

DEEP BOREHOLE DISPOSAL TECHNICAL WORKSHOP

Nuclear Waste Technical Review Board

Panel 2- October 20-21

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Current Emplacement modes under consideration

- Drill Pipe Emplacement
- Wireline (Armored Logging Cable) Emplacement

Other Emplacement Mode Options

- Gravity or freefall emplacement
- Conveyance Liner emplacement (*This employs an inner, closed-bottom concentric casing section with a bottom circulation port, long enough to contain 40 WPs, about 900 feet in length, that would have the WPs placed with wireline while at surface, then lowered to the emplacement zone via drill pipe*)

Drill Pipe Emplacement Advantages

- Lifting capacity to convey multiple waste packages during one descent-fewer descents decreases possibility of accidents
- Greater strength of drill pipe is available to free waste packages or drill pipe if they become stuck in well during emplacement
- Ability to circulate above the WP – drill pipe junction to clear debris or help free stuck drill pipe

Drill Pipe Emplacement Disadvantages

- Multiple Waste Packages needed per descent for efficiency due to time required for each drill pipe descent- up to 24 hours or more for each emplacement descent
- Complex pipe handling machinery needed directly above borehole to handle and assemble waste packages
- Prolonged presence of waste packages during assembly may accelerate aging and shorten the service life of organic materials used in the seals and hydraulic hoses employed in the surface pipe handling machinery as well as the blow out preventers due to gamma ray exposure

Drill pipe Emplacement Disadvantages

- More onsite personnel needed for this option
- No option to circulate fluid down paste waste packages
- In conveying multiple waste packages, canisters are used as structural support members for canisters below, so that a structural failure of one canister can endanger other canisters.
- A failure during assembly of waste packages may leave a partially assembled waste package connection, which would not be strong enough to move, and with the waste packages in the pipe handling facility servicing or repair would be difficult.
- Waste Packages may be exposed to crushing or impact forces from drill pipe during descent or when drill pipe is being disengaged from waste package assembly
- The pipe handling machinery may be difficult to scale down for a working test, it may be necessary to build a full scale working model for testing

Wireline Emplacement Advantages

- Due to strength limits of wireline, one WP conveyed per descent, so no assembly of WPs done-this results in simpler design of surface facility and WPs
- Less time required for each emplacement descent-approximately 6 hours
- WP can be conveyed along with instrument package, so that real time data confirming presence, condition and depth of WP can be received at surface during descent
- WP is unlikely to be damaged by wireline or instrument package due to their lighter weight
- Design could include impact absorbing modules for each WP

Wireline emplacement- disadvantages

- Due to the number of descents needed- at least 400 or possibly more to complete emplacement, there is more exposure to the possibility of a WP becoming stuck or some other undesired event occurring during emplacement.
- A WP stuck with wireline may need to be recovered with drill pipe, which could introduce some of the same hazards associated with drill pipe emplacement.
- A failure of the wireline, instrument assembly or release mechanism to release could result in a failed emplacement and having to return the WP to surface for repair of wireline or associated equipment, exposing the operation to another category of hazard.
- Weight of WP and depth of emplacement zone will place tensile loads near operational limits on the wireline.

Gravity or free-fall emplacement advantages

- This is the least complex emplacement mode.
- Less personnel required for operations
- May have the lowest chance of a WP becoming stuck in the borehole, since wireline and drill pipe not being needed during operations could reduce chance of debris in borehole.

Gravity or free-fall emplacement disadvantages

- May require a directionally drilled borehole to limit descent speed and axial load on WPs
- May not be acceptable due to lack of control and monitoring during WP emplacement

Conveyance Liner advantages

- Ability to convey multiple WPs to emplacement zone in an inner liner attached to drill pipe without the need to assemble WPs to each other
- Along-pipe movement of each WP reduced by about 90%,
- Ability to circulate borehole fluid down through liner paste WPs
- Liner would protect WPs from damaging forces from drill pipe
- Design and use of casing liners is a well developed technology in the oil and gas industry with an extensive knowledge base
- Supporting bridge plugs and cementing between groups of WPs not needed as each liner is supported separately

Conveyance Liner disadvantages

- Since the conveyance liners require an outer concentric casing to engage, alteration to well design may be needed to implement this emplacement mode
- Not part of current planning

Directional drilling as part of well design to reduce operational hazards

- Directional drilling of the borehole could reduce descent speed of WPs and help limit damage from impacts with drill pipe or other equipment, and is applicable to all emplacement modes.
- Angle build rate (the curvature of the borehole) can be designed so as not to impede passage of WPs
- Another large advantage of a directionally drilled borehole is the reduction or elimination of need for bridge plugs and cementing, as the borehole trajectory will reduce axial compressive loads on the WPs. This could streamline operations and reduces debris in the borehole
- Angle from vertical at which objects “rest” (angle of repose) is about 72 degrees from vertical for materials commonly used in oil and gas drilling.

Distributed Temperature Sensor Systems (DTS)

- Fiber Optic Cable Installed along outside of casing during casing installation
- Mature technology that has been available since the 1990s
- Gives real time temperature monitoring at about every 3 feet along casing, monitored from surface
- Could be used to monitor descent or verify location of WPs, and is applicable to all emplacement modes

Design of Waste Packages

- Waste Packages may be exposed to temperatures as high as 350 degf and pressures over 7000 psi in the emplacement zone.
- A failed or damaged waste package returned to surface during a failed emplacement could possibly contain high pressures, and its resistance to internal pressures or burst rating may be less than the external pressure rating.

SUMMARY

- Gravity deployment is least hazardous in all respects, but may not be acceptable due to limitations on control and monitoring
- Conveyance Liner may eliminate or reduce hazards associated with drill pipe and wireline emplacement modes but has not been formally proposed or reviewed.
- Drill Pipe emplacement mode is the next most hazardous due to complexity of operations needed to assemble multiple WPs and due to possibility of damage to WPs
- Wireline emplacement poses the most hazard, due to the large number of descents required to complete emplacement of 400 WPs and possible combination with drill pipe operations if there are fishing events.