/retrieval operation

- Operation of rail switches and emplacement drift access control doors

- Performance confirmation tasks

- Recovery from off-normal conditions
Subsurface Remote Operations
For Disposal Container Handling

Underground Haulage → Transfer at Emplacement → Emplacement

Retrieval

Monitoring and Performance Confirmation
Recent Activities to Resolve the Issue

Extensive review of available technologies performed during FY96: research sources include

- Mining industry: automated mining applications
- Railroad industry: automated locomotive and rail systems
- Nuclear industry: automation and robotics for high radiation environment
- Industrial application: automation, robot manipulators, controls
Recent Activities to Resolve the Issue (continued)

- Nuclear waste programs: Yucca Mountain Project, Waste Isolation Pilot Plant (WIPP)

- DOE research: intelligent mobile vehicles, advanced remote systems

- NASA research: telerobotics, operator interfaces, communications

- University research: sensors, computers, robotics, controls
Recent Activities to Resolve the Remote Operations Issue

Work has been focused on the following areas:

- Mobile remote communication technologies
- Power source technology for mobile remote machines
- Remote systems for hazardous environment
- Electronics, sensors, and equipment designed for use in elevated thermal and radiation environments
Results of Recent Remote Systems Design Effort

The evaluation of technologies are performed with licensing consideration of safety, redundancy, and back-up systems for critical items.

Evaluation criteria

- Personnel safety
- Functionality
- Reliability, maintainability
- Proven technology
- Passive/active components
Results of Recent Remote Systems Design Effort

Evaluation criteria (continued)

- Customization required
- Survivability
- Installation complexity
- Installed, operational, and management costs
Results of Recent Remote Systems Design Effort
(continued)

Available mobile communications technologies evaluated

- Leaky feeder coaxial cable
- Direct Radio Control
- Laser/optical
- Microwave
- Slotted microwave guide
- Infrared
- Cable reel
- Festoon
- Conductor bar

Leading candidates for further evaluation

- Direct Radio Control
- Leaky feeder
- Slotted microwave
Available mobile vehicle power technologies evaluated

- Electrical third rail
- Trolley wire
- Motorized cable reel
- Battery
- Conductor bar
- Festoon

Leading candidates for further evaluation

- Conductor bar
- Battery
Results of Recent Remote Systems Design Effort
(continued)

Preliminary conclusions from work performed to date are that for emplacement and retrieval operations (where temperature is < 50°C)

- Adequate technology exists for
  - Control, communication, command, and power
  - Locomotion/mobility, actuators, and sensors

- Key design areas are
  - Underground mobile communications
  - Mobile power
  - Systems integration
Preliminary conclusions are that for elevated temperature (up to 200° C) environment expected during performance confirmation period poses significant design challenges

- Promising technologies for elevated temperature applications are
  - New heat-tolerant electronics
  - Active and passive cooling systems
  - Advance heat insulation and heat rejection techniques
Recent Activities to Resolve the Issue
(continued)

For recovery from off-normal conditions

• Equipment failures such as derailment, stuck isolation doors, loss of power, communication, and other system failures are being considered in development of remote systems
  - Subsystems critical to remote systems operation will have built-in redundancy and back-up systems to ensure safety and reliability
  - Provisions will be made for inoperable remote vehicles to be removed from inaccessible areas
Planned Activities to Resolve this Issue

FY97 activity in the remote operations area will focus on

- Selection of preliminary remote handling concepts for
  - Subsurface waste package handling equipment and related communications and power supply
  - Mobile remote power, communication, and control systems for elevated thermal environment
NUCLEAR WASTE TECHNICAL REVIEW BOARD
FULL BOARD MEETING

SUBJECT:  DRIFT STABILITY AND MAINTENANCE

PRESENTER:  ALDEN M. SEGREST

PRESENTER'S TITLE AND ORGANIZATION:  MANAGER, MGDS DEVELOPMENT
MANAGEMENT AND OPERATING CONTRACTOR
LAS VEGAS, NEVADA

TELEPHONE NUMBER:  (702) 794-1924

ARLINGTON, VA
OCTOBER 9-10, 1996
Overview

• Description of the drift stability issue and long-term maintenance
• Impacts of the drift stability issue on repository design
• Recent activities to resolve the issue
Drift Stability and Maintenance

Drift stability and maintenance is an issue because

• Construction material for ground support must be compatible with post-closure performance

• The ground support method used must be compatible with
  – Performance confirmation requirements
  – Construction method

• Drifts must be safely useable for a long operational life including a potential retrieval period

• Emplaced waste packages producing heat and radiation will make access difficult for drift maintenance
Impacts of the Drift Stability and Maintenance Issue on Design

This issue affects the following aspects of repository design:

- Ground support system
- Repository layout
- Retrievability
Impacts of the Issue on the Design of Ground Support System

- Post-closure performance of repository affects the selection of ground support material, such as concrete or steel
- Requirement for data collection, such as mapping in emplacement drifts during construction, affects the method of support, such as cast-in-place or pre-cast concrete
- Long operational life, high temperature, radiation, and the need to minimize maintenance of ground support affect the selection of a support system
Impacts of the Issue on the Design of Repository Layout

- The orientation and location of the repository is affected by drift stability consideration. The repository is oriented so as to minimize adverse influence of faults and dominant fracture system.
- The size and shape of the drifts are affected by long-term stability considerations.
- The lengths of the emplacement drifts are influenced by considerations of ease-of-access and maintenance.
Impacts of the Issue on Design of Retrieval

• The ease and viability of retrieval depends on the design of a reliable ground support system

• The expected off-normal conditions to be dealt with during retrieval will depend on the system of ground support
Recent Activities to Resolve the Issue

- Using the Repository Board of Consultants to guide the evaluation of most likely candidate support system(s)
  - Providing a single and robust ground support design suitable for all expected rock conditions
  - Seeking economy in efficiency of construction of support system by making the system most compatible with the expected tunnel boring machine excavation system
  - Using the best available information from the excavation of the Exploratory Studies Facilities
Ground Support System Concept
Recent Activities to Resolve the Issue

(Continued)

• Reduced the length of emplacement drifts to a range of 350 to 600 m for ease-of-access and maintenance. Emplacement drifts accessible from the east and west sides of the block

• Developed gantry system to move waste packages out of emplacement drifts for maintenance, when required

• Provided empty drifts at intervals to “park” waste packages to allow access to emplacement drifts to be maintained
Current Repository Layout

- Development Access Ramp
- Waste Ramp
- Development East Exhaust Service shaft Emplacement Main
- Exhaust Shaft
- West Service Main
- "Parking" Drift
- "Parking" Drift
- Central Exhaust Drift
- Emplacement Exhaust Shaft

North (N)
Recent Activities to Resolve the Issue

(Continued)

- Working to resolve the issue of construction material usage (cementitious material) within M&O and with consultants
  - Preliminary recommendation regarding usage of cementitious material is expected by first quarter and decision for Viability Assessment is expected by the second quarter of FY97

- Addressing performance confirmation issues (e.g. drift wall mapping) with licensing and site groups