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Dr. Inés Triay, Manager
Carlsbad Field Office
U.S. Dept. of Energy
P.O. Box 3090
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Dear Dr. Triay:

Enclosed is a copy of a paper, titled *Evaluation of Proposed Panel Closure Modifications at the WIPP* by Allen, Abel and Morgan. The paper summarizes work performed and discussed in EEG-82, by Lawrence Allen et al, November 2001. The paper has been accepted for presentation in February 2003 at the annual meeting of the Society for Mining, Metallurgy, and Exploration (SME). This work does not address the most recent panel closure submittals to EPA and NMED (October 2002) because of paper submittal deadlines, although an update of proposed panel closure plans can be included in the presentation.

Sincerely,

Matthew K. Silva
Director

MKS:LA:pf
Enclosure

cc/enc. Betsy Forinash, EPA
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Evaluation of Proposed Panel Closure Modifications at the Waste Isolation Pilot Plant

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ABSTRACT

The Waste Isolation Pilot Plant (WIPP) is a geologic repository for disposal of transuranic waste and is operated by the U.S. Department of Energy (DOE). The repository is located at a depth of 655 m in the Permian age salt beds of the Salado Formation, 40 km east of Carlsbad, NM.

A key component in the design of the WIPP repository is the installation of concrete structures as panel seals in the intake and exhaust drifts after a panel has been filled with waste containers. The DOE has proposed several panel closure design modifications to the EPA. EPA approval of the changes is required since the details of the designs are specified in EPA's final rule as a condition for WIPP certification.

The Environmental Evaluation Group, in its role of providing technical oversight on the WIPP project, has evaluated the proposed modifications. An analysis of this evaluation is discussed.

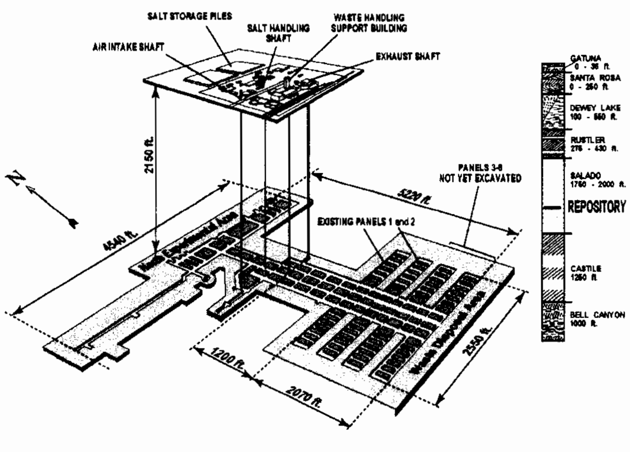
INTRODUCTION

The Waste Isolation Pilot Plant (WIPP) Project, located in southeastern New Mexico, has been constructed by the U.S. Department of Energy (DOE) to provide permanent disposal of long-lived transuranic (TRU) waste from the U.S. defense activities and programs. The repository began receiving TRU wastes in March 1999.

The underground WIPP facility design includes eight panels for disposing of TRU waste (Figure 1). At the present time waste is being emplaced in Panel 1 and excavation of Panel 2 has been completed. Each panel includes seven waste disposal rooms, a ventilation intake drift, and a ventilation exhaust drift.

Figure 1

WIPP Facility and Stratigraphic Sequence



A key component in the design of the WIPP repository is the installation of concrete structures as panel seals in the intake and exhaust drifts after a panel has been filled with waste containers (Figure 2). The panel seal closure system is intended to block brine flow, and hence, potential contaminant migration between the waste panels at the WIPP (EPA 1998, 27355). The DOE Compliance Certification Application (DOE 1996a) proposed four possible panel closure design options, with the specific option that would be implemented as determined by local panel and drift conditions. However, as a specific condition of compliance, the U.S. Environmental Protection Agency (EPA) mandated the use of one of these options, known as Option D, for all panel closures at the WIPP. The EPA further determined that the use of a Salado Mass Concrete, using brine rather than fresh water, would produce concrete seal permeabilities in the repository more consistent with the values used in the DOE performance assessment (EPA 1998, 27355).

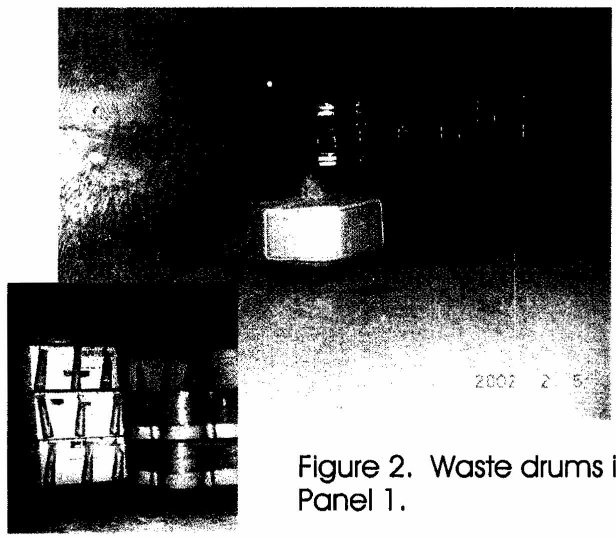


Figure 2. Waste drums in Panel 1.

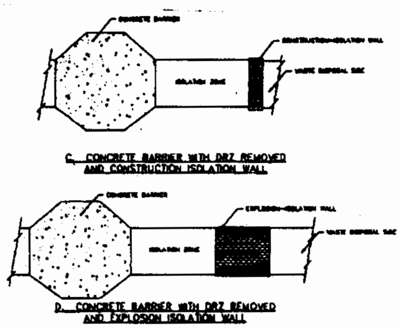
In April 2001 the DOE proposed several panel closure design modifications to the EPA (Triay 2001). EPA's approval of the proposed changes is required since details of the panel designs are specified in EPA's final rule as a condition of WIPP certification (EPA 1998, 27362). The Environmental Evaluation Group (EEG), in its role of providing technical evaluations on the design, construction, and operation of the WIPP Project, evaluated these proposed enhancements (Allen et al. 2001).

OPTION D DESIGN

The currently mandated design for panel closure, Option D (DOE 1996b), is shown in Figure 3. This design incorporates a tapered concrete barrier to seal the waste panel coupled with an explosion-isolation wall for protection during concrete barrier construction. The closure system for a panel would be constructed within 180 days of final waste emplacement within a panel.

Figure 3

Options C and D for Panel Closure Design

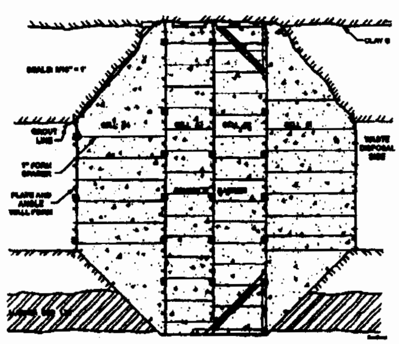


Concrete Barrier

The purpose of the concrete barrier is to provide assurance that limits for volatile organic compound (VOC) migration are in compliance for the duration of the operational emplacement period (estimated at a total of 35 years). VOCs occur in the WIPP from mixed waste originally containing quantities of VOCs or from microbrial gas generation due to decomposition of cellulose, plastic, rubber (CPR) and other organics. Large amounts of CPR are associated with the mixed waste deposited at the WIPP.

The tapered concrete bulkheads (Figure 4) were designed to seal potential leakage paths in the anhydrite Marker Bed 139 beneath the floor and in Clay G near the roof. The damaged rock zones caused fracturing in the roof and heaving, with subsequent fracturing, of the floor. These zones are removed, at the bulkheads, to also prevent potential migration.

Figure 4
Concrete Bulkhead Design.
(DOE 1996b)



The design is planned to be built using four cells. Steel forms will be used to restrain the concrete pumped into each cell until the initial set. The design specifies that these forms will then be left in place.

The EPA specified that the barrier would be constructed from Salado Mass Concrete, a specific prescription using brine from the same formation as the repository. This was done to guarantee concrete seal permeabilities consistent with values used in the performance assessment, upon which the EPA based repository certification. A crushed quartz aggregate was also specified. The concrete would be mixed at the surface and be pumped underground.

The intake drift for each panel is 6.1 m wide by 4 m high and the exhaust drift is 4.3 m wide by 3.7 m high. The intake concrete bulkhead thickness is designed at 11 m while the exhaust bulkhead thickness is 7.9 m.

The water impoundment bulkhead design method was used to confirm the ability of the concrete bulkheads to resist a methane explosion pressure (Abel 1998). Calculations showed the lowest factor of safety for the 11 m thick intake drift bulkhead is 2.40 against both pressure gradient and concrete shear. The factor of safety for the 7.9 m thick exhaust drift bulkhead is 1.54 against pressure gradient and 2.92 against concrete shear (Abel 2001). The water impoundment bulkhead method only considers the grout pressure along the rock/concrete contact and does not provide any credit for the pressure from creep closure pressure of the rock salt.

Explosion-Isolation Wall

An explosion-isolation wall is included in the panel closure design to mitigate the effects of a potential methane explosion, as well as protect against overpressure resulting from a roof fall during the concrete barrier construction period. This wall is designed to be 3.7 m thick and would be built with solid concrete blocks mortared with cement and hitched into the roof, ribs, and floor.

Methane is generated from the decomposition of organics in the mixed emplaced waste. It is assumed that the composition of the generated gas is 70 percent methane and that each drum generates between 0.01 and 1.0 mole of gas per drum per year. For an assumed composition of air in a closed panel of 18 percent oxygen, the explosive range would be from about 5 to 15 percent methane. Given an average gas generation rate and number of waste drums to be emplaced in a panel, the explosive composition would occur in about 15 to 20 years after panel closure (DOE 1995).

DOE PROPOSED MODIFICATIONS TO PANEL CLOSURE DESIGN

In April 2001 the DOE proposed seven modifications to the panel closure design system to the EPA. EEG in their role of providing technical oversight on the WIPP Project for the state of New Mexico, evaluated each of the proposed modifications.

1. Replace Salado Mass Concrete with a generic salt-based concrete.

EEG finds this proposed modification acceptable since it gives the concrete contractor more flexibility and responsibility in meeting project objectives. Specifications for the concrete should be written in performance-based language to ensure adequate performance.

2. Replace the explosion wall with a construction wall.

This modification is acceptable. A methane explosion cannot occur sooner than 15 to 20 years following panel closure and the concrete barrier bulkhead will be constructed within a year after that time. Analysis has demonstrated that a 1.2 m construction wall is adequate to protect against roof fall overpressure until the concrete bulkhead is completed (Abel 2001). The construction-isolation wall is shown in Option C in Figure 3.

3. Replace freshwater grouting with a salt-based grouting.

This modification is apparently only a point for clarification. The panel closure design report specifies that if the Salado Mass Concrete is used instead of a fresh water based cement concrete, the contractor shall use a salt saturated grout. This would be the case for a generic salt-based concrete as well.

4. Option to allow local carbonate river rock aggregate in lieu of crushed quartz.

EEG has three concerns about local carbonate river rock for use as aggregate:

- That the coefficient of thermal expansion of the aggregate influences the coefficient of expansion of the concrete containing such aggregate.
- The naturally rounded carbonate river rock may make better aggregate if it were first partially crushed.
- Some carbonate aggregate from the locale around WIPP has been reported to be chemically reactive.

Each of these concerns could be addressed through testing. Coefficients of expansion between the aggregate and concrete should be compatible. Partially crushed aggregate, containing a particular "crush-count" provides for better bonding and results in a higher-strength concrete. Chemically reactive aggregate can result in deleterious expansion of the concrete (AMEC 2001).

5. Option to allow surface- or underground-mixing.

Either surface or underground mixing is acceptable. It may be easier to meet time limitations for concrete setting if mixing is done underground.

6. Option to allow steel forms to be left in place or removed.

By providing the concrete contractor the option of either leaving the forms in place or removing them, DOE's intent is to try to reduce the number of forms remaining in the concrete bulkhead and thus reducing potential contamination migration pathways. It is EEG's opinion that rather than give the contractor the option, removing the forms should be mandated and the number of cells comprising the bulkhead should be reduced. This would also reduce potential migration pathways.

The size of these bulkheads probably precludes a monolithic single cell, but the number of cells could certainly be reduced from four or three to two. EEG recommends:

- The contractor be provided an incentive to minimize the number of cells.
- It be required that each cell be filled as a continuous monolithic concrete pour.
- It be required that the contractor support the fluid concrete in all cells with external structures.
- It be required that the contractor remove the support structures and forms between internal cells.
- That the contractor provide for a rough form surface between internal cell walls (possible with a layer of burlap).
- That the contractor should assure some grout points are located at the roof concrete/rock salt contact.
- That the use of all internal form spacer supports is prohibited.

7. Option to allow up to one year for completion of closure in lieu of 180 days.

EEG finds this option acceptable. Significant gas generation concentrations take much longer than one year to occur, and it is preferable to do the construction properly without the pressure of an artificial deadline.

CONCLUSIONS

The EPA mandated that the Option D panel closure design be implemented for the WIPP Project. The DOE proposed seven modifications to this design with the stated intent of providing construction flexibility to increase worker safety and improve the constructability of the closure system (DOE 2001).

The EEG readily agrees with five of the proposed modifications: 1) replacement of Salado Mass Concrete with a generic-salt-based concrete, 2) replacement of the explosion wall with a construction wall, 3) replacement of freshwater grouting with salt-based grouting, 4) option to allow surface or underground mixing, and 5) option to allow up to one-year for completion of closure. The proposed modification to allow local carbonate river rock is acceptable pending demonstration that no problems will exist in the resulting concrete. The proposed modification to give the contractor discretion in removal of steel forms is not supported by the EEG. Instead the EEG has proposed a number of recommendations to specifically reduce the number of forms which are left, thereby reducing potential migration pathways.

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