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Class 3 Permit Modification Request Overview

This Permit Modification Request (PMR) is being submitted to request the following changes to the closure design for the WIPP Underground Hazardous Waste Disposal Units (HWDU):

- Beginning with Panel 3, add a component to the closure design (steel bulkhead with no personnel access in the entries to each filled panel),
- Monitor behind each bulkhead for methane and other flammable gases,
- Establish action levels that would trigger the installation of other panel closure components in the event of the buildup of methane and other flammable gases behind the bulkheads,
- Collect data to be used in determining an appropriate final closure for the Underground HWDUs.

The modification of the closure plan will allow monitoring for flammable gases, if any, in the closed panels (Panel 3 and beyond). The panels will be removed from the ventilation system by installing bulkheads in the panel entries. The bulkheads will prevent entry to the panels as well as restricting release of hazardous materials into the operational areas of the repository. The concentration of flammable gases in the closed panels will be monitored periodically using the same monitoring network installed in the operational panels to monitor VOCs. Trigger values have been established, and should those trigger values be reached, actions to be taken have been determined. The trigger values are related to the concentration of the mixture of flammable gases relative to the lower explosive limit (LEL) of the mixture. Conservative transportation requirements preclude the shipment and receipt of any waste packages containing headspace gas concentrations above a flammability limit.

Hydrogen and methane may be generated from the waste after it is placed in the disposal room.. Hydrogen may be generated from radiolysis and corrosion, while methane may be generated by microbial degradation. The quantities of these gases in the as-received waste are also extremely small because of the safety requirements for transportation. Calculations based on conservatively assumed maximum gas generation rates show that more than 20 years will be required for either one to reach its explosive limit.

Generation of these gases will be sufficiently slow such that monitoring them will allow time to take appropriate action to install the rest of the closure components in the panel if the levels reach a significant fraction of their lower explosive limit.

<u>Worker Protection and the current regulatory status</u>

The purpose of the Panel Closure System is to protect human health and the environment, during the operational phase. In the context of the WIPP waste panels the potential hazards come from the escape of hazardous gases into the work atmosphere or into the environment. The Hazardous Waste Facility Permit (HWFP) states that:

> *"Closure at the panel level will include the construction of barriers to limit the emission of hazardous waste constituents from the panel into the mine ventilation air stream below levels that meet environmental performance standards and to mitigate the impacts of methane buildup and deflagration that may be postulated for some closed panels."*

It goes on to state that:

> *"The design of the panel closure system is based on the criteria that the closure system for closed underground HWDUs will prevent migration of hazardous waste constituents in the air pathway in concentrations above health-based levels beyond the WIPP land withdrawal boundary during the thirty-five (35) year operational and facility closure period and to withstand any flammable gas deflagration that may occur prior to final facility closure."*

The hazardous materials which might escape from the panels are VOCs. Hazardous materials which might accumulate in panels are non-VOC explosive gases. VOCs are monitored during waste operations in a panel through a network of tubing installed in the rooms, as well as outside of the operational panel. The non-VOC gases of concern are the flammable gases methane and hydrogen, which may be generated by reactions in the waste.

The HWFP goes on to stipulate that the design of the panel closure will follow that described in the application as Option D, consisting of a concrete monolith and explosion-isolation wall:

> *"Although the permit application proposed several panel closure design options, depending on the gas generated by wastes and the age of the mined openings, the NMED and EPA determined that only the most robust design option (D) would be approved."*

However, the HWFP goes on to state that:

> *"This decision does not prevent the Permittees from continuing to collect data on the behavior of the wastes and mined openings, or proposing a modification to the Closure Plan in the future, using the available data to support a request for reconsideration of one or more of the original design options. If a design different from Option D as defined in Permit Attachment I1 is proposed, the appropriate permit modification will be sought."*

In October 2002 a Class 3 PMR was submitted to NMED to request approval of a revised closure design, and a concurrent PCR was submitted to EPA. Since the EPA was entering a consideration of the first Recertification for the WIPP they advised DOE that they would not be able to consider the PCR at that time. In view of this delay, the DOE submitted a Class 1* PMN to NMED asking for an extension of the time to close Panel 1. Specifically the request was to install the explosion isolation wall component of the Panel

closure System, but to delay installing the concrete monolith until the request for a modified design had been considered. This request to NMED was supported by an engineering assessment of the short-term stability of the explosion isolation wall.

This request was approved in a letter to DOE from NMED in December 2002:

> *NMED has modified the language in Attachment I, Section 1-ld(9) to read as follows:*
>
> > *"The Permittees will initially block ventilation through Panel 1 as described in Permit Attachment M2, once Panel 1 is full to ensure continued protection of human health and the environment. The Permittees will then install the explosion isolation wall portion of the panel closure system that is described in Permit Attachment I1, Section 3.3.2, Explosion- and Construction-Isolation Walls. Construction of the explosion isolation wall <u>will not exceed</u> 180 days after the last receipt of waste in Panel 1. <u>Final closure of Panel 1 will be completed as specified in this Permit no later than five years after completion of the explosion isolation wall.</u>"*
>
> *Furthermore, NMED has modified Note 5 to Table I-1, Anticipated Earliest Closure Dates for the underground HWMUs to read as follows:*
>
> > *"NOTE 5: The anticipated closure end date for Panel 1 is for installation of the <u>12-foot</u> explosion isolation wall. <u>Final closure of Panel 1 will be completed as specified in this Permit no later than five years after completion of the explosion isolation wall.</u>"*

A similar request for panel 2 was approved by NMED in 2005.

<u>Design of the explosion isolation wall</u>

As noted above, the currently approved design by NMED and EPA is that described in the permit application and certification application as Option D, consisting of removal of the DRZ, emplacement of a concrete monolith, with a 12 foot explosion wall on the waste side of the closure. As also noted above, NMED has approved a change in the closure schedule for Panels 1 and 2 such that the explosion wall would be installed once the panels were filled, but the construction of the concrete monolith would be delayed until the PMR has been reviewed by NMED and the Planned Change Request approved by EPA. As a result of these requests, and the subsequent approval of NMED, explosion walls have been emplaced in Panels 1 and 2. Since the five year extension of the closure period for Panel 1 will end in September 2008, and since review of the new proposed design is not expected to be complete by that time, a request for an additional extension has been sent to NMED.

The stability of the existing explosion walls has been verified by periodic inspection: the walls in Panel 1 show only minor surficial spalling of the front face, especially in the

corners due to load imposed by salt creep. The walls in Panel 2 show no visible effects of stress build up. A further assessment shows that the explosion isolation walls will remain stable for the additional time necessary for regulatory actions (Further Assessment of Short-term Stability of the 12 Foot Explosion Isolation Wall, RockSol Consulting Group, Inc., June 30, 2006).

Purpose of monitoring

Gas may be generated in closed panels that contain waste. Carbon dioxide and methane may be generated under inundated to humid conditions by the microbial degradation of cellulosics, plastics and rubbers (CPR) in the waste. The generation of methane relative to carbon dioxide is uncertain. Hydrogen may be generated by radiolysis, or by corrosion of the steel drums and other steel materials in the waste under inundated conditions. Inundated conditions are not expected to occur throughout the life of the repository. For both gases, there are considerable uncertainties in the rates of gas generation. These include brine/moisture availability, the viability of microbes over the long-term in the WIPP, the extent to which certain CPR components are susceptible to microbial degradation, and the extent to which steel materials in the waste may be passivated under WIPP conditions.

Monitoring of the quantities of hydrogen and methane present over the time period of interest (during operations) is an effective way to gather data which will help establish whether generation of these gases actually occurs and if so, determine more realistic generation rates. This monitoring will provide data to assure worker safety during operation of the repository. In addition, gathering these data may also be a benefit if they allow the confirmation or refinement of some of the mechanisms included in performance assessment. Using actual data to verify mechanisms included in the performance assessment will enhance public confidence in the scientific understanding of the repository and waste degradation mechanisms. Monitoring of these gases also fulfills a recommendation from the NAS WIPP committee.

> *The committee recommends pre-closure monitoring of gas generation rates, as well as the volume of hydrogen, carbon dioxide, and methane produced. Such monitoring could enhance confidence in the performance of the repository, especially if no gas generation is observed. Observation should continue at least until the repository shafts are sealed and longer if possible. The results of the gas generation monitoring program should be used to improve the performance assessment for recertification purposes.*

This PMR concentrates on monitoring hydrogen and methane, and does not include carbon dioxide for the following reasons:

- Hydrogen and methane are the only hazardous gases expected to be generated.
- Hydrogen and methane generation may develop a potentially explosive mixture over a long period of time.

- The presence or absence of methane as a generated gas will help validation of the current microbial gas generation models.
- The presence or absence of hydrogen as a generated gas will help validation of the current radiolysis and corrosion models.

Potential Sources of Hydrogen and Methane

Hydrogen can be generated by radiolysis and by corrosion of iron based materials under inundated conditions. A conservative, constant estimate of the production rate of hydrogen by radiolysis of waste, based on the inventory from a full Panel 3, is about 4.5E-05 moles per second. Generation at this rate might lead to an average concentration of 5% by volume in a filled and closed WIPP panel in about 20 years ("Estimation of Hydrogen Generation Rates From Radiolysis in WIPP Panels", July 26, 2006), neglecting any loss of hydrogen by diffusion. In reality hydrogen generation by radiolysis should decrease asymptotically to a very low value. Hydrogen generation by corrosion is only expected under inundated conditions, a situation which cannot be reasonably expected during the operational period.

Methane can be produced from microbial degradation of cellulosics, plastics and rubbers. These microbial processes are conceptualized to occur sequentially, with the organic carbon being consumed by denitrification, followed by sulfate reduction, both of which produce carbon dioxide, and ultimately by methanogenesis which produces carbon dioxide and methane (Brush 1990; Brush 1995; Wang and Brush 1996a). In the WIPP, nitrate (NO_3^-) and sulfate (SO_4^{2-}) will be present in the waste and it is assumed that methane will not be produced until these electron acceptors are exhausted.

Under some scenarios envisaged for the WIPP sufficient sulfate will be available from the waste, the Salado and Castile brines, and sulfate minerals in the surrounding rock mass to prohibit methane generation. Under other scenarios the sulfate is limited to that in the waste and Salado brines: in this case it is estimated that denitrification, sulfate reduction, and methanogenesis consume 4.72%, 0.82%, and 94.46% of the organic carbon in CPR materials, respectively (Hansen et al. 2004)(DOE 2004, Appendix BARRIERS). If it is assumed that the processes are indeed purely sequential, then it may be assumed that no methane will be generated until about 5.5% of the CPR has been degraded. With the shortest time for full degradation of the CPR estimated at about 200 years, this means no methane will be generated for the first 10 years after degradation starts. If it is assumed that the generation rate will be 0.1 moles per drum per year, then it will take about 20 years after that for a 5% methane concentration to be achieved (DOE 2004, Appendix PCS).

There are flammable VOCs in the waste. However these represent a fixed source which will deplete over time, and a source which is limited to levels well below flammability by the transportation requirements. Since additional VOCs are not generated the quantities of the flammable components are expected to be quite small, and hence are not considered a significant issue related to the development of an explosive atmosphere in a closed panel.

Trigger levels and related actions

The monitoring plan includes trigger levels (action levels) based on the concentration of the flammable gases relative to their lower explosive limits in order to ensure that if an explosive mixture continues to develop within a panel, the panel will be closed using the existing approved panel closure design to ensure the protection of human health and the environment.

- The flammable gases which might be generated are some combination of hydrogen and methane. Hydrogen has a lower explosive limit of 4% while that for methane is about 5% under the oxygen conditions expected during the operational period.

- The lower trigger level for a mixture of methane and hydrogen in a panel is 10% of the mixtures LEL for the gas mixture in that panel.

- The upper trigger level for a mixture of hydrogen and methane in a panel is 20% of the mixtures LEL for the gas mixture in that panel.

Bulkhead design, monitoring plans and related actions

The proposed bulkhead which will be used in the panel entries to remove the panel from the ventilation system will be constructed similar to those currently used for ventilation control in the WIPP underground. The bulkhead will consist of a steel member frame covered with galvanized sheet metal, and will not allow personnel access. Rubber conveyor belt will be used as a gasket to seal the steel frame to the salt. (Figure 1). Over time it is possible that the bulkhead may be damaged by creep closure around it. If the damage is such as to indicate a possible loss of functionality then an additional bulkhead will be constructed outside of the original one.

VOC monitoring in the closed panels will be continued until such time as the Class 3 PMR for monitoring behind the bulkhead is approved by the NMED. The action levels for closed room monitoring will remain the same as those specified in Permit Condition IV.F.3.b.

Once the Class 3 PMR is approved, hydrogen and methane will be monitored using the monitoring lines installed during operations, as detailed in the current monitoring plan (Attachment N). Hydrogen and methane will be monitored using a similar technique to that currently used for VOC determination, that is, a period of purging of the lines followed by collection of samples for laboratory determination. Monitoring will occur in each of the closed rooms, behind the bulkhead and immediately outside of each bulkhead. If more than one-half of the 14 sampling lines back to the disposal rooms fail during the monitoring process, an explosion isolation wall will be installed.

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The sampling schedule to be followed will be:

- Conduct sampling at monthly intervals to establish the panel baseline.
- Once baseline is established, sample bimonthly if baseline is greater than 5% of the mixed LEL. Otherwise sample quarterly.
- When the lower trigger level is exceeded, sample monthly. If samples drop below the lower trigger level resume bi-monthly sampling.
- If the upper trigger level is reached for three consecutive monthly readings, commence closure with approved design.

The use of this bulkhead design, the accompanying monitoring, and related trigger levels will ensure safe operations:

- Ingress to the closed panel will be prevented
- The conditions inside the panel, in terms of flammable gases, will be known at all times, and preventive actions are taken well before a potentially dangerous accumulation occurs.

<u>Actions after completion of waste operations in Panels 3-6</u>

At the conclusion of filling of Panels 3 – 6 a choice of actions is anticipated:

- The approved panel closure design will be installed in Panels 1 – 6. In panels 1 and 2, the approved closure will be installed outside of the existing explosion isolation walls.

- If it is determined from the cumulative monitoring data from panels 3 – 6 that there is no significant build up of flammable gases, then it is anticipated that the Permittees will submit an additional PMR to allow those panels to be closed with no further installations, i.e. to retain the bulkheads as the final panel closures.

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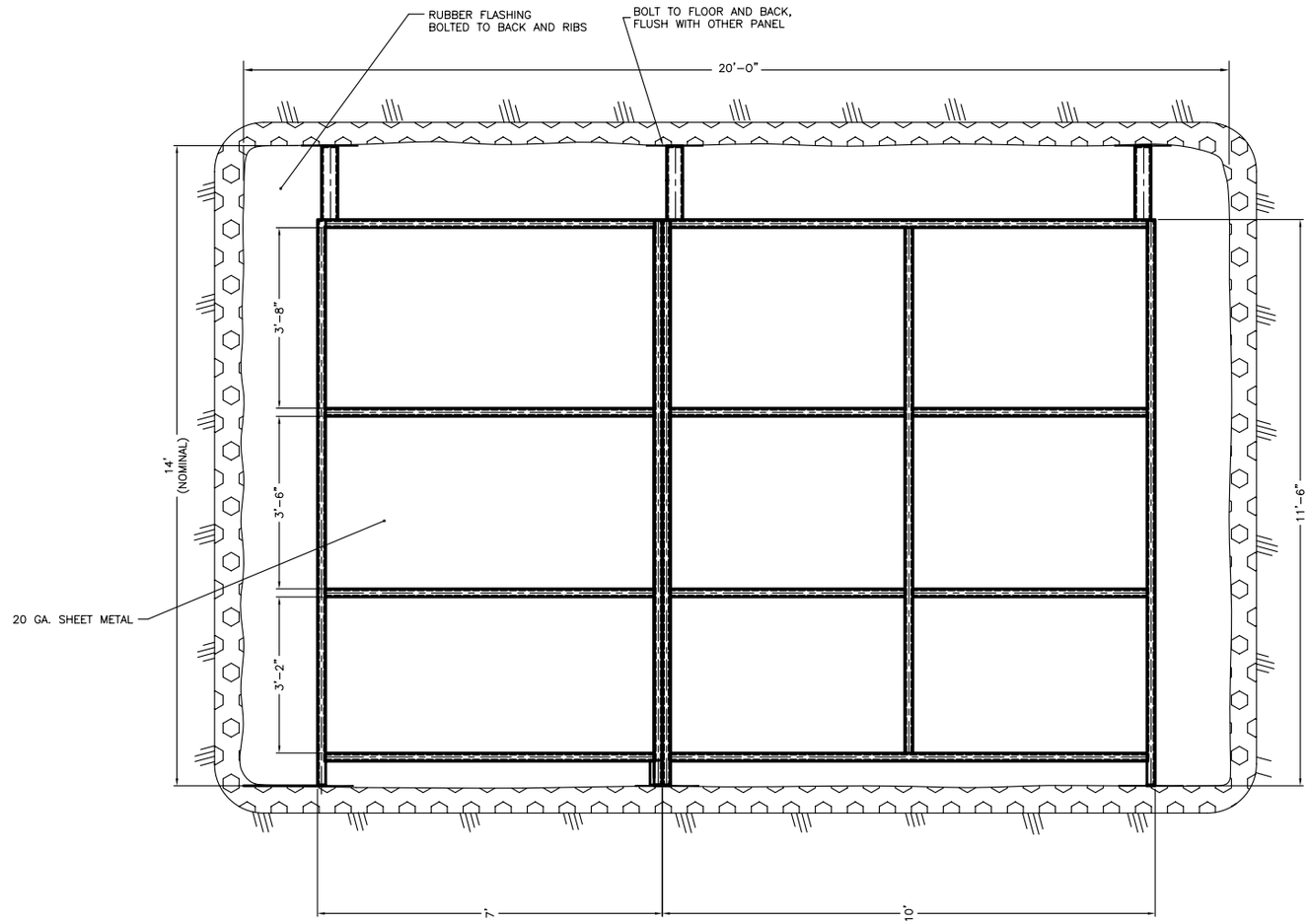
Figure 1

Typical Bulkhead Design



TYPICAL BULKHEAD

NOTE: 1) The joining of the two modular pieces (the 10' & 7' sections) should be sealed with taped foam similar to what is used around mandoors.

2) All framing will be covered with 20 guage sheet metal.

3) Rubber belt or other suitable material will be used to seal from the frame to the back, floor and ribs.

NOTES

1. ALL DIMENSIONS INDICATED ARE NOMINAL DUE TO ACCESS LIMITATIONS. ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE NOTED.

REFERENCE DRAWINGS

U.S DEPARTMENT OF ENERGY

Washington TRU Solutions

Waste Isolation Pilot Plant **Carlsbad, New Mexico**

SYSTEM	WBS	DWG TYPE	CL	VENDOR

PANEL NO

SKETCH #

REV	ISSUE DESCRIPTION	DFTR	CHKR	COG	DM	ECO	PWR
NEW	ADDED PER ECO						

THIS DWG TAKEN FROM: N/A

VENDOR: N/A